

PRACTICAL

# ELECTRONICS

FEBRUARY 1973

20p

## P.E. SOUND SYNTHESIZER



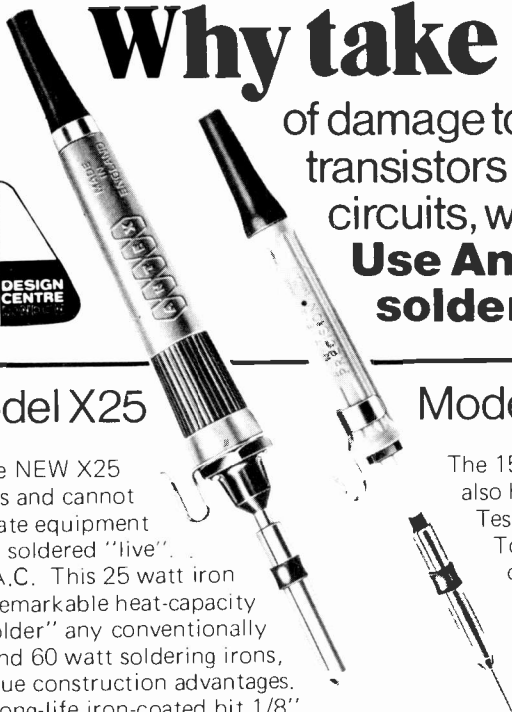
**FREE** **INSIDE**  
**CAPACITOR IDENTICHART**

P.E. TRIFFID  
**LATEST DESIGN!**  
SIMPLE I.C. RADIO

# Why take the risk?

of damage to expensive transistors and integrated circuits, when soldering?

**Use Antex low-leakage soldering irons**



220-240 Volts or  
100-120 Volts

## Model X25

The leakage current of the NEW X25 is only a few microamps and cannot harm the most delicate equipment even when soldered "live".

Tested at 1500v. A.C. This 25 watt iron with its truly remarkable heat-capacity will easily "out-solder" any conventionally made 40 and 60 watt soldering irons, due to its unique construction advantages.

Fitted long-life iron-coated bit 1/8".  
**2 other bits available 3/32" and 3/16".**

Totally enclosed element in ceramic and steel shaft Bits do not "freeze" and can easily be removed

PRICE: £1.75 (rec. retail)  
Suitable for production work and as a general purpose iron

## Model CCN

220 volts or 240 volts

The 15 watt miniature model CCN. also has negligible leakage.

Test voltage 4000v. A.C.

Totally enclosed element in ceramic shaft. Fitted long-life iron-coated bit 3/32"

**4 other bits available 1/8", 3/16" 1/4" and 1/16"**

PRICE: £1.80 (rec. retail)

OR Fitted with triple-coated, (iron, nickel and Chromium) bit 1/8"

PRICE: £1.95 (rec. retail)

### A SELECTION OF OTHER SOLDERING EQUIPMENT.



#### MODEL CN

Miniature 15 watt soldering iron fitted 3/32" iron-coated bit. Many other bits available from 3/64" to 3/16". Voltages 240, 220, 110, 50 or 24  
PRICE: £1.70 (rec. retail)

#### MODEL CN2

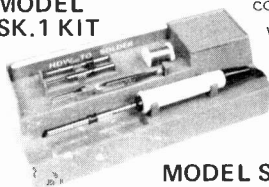
Miniature 15 watt soldering iron fitted with nickel plated bit 3/32". Voltages 240 or 220.  
PRICE: £1.70 (rec. retail)



#### MODEL G

18 Watt miniature iron, fitted with long life iron-coated bit 3/32". Voltages 240, 220 or 110.  
PRICE: £1.83 (rec. retail)

#### MODEL SK.1 KIT

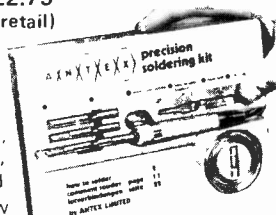


contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder, stand and "How to Solder" booklet.

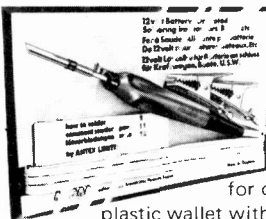
PRICE £2.75  
(Rec. retail)

#### MODEL SK.2 KIT

contains 15 Watt miniature iron fitted with 3/16" bit, 2 spare bits 5/32" and 3/32", heat sink, solder and booklet "How to Solder"



PRICE £2.40  
(Rec. retail)



#### MODEL MES. KIT

Battery-operated 12v. 25 watt iron fitted with 15' lead and 2 heavy clips for connection to car battery. Packed in strong plastic wallet with booklet "How to Solder."  
PRICE £1.95  
(Rec. retail)



From radio or electrical dealers, car accessory shops or, in case of difficulty direct from:—  
**ANTEX LTD. FREEPOST**  
(no stamp required) **Plymouth**  
**PL1 1BR** Tel: 0752 67377

- Please send the ANTEX colour catalogue.  
 Please send the following:

I enclose cheque/P.O./Cash  
(Giro No. 2581000)

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

PE2

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VOLUME 9 No. 2 FEBRUARY 1973

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**Our March issue will be published on Friday, February 9, 1973**

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# The revolutionary new Supertester 680R.

Buy it for what it is.  
Or buy it for what it can be.

The Supertester 680R is a completely new concept in measuring instruments. In itself a high quality test meter with eighty ranges on a 128mm mirror backed scale. It is also the basis of a complete measurement system. With the addition of the appropriate accessories it can measure a wide range of values including light, temperature, gauss and phase sequence. And there are other accessories to greatly extend the 680R's range. The 680R System offers many advantages over conventional test meters including tremendous versatility and economy.

ACCESSORIES TO CONVERT THE SUPERTESTER 680R TO THE FOLLOWING:

### Amperclamp



For measuring a.c. currents from 250mA to 500A £11.95

### Signal Injector

Producing 1kHz and 500kHz signals £5.95

### Temperature Probe

Covering the range 30°C to -200°C £11.95

### Gauss Meter

For measuring magnetic field strengths £11.95

### Phase Sequence Indicator

To indicate the phase sequence of a 3-phase supply £5.95



### Electronic Voltmeter

input resistance 11MΩ £18.00

### Transistor Tester

For transistors and diodes £11.00



SUPERTESTER 680R SPECIFICATION:

13 d.c. ranges from 0.1 to 2000V  
12 ranges from 0.1 to 5A  
20,000Ω/V Accuracy  
1% 11 a.c. ranges from 2 to 250V  
10 ranges from 250μA to 5A  
4,000Ω/V Accuracy  
2% Resistance: 6 ranges from 0.5Ω to 100MΩ  
Reactance: 1 range of 0-10M  
Frequency: 2 ranges of 0-50 and 0-5000Hz  
Output Volts: 9 ranges from 10 to 2000V  
Decibels: 10 ranges from 24 to -70dB  
Capacitance: 6 ranges 4 ranges from 20 to 20,000mF from internal battery and 2 ranges from 50,000 to 500,000pF using mains  
£18.50 complete with case and probes

SHUNTS D.C. 25, 50 AND 100A £4.50 each. CURRENT TRANSFORMERS A.C. 25 AND 100A £7.00 each. E.H.T. PROBE Extends d.c. voltage to 25,000V. £5.95  
ELECTRONIC BROKERS LTD 49-53 Pancras Rd., London NW1 2QB. Tel. 01-837 7781

# EXCLUSIVE STEREO SYSTEM

## LASKYS Super New Year Offer

Lasky's bring the pleasure of real stereo to you this New Year at an unbeatable bargain price - with the exclusive RIGONDA "Electroacoustic" stereo system. This tremendous quality system comprises two RIGONDA combined amplifier/speaker units (each containing bass and treble speakers) housed in handsome teak veneer cabinets, with brushed aluminium grille panel. All controls including bass, treble, and volume together with input sockets etc., are neatly inset at side of cabinet. The system is completed by an attractive B.S.R. 4 speed Auto-record changer with cartridge and sapphire stylus, styrene plinth and tinted cover. The RIGONDA Stereo system will bring all the magic of stereo to your home with rich tone and ample six watts (max each unit) output power. Size - each RIGONDA: 23 x 10 1/2 x 9 1/2 in. Player size: 13 1/2 x 8 x 5 1/2 in. All units AC mains operated. RIGONDA units may also be used singly to provide enhanced sound and power from Transistor Radio sets, mono tape recs. and record players with suitable output. 9V DC output provided to power radio or cassette recorder. Complete with all leads etc. Fully guaranteed. DEFINITELY THE STEREO BARGAIN OF THE YEAR ORIGINAL LIST VALUE OF THE SYSTEM AS OFFERED OVER £46.00!  
**COMPLETE STEREO SYSTEM - NO EXTRAS**



LASKYS SUPER  
NEW YEAR  
OFFER PRICE

**ONLY £29.75**

C & P  
£1.25.

RIGONDA units are available separately for use with existing equipment or any record player of your choice £11.50 each - C & P 50p or £22.00 per pair - C & P 85p.

See Laskys full page advertisement for addresses

# THIS IS THE FIRST PAGE OF THE GREAT BI-PAK SECTION

## BRAND NEW FULLY GUARANTEED DEVICES

AC107	0 20	AD162	0 38	BC148	0 10	BD137	0 45	BF188	0 40	OC19	0 35	2G371	0 16	2N2219	0 20	2N3054	0 48	2N4059	0 10
AC113	0 20	AD161 &		BC149	0 12	BD138	0 40	BF194	0 12	OC20	0 63	2G371B	0 12	2N2220	0 22	2N3055	0 50	2N4060	0 12
AC115	0 23	AD162 (MP)		BC150	0 18	BD139	0 50	BF195	0 12	OC22	0 38	2G373	0 17	2N2221	0 20	2N3091	0 14	2N4061	0 12
AC117K	0 20			BC151	0 20	BD140	0 60	BF196	0 14	OC23	0 42	2G374	0 17	2N2222	0 20	2N3091A	0 16	2N4062	0 12
AC122	0 12	ADT140	0 50	BC152	0 17	BD165	0 80	BF197	0 14	OC24	0 56	2G377	0 30	2N2268	0 17	2N3392	0 14	2N4284	0 12
AC126	0 17	AF114	0 24	BC153	0 28	BD175	0 80	BF200	0 45	OC25	0 38	2G378	0 16	2N2389	0 14	2N3393	0 14	2N4285	0 12
AC128	0 17	AF115	0 24	BC154	0 30	BD176	0 80	BF222	0 95	OC26	0 25	2G381	0 18	2N2390A	0 14	2N3394	0 14	2N4286	0 17
AC127	0 17	AF116	0 24	BC157	0 18	BD177	0 65	BF257	0 45	OC28	0 50	2G382	0 16	2N2411	0 24	2N3395	0 17	2N4287	0 17
AC128	0 17	AF117	0 24	BC158	0 12	BD178	0 65	BF258	0 80	OC29	0 50	2G401	0 30	2N2412	0 24	2N3402	0 21	2N4288	0 17
AC132	0 14	AF118	0 25	BC159	0 12	BD179	0 70	BF259	0 85	OC30	0 42	2G414	0 30	2N2646	0 47	2N3403	0 21	2N4289	0 17
AC134	0 14	AF124	0 30	BC160	0 45	BD180	0 70	BF262	0 55	OC36	0 50	2G417	0 25	2N2711	0 21	2N3404	0 28	2N4290	0 17
AC137	0 14	AF125	0 25	BC161	0 50	BD185	0 85	BF263	0 55	OC41	0 20	2N388	0 35	2N2712	0 21	2N3405	0 42	2N4291	0 17
AC141	0 14	AF126	0 28	BC167	0 12	BD186	0 85	BF270	0 35	OC42	0 24	2N388A	0 35	2N2714	0 21	2N3414	0 15	2N4292	0 17
AC141K	0 17	AF127	0 28	BC168	0 12	BD187	0 70	BF271	0 30	OC44	0 15	2N404	0 20	2N2904	0 17	2N3415	0 15	2N4293	0 17
AC142	0 14	AF129	0 30	BC169	0 12	BD188	0 70	BF272	0 30	OC45	0 12	2N404A	0 24	2N2904A	0 21	2N3416	0 28	2N4294	0 12
AC142K	0 17	AF128	0 30	BC170	0 12	BD189	0 75	BF273	0 35	OC70	0 10	2N524	0 45	2N2905	0 21	2N3417	0 28	2N4295	0 12
AC151	0 15	AF179	0 50	BC171	0 14	BD190	0 75	BF274	0 35	OC71	0 10	2N527	0 49	2N2905A	0 21	2N3525	0 75	2N4588	0 32
AC154	0 20	AF180	0 50	BC172	0 14	BD195	0 85	BFW10	0 27	OC72	0 14	2N598	0 42	2N2906	0 15	2N3642	0 09	2N4589	0 40
AC155	0 20	AF181	0 45	BC173	0 14	BD196	0 85	BFX29	0 67	OC74	0 14	2N599	0 45	2N2906A	0 18	2N3646	0 10	2S301	0 50
AC156	0 20	AF186	0 45	BC174	0 14	BD197	0 90	BFX84	0 22	OC75	0 15	2N696	0 12	2N2907	0 20	2N3703	0 10	2S302A	0 42
AC157	0 24	AF239	0 37	BC175	0 22	BD198	0 90	BFX85	0 30	OC76	0 15	2N697	0 13	2N2907A	0 22	2N3704	0 11	2S302	0 42
AC158	0 20	AL102	0 65	BC177	0 19	BD199	0 95	BFX86	0 22	OC77	0 25	2N698	0 24	2N2922	0 14	2N3705	0 10	2S303	0 55
AC166	0 20	AS162	0 24	BC178	0 19	BD200	0 95	BFX87	0 24	OC81	0 15	2N699	0 45	2N2924	0 10	2N3706	0 28	2S304	0 70
AC167	0 20	AS126	0 25	BC179	0 19	BD205	0 80	BFX88	0 22	OC81D	0 15	2N706	0 28	2N2925	0 14	2N3707	0 11	2S305	0 84
AC168	0 24	AS127	0 30	BC180	0 24	BD206	0 80	BFY50	0 20	OC82	0 15	2N706A	0 09	2N2926 (G)	0 12	2N3708	0 07	2S306	0 84
AC169	0 14	AS128	0 25	BC181	0 24	BD207	0 85	BFY51	0 20	OC82D	0 15	2N708	0 12	2N2926 (Y)	0 12	2N3709	0 09	2S307	0 84
AC170	0 20	AS129	0 25	BC182	0 10	BD208	0 85	BFY52	0 20	OC83	0 20	2N711	0 30	2N2926 (V)	0 11	2N3710	0 09	2S321	0 56
AC177	0 24	AS130	0 25	BC182L	0 10	BDY20	1 00	BFY53	0 17	OC84	0 20	2N717	0 35	2N2926 (O)	0 11	2N3711	0 09	2S322	0 42
AC178	0 20	AS131	0 25	BC183	0 10	BF115	0 24	BFY54	0 15	OC85	0 20	2N718	0 24	2N2926 (R)	0 10	2N3712	0 28	2S322A	0 42
AC179	0 28	AS132	0 25	BC183L	0 10	BF117	0 45	BFX19	0 35	OC86	0 20	2N718A	0 50	2N2926 (B)	0 10	2N3713	0 28	2S323	0 56
AC180	0 17	AS154	0 25	BC184	0 12	BF118	0 70	BFX20	0 15	OC169	0 25	2N726	0 28	2N2926 (A)	0 10	2N3714	0 28	2S324	0 70
AC180K	0 20	AS156	0 25	BC184L	0 12	BF119	0 70	BFX21	0 15	OC170	0 25	2N727	0 28	2N2926 (C)	0 10	2N3715	0 28	2S325	0 70
AC181	0 17	AS156	0 25	BC186	0 28	BF121	0 45	BFX22	0 15	OC171	0 25	2N743	0 20	2N2926 (B)	0 10	2N3903	0 28	2S326	0 70
AC181K	0 20	AS157	0 25	BC187	0 28	BF123	0 60	BFX23	0 15	OC200	0 25	2N744	0 20	2N2926 (D)	0 10	2N3904	0 30	2S327	0 70
AC187	0 22	AS158	0 25	BC207	0 11	BF125	0 45	BFX24	0 15	OC201	0 28	2N914	0 14	2N3010	0 70	2N3905	0 28	2S371	0 42
AC187K	0 20	AS159	0 40	BC208	0 10	BF127	0 45	BFX25	0 15	OC202	0 28	2N918	0 14	2N3011	0 14	2N3906	0 27	40361	0 40
AC188	0 22	AS160	0 09	BC209	0 12	BF152	0 55	BFX26	0 18	OC203	0 25	2N929	0 21	2N3053	0 17	2N4058	0 12	40362	0 45
AC188K	0 20	BC108	0 09	BC212L	0 11	BF153	0 45	BFX29	0 18	OC204	0 25	2N930	0 21						
AC197	0 25	BC109	0 10	BC213L	0 11	BF154	0 45	BFX40	0 28	OC205	0 35	2N131	0 20						
AC198	0 20	BC113	0 10	BC214L	0 14	BF155	0 70	BFX41	0 28	OC309	0 40	2N132	0 22						
AC199	0 20	BC114	0 15	BC225	0 25	BF156	0 48	BFX95A	0 12	P346A	0 20	2N1302	0 14						
AC200	0 20	BC115	0 15	BC226	0 35	BF157	0 55	BFX95A	0 12	P347	0 42	2N1303	0 14	AA119	0 08	BY133	0 21	OA10	0 35
AC201	0 20	BC116	0 15	BCY30	0 24	BF158	0 55	Bu105	0 30	OCPT1	0 35	2N1304	0 17	AA120	0 08	BY164	0 50	OA47	0 07
AC202	0 18	BC117	0 15	BCY31	0 28	BF159	0 60	CU11E	0 50	ORP12	0 43	2N1305	0 17	AA129	0 08	BYX38/30	0 50	OA70	0 07
AC207	0 18	BC118	0 10	BCY32	0 30	BF160	0 40	C400	0 30	ORP40	0 40	2N1306	0 21	AA130	0 09	BYZ10	0 42	OA79	0 07
AC208	0 19	BC119	0 30	BCY33	0 22	BF162	0 40	C407	0 25	ORP61	0 40	2N1307	0 21	AA131	0 10	BYZ10	0 35	OA81	0 07
AC209	0 35	BC120	0 30	BCY34	0 25	BF163	0 40	C424	0 20	RT140	0 12	2N1308	0 23	BA100	0 10	BYZ11	0 30	OA85	0 09
AC230	0 28	BC125	0 12	BCY70	0 14	BF164	0 40	C425	0 50	RT141	0 17	2N1309	0 23	BA116	0 21	BYZ12	0 30	OA90	0 06
AC231	0 28	BC126	0 18	BCY71	0 18	BF165	0 40	C426	0 35	TS143	0 30	2N1613	0 20	BA126	0 22	BYZ13	0 25	OA91	0 06
AC234	0 21	BC132	0 12	BCY72	0 14	BF167	0 22	C428	0 20	UT16	0 27	2N1711	0 30	BA148	0 14	BYZ16	0 40	OA95	0 07
AC235	0 28	BC133	0 18	BCY73	0 20	BF173	0 22	C441	0 30	2C301	0 09	2N1889	0 32	BA154	0 12	BYZ17	0 35	OA200	0 06
AC236	0 28	BC135	0 12	BCZ11	0 25	BF176	0 35	C442	0 30	2C302	0 19	2N1890	0 45	BA155	0 14	BYZ18	0 35	OA202	0 07
AC240	0 17	BC136	0 15	BCZ12	0 25	BF177	0 35	C444	0 35	2C303	0 19	2N1893	0 37	BA156	0 13	BYZ19	0 28	SD10	0 05
AC241	0 18	BC137	0 15	BD121	0 60	BF178	0 30	C450	0 28	2C304	0 24	2N2147	0 72	BY100	0 15	CG62	0 28	SD19	0 05
AC244	0 35	BC139	0 40	BD123	0 65	BF179	0 30	MAT100	0 19	2C306	0 40	2N2148	0 57	BY101	0 12	(EG) OA91	0 05	IN34	0 07
AD130	0 38	BC140	0 40	BD124	0 60	BF180	0 30	MAT101	0 20	2C308	0 35	2N2160	0 60	BY105	0 17	CG65	0 05	IN34A	0 07
AD140	0 48	BC141	0 30	BF181	0 50	BF181	0 30	MAT120	0 19	2C309	0 35	2N2192	0 35	BY114	0 12	CG651	0 50	IN914	0 06
AD142	0 48	BC142	0 30	BF182	0 60	BF182	0 40	MAT121	0 20	2C339	0 20	2N2193	0 35	BY126	0 14	(E7) OA70	0 05	IN918	0 06
AD143	0 38	BC143	0 30	BF183	0 65	BF183	0 40	MFF102	0 42	2C339A	0 18	2N2194	0 35	BY127	0 15	OA79	0 08	IN414B	0 06
AD149	0 50	BC145	0 45	BD135	0 40	BF184	0 25	MFF104	0 37	2G344	0 18	2N2217	0 22	BY128	0 15	OA5	0 35	IR021	0 10
AD161	0 33	BC147	0 10	BD136	0 40	BF185	0 30	MFF105	0 37	2G345	0 16	2N2218	0 20	BY130	0 18	OA58L	0 21	IR951	0 08

### DIODES AND RECTIFIERS

AA119	0 08	BY133	0 21	OA10	0 35
AA120	0 08	BY164	0 50	OA47	0 07
AA129	0 08	BYX38/30	0 50	OA70	0 07
AA130	0 09	BYZ10	0 42	OA79	0 07
AA131	0 10	BYZ10	0 35	OA81	0 07
BA100	0 10	BYZ11	0 30	OA85	0 09
BA116	0 21	BYZ12	0 30	OA90	0 06
BA126	0 22	BYZ13	0 25	OA91	0 06
BA148	0 14	BYZ16	0 40	OA95	

# The largest selection

## NEW LOW PRICE TESTED S.C.R.'s

PIV 1A	3A	5A	5A	7A	10A	16A	30A
TO5	TO66	TO68	TO64	TO48	TO48	TO49	TO48
50	0.25	0.25	0.35	0.47	0.50	0.53	1.15
100	0.25	0.33	0.47	0.47	0.50	0.58	1.40
200	0.35	0.37	0.49	0.49	0.57	0.61	1.60
400	0.43	0.47	0.56	0.56	0.67	0.75	0.93
600	0.53	0.57	0.68	0.68	0.77	0.97	1.25
800	0.63	0.70	0.80	0.80	0.90	1.20	1.50

## SIL. RECTS. TESTED

PIV 300mA	750mA	TA	1.5A	3A	10A	30A
50	0.04	0.05	0.05	0.07	0.14	0.21
100	0.04	0.05	0.05	0.13	0.16	0.23
200	0.05	0.09	0.06	0.14	0.20	0.24
400	0.06	0.13	0.07	0.20	0.27	0.37
600	0.07	0.16	0.10	0.20	0.34	0.45
800	0.10	0.17	0.11	0.25	0.37	0.55
1000	0.11	0.25	0.14	0.30	0.46	0.63
1200	—	0.33	—	0.38	0.67	0.75

## TRIACS

VBOM 2A	6A	10A
TO-1	TO-68	TO-88
\$p	\$p	\$p
100	30	50
200	80	60
400	70	75

## DIACS

FOR USE WITH TRIACS
BR100 (D32) 37p each
<b>FREE</b>
One 50p Pak of your own choice free with orders valued £4 or over.

## BRAND NEW TEXAS GERM. TRANSISTORS

Coded and Guaranteed

Pak No.	EQVT
T1	8 2G3713 OC71
T2	8 D1374 OC75
T3	8 D1216 OC81D
T4	8 2G381T OC81
T5	8 2G382T OC82
T6	8 2G344B OC94
T7	8 2G345B OC45
T8	8 2G378 OC78
T9	8 2G399A 2N1302
T10	8 2G417 AF117

2N2060 NPN SIL. DUAL TRANS. CODE D1699 TEXAS. Our price 25p each.

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GENERAL PURPOSE GERM. PNP Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.—OC25-28-29-30-36-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCB0 80V VCEO 60V IC 10A PT. 30 WATTS Hfe 30-170.

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10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 90p each

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Plastic Encapsulated 2 amp. BRIDGE RECTS. 50 v RMS 32p each 100 v RMS 37p .. 400 v RMS 46p .. Size 15 mm x 6 mm.

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SIM. TO 2N700/8, BSY-27/28/95A. All usable devices no oven or other circuits. ALSO AVAILABLE IN PNP 8im. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

20	For	0.50
50	For	1.00
100	For	1.75
500	For	7.50
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## SIL. G.P. DIODES 5p

300mW 30. 0.50 40PIV (Min.) 100. 1.50 Sub-Min. 500. 5.00 Full Tested 1,000. 9.00 Ideal for Organ Builders.

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2N3055 115 WATT SIL. POWER NPN 50p EACH

SILICON 50 WATTS MATCHED NPN/PNP BIP 19 NPN TO-3 Plastic. BIP 20 PNP. Brand new. VCEO 100V VCEO 50V IC 10A. HFE type 100/IT 3mHz. OUR PRICE PER PAIR: 1-24 prs. 60p 25-99 prs. 55p 100 prs. 50p

## KING OF THE PAKS Unequalled Value and Quality

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Satisfaction GUARANTEED In Every Pak, or money back.

Pak No.	Description	Price
U 1	120 Glass Sub-Min. General Purpose Germanium Diodes	0.50
U 2	60 Mixed Germanium Transistors A/RF	0.50
U 3	75 Germanium Gold Bonded Sub-Min. like OA5, OA47	0.50
U 4	40 Germanium Transistors like OC81, AC128	0.50
U 5	60 200mA Sub-Min. Silicon Diodes	0.50
U 6	30 Sil. Planar Trans. NPN like BBT95A, 2N706	0.50
U 7	16 Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000V	0.50
U 8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	0.50
U 9	20 Mixed Voltages, 1 Watt Zener Diodes	0.50
U10	20 BAY50 charge storage Diodes DO-7 Glass	0.50
U11	25 PNP Sil. Planar Trans. TO-5 like 2N1152, 2N2904	0.50
U12	12 Silicon Rectifiers Epoxy 600mA up to 800 PIV	0.50
U13	30 PNP-NPN Sil. Transistors OC200 & 28 104	0.50
U14	150 Mixed Silicon and Germanium Diodes	0.50
U15	25 NPN Sil. Planar Trans. TO-5 like BFY51, 2N697	0.50
U16	10 3 Amp Silicon Rectifiers Stud Type up to 1000PIV	0.50
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	0.50
U18	8 8 Amp Silicon Rectifiers B7Z13 Type up to 600 PIV	0.50
U19	25 Silicon NPN Transistors like BC108	0.50
U20	12 1.5 Amp Silicon Rectifiers Top Hat up to 1000 PIV	0.50
U21	30 AF Germanium Alloy Transistors 26300 Series & OC71	0.50
U22	30 MDT's like MHz Series PNP Transistors	0.50
U23	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0.50
U24	25 300 MHz NPN Silicon Transistors 2N708, BSY27	0.50
U25	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	0.50
U26	12 NPN Germanium AF Transistors TO-1 like AC127	0.50
U27	10 1 Amp SCR's TO-5 can, up to 600 PIV CR81/25-600	1.00
U30	15 Plastic Silicon Planar Trans. NPN 2N2926	0.50
U31	20 Silicon Planar Plastic NPN Trans. Low Noise Amp 2N3707	0.50
U32	25 Zener Diodes 400mW DO-7 case 3-18 volts mixed	0.50
U33	15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	0.50
U34	30 Silicon PNP Alloy Trans. TO-5 BCY26 28302/4	0.50
U35	25 Silicon Planar Transistors PNP TO-18 2N2906	0.50
U36	25 Silicon Planar NPN Transistors TO-5 BFY50/51/52	0.50
U37	30 Silicon Alloy Transistors 80-2 PNP OC200, 28322	0.50
U38	20 Fast Switching Silicon Trans. NPN 400 MHz 2N3011	0.50
U39	30 RF. Germ. PNP Transistors 2N1302/5 TO-5	0.50
U40	10 Dual Transistors 6 lead TO-5 2N2600	0.50
U41	25 RF Germanium Transistors TO-5, OC45, NKT72	0.50
U42	10 VHF Germanium PNP Transistors TO-1 NKT687, AF117	0.50
U43	25 Sil. Trans. Plastic TO-18 A.F. BC113/114	0.50
U44	20 Sil. Trans. Plastic TO-5 BC115/NPN	0.50
U45	7 3A SCR. TO66 up to 600PIV	1.00

Code No's. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

SILICON PHOTO TRANSISTOR. TO-18 Lens end NPN Sim. to BP x25 and P21. BRAND NEW. Full data available. Fully guaranteed. Qty. 1-24 25-99 100 up Price each 45p 40p 35p

F.E.T.'S	
2N3819	35p 2N8458 50p
2N3820	50p 2N8459 40p
2N3821	35p BFW10 40p
2N3823	30p MPF105 40p

## INTEGRATED CIRCUIT PAKS

Manufacturers "Fall Outs" which include Functional and Part-Functional Units. These are classed as "out-of-spec" from the maker's very rigid specifications, but are ideal for learning about IC's and experimental work.

Pak No.	Contents	Price
UIC00	-12 x 7400	0.50
UIC01	-12 x 7401	0.50
UIC02	-12 x 7402	0.50
UIC03	-12 x 7403	0.50
UIC04	-12 x 7404	0.50
UIC05	-12 x 7405	0.50
UIC06	-8 x 7406	0.50
UIC07	-8 x 7407	0.50
UIC10	-12 x 7410	0.50
UIC13	-8 x 7413	0.50
UIC20	-12 x 7420	0.50
UIC30	-12 x 7430	0.50
UIC40	-12 x 7440	0.50
UIC41	-5 x 7441	0.50
UIC42	-5 x 7442	0.50
UIC43	-5 x 7443	0.50
UIC44	-5 x 7444	0.50
UIC45	-5 x 7445	0.50
UIC46	-5 x 7446	0.50
UIC47	-5 x 7447	0.50
UIC48	-5 x 7448	0.50
UIC50	-12 x 7450	0.50
UIC51	-12 x 7451	0.50
UIC53	-12 x 7453	0.50
UIC54	-12 x 7454	0.50
UIC56	-5 x 7460	0.50
UIC70	-8 x 7470	0.50
UIC72	-8 x 7472	0.50
UIC73	-8 x 7473	0.50
UIC74	-8 x 7474	0.50
UIC75	-8 x 7475	0.50
UIC76	-8 x 7476	0.50
UIC80	-5 x 7480	0.50
UIC81	-5 x 7481	0.50
UIC82	-5 x 7482	0.50
UIC83	-5 x 7483	0.50
UIC86	-5 x 7486	0.50
UIC89	-5 x 7489	0.50
UIC91	-5 x 7491	0.50
UIC92	-5 x 7492	0.50
UIC93	-5 x 7493	0.50
UIC94	-5 x 7494	0.50
UIC95	-5 x 7495	0.50
UIC96	-5 x 7496	0.50
UIC100	-5 x 74100	0.50
UIC121	-5 x 74121	0.50
UIC141	-5 x 74141	0.50
UIC151	-5 x 74151	0.50
UIC154	-6 x 74154	0.50
UIC193	-5 x 74193	0.50
UIC199	-5 x 74199	0.50
UICX1	-25 Assorted	74's 1.50

Packs cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

## QUALITY TESTED SEMICONDUCTORS

Pak No.	Description	Price
Q1	20 Red spot transistors PNP	0.50
Q2	16 White spot R.F. transistors PNP	0.50
Q3	4 OC 77 type transistors	0.50
Q4	6 Matched transistors OC44/45/81/81D	0.50
Q5	4 OC 75 transistors	0.50
Q6	5 OC 72 transistors	0.50
Q7	4 AC 128 transistors PNP high gain.	0.50
Q8	4 AC 126 transistors PNP	0.50
Q9	7 OC 81 type transistors	0.50
Q10	7 OC 71 type transistors	0.50
Q11	2 AC 127/128 Complementary pairs PNP/NPN	0.50
Q12	3 AF 116 type transistors	0.50
Q13	3 AF 117 type transistors	0.50
Q14	3 OC 171 H.F. type transistors	0.60
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0.50
Q16	2 GBT880 low noise Germanium transistors	0.50
Q17	5 NPN 2 x ST.141 & 3 x ST.140	0.50
Q18	4 MDT'S 2 x MAT 100 & 2 x MAT 120	0.50
Q19	3 MDT'S 2 x MAT 101 & 1 x MAT 121	0.50
Q20	4 OC 44 Germanium transistors A.F.	0.50
Q21	4 AC 127 NPN Germanium transistors	0.50
Q22	20 NKT transistors A.F. R.F. coded	0.50
Q23	10 OA 202 Silicon diodes sub-min.	0.50
Q24	8 OA 81 diodes	0.50
Q25	15 IN914 Silicon diodes 75 PIV 75mA	0.50
Q26	8 OA95 Germanium diodes sub-min IN99	0.50
Q27	2 10A PIV Silicon rectifiers IB425R.	0.50
Q28	2 Silicon power rectifiers BYZ 13	0.50
Q29	4 Silicon transistors 2 x 2N696, 1 x 2N697, 1 x 2N698	0.50
Q30	7 Silicon switch transistors 2N706 NPN	0.50
Q31	6 Silicon switch transistors 2N708 NPN	0.50
Q32	3 PNP Silicon transistors 2 x 2N1131, 1 x 2N1132	0.50
Q33	3 Silicon NPN transistors 2N1711	0.50
Q34	7 Silicon NPN transistors 2N2369, 500MHz (code P397)	0.50
Q35	3 Silicon PNP TO-5, 2 x 2N2904 & 1 2N2905	0.50
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	0.50
Q37	3 2N3053 NPN Silicon transistors	0.50
Q38	7 NPN transistors 4 x 2N3703, 3 x 2N3702	0.50

## ELECTRONIC SLIDE-RULE

The MK Slide Rule, designed to simplify Electronic calculations features the following scales:— Conversion of Frequency and Wavelength. Calculation of L, C and f of Tuned Circuits. Reactance and Self Inductance. Area of Circles. Volume of Cylinders. Resistance of Conductors. Weight of Conductors. Decibel Calculations. Angle Functions. Natural Logs and e Functions. Multiplication and Division. Squaring, Cubing and Square Roots. Conversion of kW and Hp. A must for every electronic engineer and enthusiast. Size: 2 cm x 4cm. Complete with case and instructions. Price each: £3-35



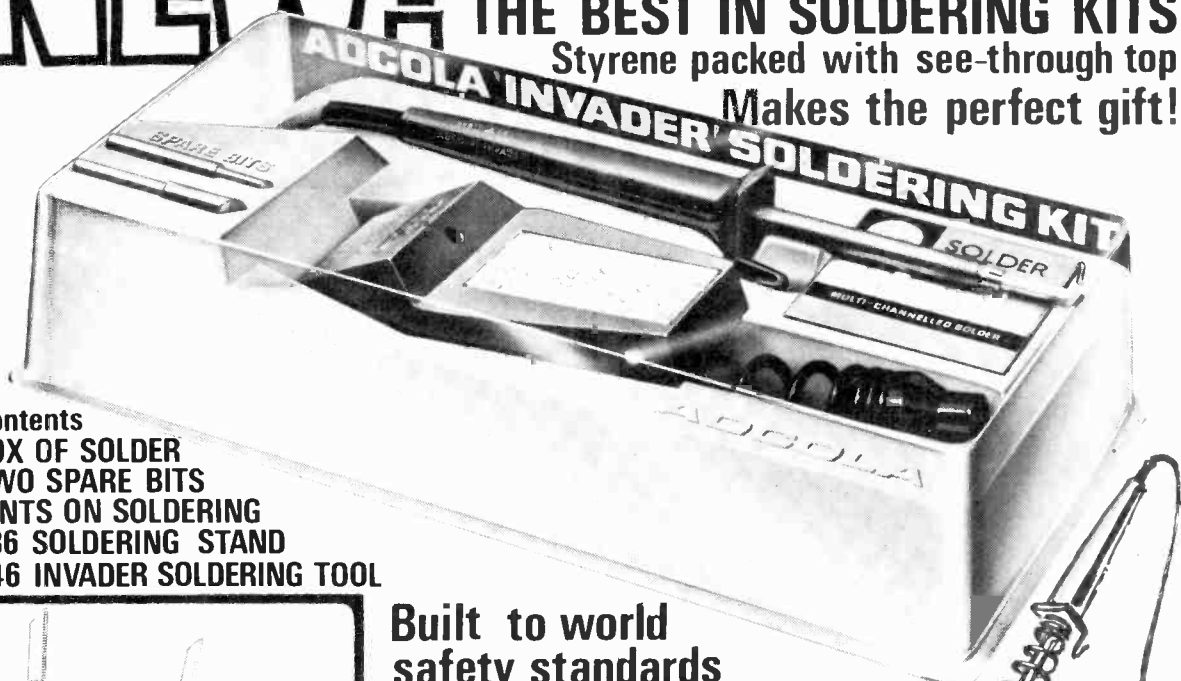




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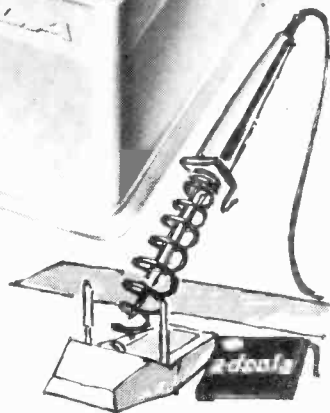


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**646 INVADER SOLDERING TOOL**

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The number one accepted soldering instrument used by the professional in industry. IS NOW ON OFFER TO YOU.

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- L 646 23watts £2.12
- L1076 27watts £2.18

No heat sink required. Stock voltages 110v., 220v. and 230/250v.

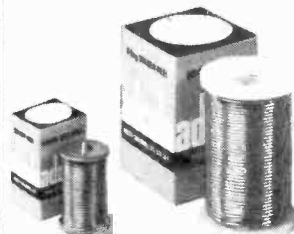
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# Sinclair Project 60



## Active Filter Unit (A.F.U.)

Built and tested post free  
**£5.98**

The value of an efficient filtering system cannot be over emphasized in these days of very high quality reproduction since there are so often occasions where its use can mean the difference between comfortable and uncomfortable listening. On the low pass side the Sinclair A.F.U. will effectively reduce hiss from radio or tape, cut out heterodyne whistles on A.M. reception, greatly reduce record surface noise and other imperfections; on the high-pass side it will cut out motor rumble and other spurious low frequency intrusion. The unit is for use between pre-amp (including tape pre-amps) and power amplifiers, and operates in two sections, both stereo. The cut-off frequencies are continuously variable, and since attenuation in the rejection band is rapid (12dB/octave) there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is as easy to mount as the stereo 60 pre-amp/control unit which it matches in styling, along with the Stereo FM Tuner.

### SPECIFICATIONS

The A.F.U. employs two Sallen and Key type active filter stages, one rumble (high pass) and one scratch (low pass). The two stages use complementary transistors to minimise distortion.

**Supply voltage:** 15 to 35 volts Current 3mA maximum.

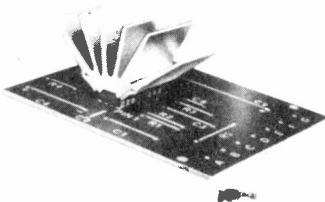
**Gain at 1kHz:** Filters flat 0.98 (-0.2 dB)

**HF cut off:** (-3dB) variable from 28 kHz to 5 kHz at 12 dB/octave.

**LF cut off:** (-3dB) variable from 25 Hz to 100 Hz at 12 dB/octave.

**Distortion:** at 1 kHz (35 volt supply) 0.02% at rated output.

## Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, the first time an IC had ever been made available for such purposes, we have followed it with an even more efficient version, the Super IC.12, a most exciting advance over our original unit. This needs very few external resistors and capacitors to make an astonishingly good high fidelity amplifier for use with 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. It is the equivalent of a 22 tran-

sistor circuit contained within a 16 lead DIL package, and the finned heat sink is sufficient for all requirements. The Super IC.12 is compatible with 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), 6-8Ω. **Frequency Response:** 5Hz to 100KHz ±1dB. **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:** 22x45x28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.  
**£2.98** Post free

## Project 605



The easy way to buy and build Project 60

Project 605 is one pack containing one P25 two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

Everything you need to assemble a superb 30 watt high fidelity stereo amplifier without having to solder.

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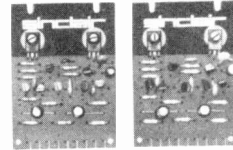
# the world's most advanced high fidelity modules

## Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual **Z.30 £4.48** **Z.50 £5.48**

The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to provide unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and are intended for use principally with other units in the Project 60 range. Their performance and design are such, however, that Z.50s and Z.30 may be used in a far wider range of applications.

**SPECIFICATIONS (Z.50 units are interchangeable with Z.30s in all applications).**— **Power Outputs:** Z.30 15 watts R.M.S. into 8 ohms using 35 volts; 20 watts R.M.S. into 3 ohms using 30 volts Z.50 40 watts R.M.S. into 3 ohms using 40 volts 30 watts R.M.S. into 8 ohms using 50 volts. **Frequency response:** 30 to 300,000Hz ± 1dB. **Distortion:** 0.02% into 8 ohms. **Signal to noise ratio:** better than 70dB unweighted. **Input sensitivity:** 250mV into 100 Kohms (for 15w into 8Ω). For speakers from 3 to 15 ohms impedance. **Size:** 14 x 80 x 57mm.



## Stereo 60 Pre-amp/control unit

Built, tested and guaranteed. **£9.98**

Designed specifically for use on Project 60 systems, the Stereo 60 is equally suitable for use with any high quality power amplifier. Since silicon epitaxial planar transistors are used throughout, a really high signal-to-noise ratio and excellent tracking between channels is achieved. Input selection is by means of press buttons, with accurate equalisation on all input channels. The Stereo 60 is particularly easy to mount.

**SPECIFICATIONS—Input sensitivities:** Radio — up to 3mV. Mag. p.u. 3mV correct to R.I.A.A. curve ± 1dB 20 to 25,000 Hz. 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 -12dB at 10KHz; BASS +12 to -12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.



## Project 60 Stereo F.M. Tuner

Built and tested. Post free. **£25**

The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other advanced features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and switchable squelch circuit for silent tuning between stations. In terms of high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

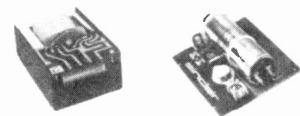
**SPECIFICATIONS—Number of transistors:** 16 plus 20 in I.C. **Tuning range:** 87.5 to 108MHz. **Sensitivity:** 7μV for lock-in over full deviation. **Squelch level:** Typically 20μV. **Signal to noise ratio:** > 65dB. **Audio frequency response:** 10Hz — 15KHz (± 1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. maximum. **Operating voltage:** 25–30VDC. **Indicators:** Stereo on; tuning. **Size:** 93 x 40 x 207mm



## Power Supply Units

Designed specifically for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 or PZ.8 where a stabilised supply is essential.

**PZ.5 30 volts un stabilised £4.98**  
**PZ.6 35 volts stabilised £7.98**  
**PZ.8 45 volts stabilised £7.98**  
*(less mains transformer)*  
**PZ.8 mains transformer £5.98**



### Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	Z.30	Crystal P.U., 12V battery volume control, etc.	<b>£4.48</b>
Mains powered record player	Z.30, PZ.5	Crystal or ceramic P.U. volume control, etc.	<b>£9.45</b>
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.30s, Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	<b>£23.90</b>
25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	2 x Z.30s, Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	<b>£26.90</b>
80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50s, Stereo 60; PZ.8, mains transformer	As above	<b>£34.88</b>
Indoor P.A.	Z.50, PZ.8, mains transformer	Mic., guitar, speakers, etc., controls	<b>£19.43</b>

F.M. Stereo Tuner (**£25**) & A.F.U. (**£5.98**) may be added as required.

## 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 is guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you, if it is returned within two years from the date of purchase. Outside this period of guarantee a small charge (typically £1.00) will be made. No charge is made for postage by surface mail. Air Mail is charged at cost.

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## TRANSISTORS

AC107	15p	AL102	50p	BD116	79p	OC44	13p	TIP33A	85p	2N3711	10p
AC126	11p	AL103	49p	BD121	50p	OC45	13p	TIP34A	£1.80	40251	48p
AC127	11p	AL103	49p	BD131	59p	OC71	12p	2N697	£1.80	40636	55p
AC128	11p	AL103	85p	BF194	15p	OC81	13p	2N1304	25p		
AC128	11p	AL111	85p	BFY50	15p	OC81D	13p	2N1305	25p		
AC176	25p	BC107	8p	BFY51	12p	OC83	20p	2N2646	47p		
AC141K	20p	BC108	8p	BFY95A	15p	OC170	24p	2N2926	10p		
AD14	40p	BC109	8p	ME4042	18p	OC200	25p	2N3053	20p	DIODES	
AD150	44p	BC134	20p	ME4044	14p	OC201	25p	2N3055	48p	IN4001	4p
AD161	M/P 55p	BC168	10p	ME4401	10p	OC235	25p	2N3702	12p	IN4002	4p
AD162	M/P 55p	BC169	11p	ME4102	12p	OC238	30p	2N3703	12p	IN4003	5p
AF114	15p	BC182L	8p	ME6002	14p	OC29	36p	2N3704	12p	IN4004	7p
AF115	15p	BC183L	8p	ME6101	14p	OC35	25p	2N3705	12p	OA90	6p
AF116	15p	BC184L	8p	ME6102	15p	OC36	36p	2N3706	10p	OA200	10p
AF116	15p	BC212L	8p	MP8111	32p	TIP29A	48p	2N3707	10p	OA202	8p
AF117	15p	BC214L	8p	MP8511	34p	TIP30A	55p	2N3708	8p	IS44	10p
				MP8513	45p	TIP31A	58p	2N3709	10p	IN4149	40p
				OC41	13p	TIP32A	69p	2N3710	10p	W02	32p

## CAPACITORS

**MULLARD POLYESTER CAPACITORS C280 SERIES**  
250V P.C. mounting: 0.01µF, 0.015µF, 0.022µF, 3p, 0.033µF, 0.047µF, 0.068µF, 31p, 0.1µF, 4p, 0.15µF, 0.22µF, 5p, 0.33µF, 81p, 0.47µF, 81p, 0.68µF, 11p, 1.0µF, 13p, 1.5µF, 20p, 2.2µF, 2p, 2p.

**MULLARD POLYESTER CAPACITORS C296 SERIES**  
400V, 0.001µF, 0.0015µF, 0.0022µF, 0.0033µF, 0.0047µF, 0.0068µF, 0.01µF, 0.015µF, 0.022µF, 0.033µF, 3p, 0.047µF, 0.068µF, 0.1µF, 4p, 0.15µF, 6p, 0.22µF, 73p, 0.33µF, 11p, 0.47µF, 13p.  
160V: 0.01µF, 0.015µF, 0.022µF, 0.033µF, 0.047µF, 0.068µF, 3p, 0.1µF, 31p, 0.15µF, 41p, 0.22µF, 5p, 0.33µF, 6p, 0.47µF, 73p, 0.68µF, 11p, 1.0µF, 13p.

**ELECTROLYTIC CAPACITORS—MULLARD C426 SERIES** 6p each  
(µF/V) 10/2.5, 20/2.5, 40/2.5, 160/2.5, 320/2.5, 500/2.5, 8/4, 32/4, 64/4, 125/4, 250/4, 400/4, 64/6.4, 25/6.4, 50/6.4, 100/6.4, 200/6.4, 320/6.4, 4/10, 16/10, 32/10, 64/10, 125/10, 200/10, 2.5/16, 10/16, 20/16, 40/16, 80/16, 125/16, 160/16, 320/16, 12.5/25, 25/25, 50/25, 80/25, 160/25, 1/40, 4/40, 8/40, 16/40, 32/40, 50/40, 0.64/64, 2.5/64, 5/64, 10/64, 20/64, 32/64.

**MULLARD C437 SERIES**  
100/40, 160/25, 250/16, 400/10, 640/6.4, 800/4, 1,000/2.5, 9p, 100/64, 160/40, 250/25, 400/16, 640/10, 1,250/4, 1,000/6.4, 1,600/2.5, 12p, 160/64, 250/40, 400/2.5, 640/16, 2,000/4, 1,000/10, 1,600/6.4, 2,500/2.5, 15p, 250/64, 400/40, 640/25, 3,200/4, 1,000/16, 1,600/10, 2,500/6.4, 4,000/2.5, 18p.

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Preferred values from 18pf to 10,000pf.

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301A	DIL	45p
790C	To99	28p
790C	DIL	30p
723C	To99	87p
723C	DIL	90p
741C	To99	30p
741C	DIL	34p
741C	8p in DIL	40p
747C	DIL	40p
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3 1/2in x 3 1/2in		25p		25p
3 1/2in x 5in		30p		29p
Vero Pins (Bag of 36)		20p		
Vero Cutter		45p		
Pin insertion Tools (1 and 15 matrix)		at 55p.		

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SINGLE GANGED, LOG or LIN  
1k to 1M, 40p each.  
TWIN GANGED, LOG or LIN  
1k to 500k, 60p each.

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Pack of 10 BC169 (unmarked) but tested	50p	Pack of 25 IN4148	50p
2N2646 (unmarked) 30p each		Pack of 10 BC108 BC107 (Plastic can)	50p 50p
AC127 & AC128 1-9 10 plus 100 plus	13p 11p 9p	AD161, AD162 M/P	54p 48p
2N2926D (unmarked) but tested	50p	BC107-BC108 BC109	8p 7p 6p
Unmarked but fully tested 2N3055	30p	BC182L-3-4-212-4 1-9 10 plus	8p 7p
1-9 10 plus	25p	Pack of 10 Plastic BC109	50p

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Log or Linear  
Single 12p. Dual gang (stereo) 40p.  
Single type with D.P. switch 12p extra.

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1W 5% carbon 1p each  
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range 27 Ω to 10 M Ω type TR0  
triple rated: 1-1-1, (tin oxide) x 2%  
range 10 Ω to 1 M Ω. 3p each

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10K, 22K, 47K, 100K, 220K, 470K, 1M,  
2M, 4M7, 10M Ω. Vertical or horizontal  
mounting, 6p each.

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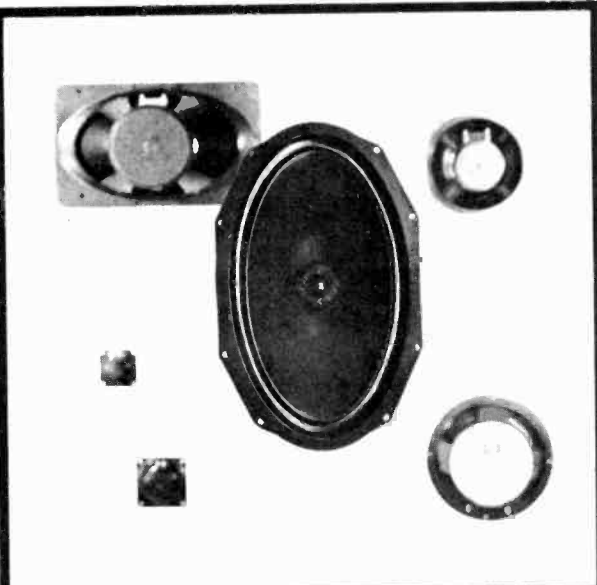
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# SEW PANEL METERS

## CLEAR PLASTIC PANEL METERS

**TYPE SW.100** 100mm x 80mm Fronts

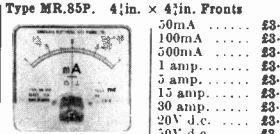
30μA	£2-80
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-70
500μA	£2-50
1mA	£2-40
20V d.c.	£2-40
50V d.c.	£2-40
300V a.c.	£2-40
1 amp. d.c.	£2-40



5 amp. d.c. £2-40  
VU Meter £2-15

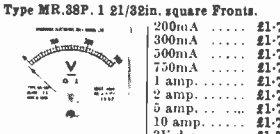
**Type MR.85P.** 4 1/2in. x 4 1/2in. Fronts

50mA	£2-30
100mA	£2-10
500mA	£2-10
1 amp.	£2-10
5 amp.	£2-10
15 amp.	£2-10
30 amp.	£2-20
20V d.c.	£2-10
50V d.c.	£2-10
150V d.c.	£2-10
300V d.c.	£2-10
15V a.c.	£2-10
30V a.c.	£2-10
300V a.c.	£2-10
8 Meter 1mA	£2-15
VU Meter	£2-95
1 amp. a.c.	*£2-10
5 amp. a.c.	*£2-10
10 amp. a.c.	*£2-10
20 amp. a.c.	*£2-10
30 amp. a.c.	*£2-10



**Type MR.38P.** 1 21/32in. square Fronts.


200mA	£1-75
300mA	£1-75
500mA	£1-75
750mA	£1-75
1 amp.	£1-75
2 amp.	£1-75
5 amp.	£1-75
10 amp.	£1-75
3V d.c.	£1-75
10V d.c.	£1-75
15V d.c.	£1-75
20V d.c.	£1-75
100-0-100μA	£1-85
200μA	£1-95
500μA	£1-80
1000-0-1000μA	£1-75
1mA	£1-75
1-0-1mA	£1-75
2mA	£1-75
5mA	£1-75
10mA	£1-75
20mA	£1-75
50mA	£1-75
100mA	£1-75
150mA	£1-75



## "SEW" BAKELITE PANEL METERS

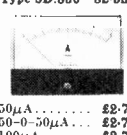
**Type MR.65.** 3 1/2in. square Fronts.

1 amp.	£2-15
5 amp.	£2-15
15 amp.	£2-15
30 amp.	£2-15
5V d.c.	£2-15
10V d.c.	£2-15
20V d.c.	£2-15
50V d.c.	£2-15
150V d.c.	£2-15
300V d.c.	£2-15
500μA	£2-85
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-50
500μA	£2-45
500-0-500μA	£2-15
1mA	£2-15
1-0-1mA	£2-15
10mA	£2-15
100mA	£2-15
50mA	£2-15
100mA	£2-15
500mA	£2-15



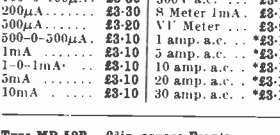
**Type SD.830** 82-5mm x 110mm Fronts

10mA	£2-50
50mA	£2-50
100mA	£2-50
500mA	£2-50
1 amp.	£2-50
5 amp.	£2-50
10 amp.	£2-50
5V d.c.	£2-50
10V d.c.	£2-50
20V d.c.	£2-50
50V d.c.	£2-50
300V d.c.	£2-50
15V a.c.	£2-75
30V a.c.	£2-75
300V a.c.	£2-75
5mA	£2-50
VU Meter	£2-80



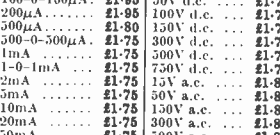
**Type MR.52P.** 2 1/2in. square Fronts.

50μA	£2-40
50-0-50μA	£2-85
100μA	£2-85
100-0-100μA	£2-75
500μA	£2-55
1mA	£2-20
5mA	£2-20
10mA	£2-20
50mA	£2-20
100mA	£2-20
500mA	£2-20
1 amp.	£2-20
5 amp. a.c.	*£2-20
10 amp. a.c.	*£2-20
20 amp. a.c.	*£2-20
30 amp. a.c.	*£2-20



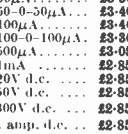
**Type MR.45P.** 2in. square Fronts.

50μA	£2-50
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-05
200μA	£2-05
500μA	£1-95
500-0-500μA	£1-85
1mA	£1-85
5mA	£1-85
10mA	£1-85
50mA	£1-85
100mA	£1-85
150mA	£1-85



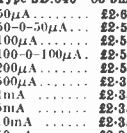
**Type S-80** 80mm square Fronts

50μA	£2-50
50-0-50μA	£2-40
100μA	£2-40
100-0-100μA	£2-80
500μA	£2-05
1mA	£2-85
5 amp. a.c.	£2-85
10 amp. a.c.	£2-85
20 amp. a.c.	£2-85
30 amp. a.c.	£2-85
5V d.c.	£2-85
1 amp. d.c.	£2-85
5 amp. d.c.	£2-85



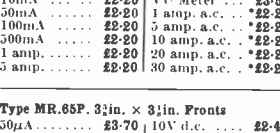
**Type SD.640** 63-5mm x 85mm Fronts

50μA	£2-60
50-0-50μA	£2-55
100μA	£2-55
100-0-100μA	£2-55
200μA	£2-50
500μA	£2-35
1mA	£2-35
5mA	£2-35
10mA	£2-35
50mA	£2-35
100mA	£2-35



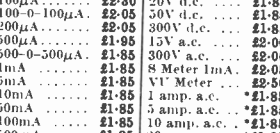
**Type MR.65P.** 3 1/2in. x 3 1/2in. Fronts

50μA	£2-70
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-80
200μA	£2-80
500μA	£2-65
500-0-500μA	£2-40
1mA	£2-40
5mA	£2-40
10mA	£2-40
50mA	£2-40
100mA	£2-40
500mA	£2-40
1 amp.	£2-40
5 amp. a.c.	*£2-40
10 amp. a.c.	*£2-40
20 amp. a.c.	*£2-40
30 amp. a.c.	*£2-40



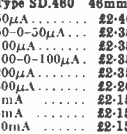
**Type MR.45P.** 2in. square Fronts.

50μA	£2-50
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-05
200μA	£2-05
500μA	£1-95
500-0-500μA	£1-85
1mA	£1-85
5mA	£1-85
10mA	£1-85
50mA	£1-85
100mA	£1-85
150mA	£1-85



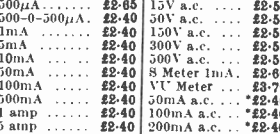
**Type SD.460** 46mm x 59-5mm Fronts

30μA	£2-40
50-0-50μA	£2-35
100μA	£2-35
100-0-100μA	£2-35
200μA	£2-35
500μA	£2-35
1mA	£2-35
5mA	£2-35
10mA	£2-35
50mA	£2-35
100mA	£2-35



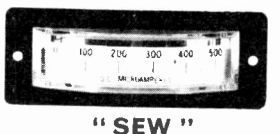
**Type MR.65P.** 3 1/2in. x 3 1/2in. Fronts

50μA	£2-70
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-80
200μA	£2-80
500μA	£2-65
500-0-500μA	£2-40
1mA	£2-40
5mA	£2-40
10mA	£2-40
50mA	£2-40
100mA	£2-40
500mA	£2-40
1 amp.	£2-40
5 amp. a.c.	*£2-40
10 amp. a.c.	*£2-40
20 amp. a.c.	*£2-40
30 amp. a.c.	*£2-40



**Type MR.45P.** 2in. square Fronts.

50μA	£2-50
50-0-50μA	£2-80
100μA	£2-80
100-0-100μA	£2-05
200μA	£2-05
500μA	£1-95
500-0-500μA	£1-85
1mA	£1-85
5mA	£1-85
10mA	£1-85
50mA	£1-85
100mA	£1-85
150mA	£1-85



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**Type PE.70.** 3 1/2in. x 1 15/32in. x 2 1/2in. deep.

50μA	£2-40
50-0-50μA	£2-30
100μA	£2-30
100-0-100μA	£2-20
200μA	£2-20

500μA £2-05  
1mA £2-70  
300V a.c. £2-70  
VU Meter £2-75

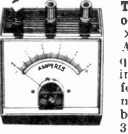
## "SEW" EDUCATIONAL METERS

**Type ED.107.** Size overall 100mm x 90mm x 108mm.

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3in. mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

50μA	£2-50
100μA	£2-50
1mA	£2-85
50-0-50μA	£2-10
1-0-1mA	£2-85
1A d.c.	£2-85
5A d.c.	£2-85

10V d.c. £2-85  
20V d.c. £2-85  
300V d.c. £2-85  
Dual range 500mA/5A d.c. £2-10  
5V/50V d.c. £2-10



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**50 WATT.** 10/25/50/100/250/500/1000/2500 or 5000 ohms. £1-15. P. & P. 7 1/2p.  
**100 WATT.** 1/5/10/25/50/100/250/500/1000 or 2500 ohms. £1-65. P. & P. 7 1/2p.

## "YAMABISHI" VARIABLE VOLTAGE TRANSFORMERS

Excellent quality. Low price. Immediate delivery

<b>S-260 General Purpose Bench Mounting</b>		<b>S-260 Panel Mounting</b>	
1 amp.	£7-00	1 amp.	£7-00
2 1/2 amp.	£8-05	2 1/2 amp.	£8-05
5 amp.	£11-75	Please add postage	
8 amp.	£15-90	ALL MODELS	
10 amp.	£22-50	INPUT 230V 50/60 CYCLES	
12 amp.	£23-60	OUTPUT VARIABLE 0-260 VOLTS.	
20 amp.	£48-00	Special discounts for quantity	
25 amp.	£58-00		
40 amp.	£82-50		




## AUTO TRANSFORMERS

0/115/230V. Step up or step down. Fully shrouded.

80W	£2-10	P. & P. 18p
150W	£2-70	P. & P. 18p
300W	£2-60	P. & P. 23p
500W	£5-25	P. & P. 33p
1000W	£7-50	P. & P. 38p
1500W	£10-20	P. & P. 43p
2250W	£17-25	P. & P. 50p
3000W	£35-00	P. & P. £1

## AVOMETER MOVEMENTS




Spare movements for Model 8 or 9. (Fitted with Model 9 scale) or basis for any multi-meter. Brand New and Boxed.

**£3-50** Post 25p.

## 230 VOLT A.C. 50 CYCLES RELAYS

Brand new. 3 sets of changeover contacts at 5 amp. rating. 50p each. Post. £1.00 (lots £40) Quantities available.




**240° Wide Angle 1mA Meters**

MW1-6 60mm square £2-97  
MW1-8 80mm square £4-97  
Post extra


## RP214 REGULATED POWER SUPPLY

Solid state. Variable output 0-24V d.c. up to 1 amp. Dual scale meter to monitor voltage and current. Input 220/240V a.c. Size 185 x 85 x 105mm. £28-97 Post 25p.




## PS.200 REGULATED P.S.U.

Solid state. Variable output 5-20V d.c. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240V a.c. Size 7 1/2in. x 5 1/2in. x 3 1/2in. £14-97. Post 25p.



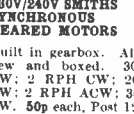
## PS.1000B REGULATED POWER SUPPLY

Solid state. Output 6, 9 or 12V d.c. up to 3 amps. Meter to monitor current. Input 220/240V a.c. Size 4in. x 3 1/2in. x 6 1/2in. £11-97. Post 25p.




**230V/240V SMITHS SYNCHRONOUS GEARED MOTORS**

Built in gearbox. All brand new and boxed. 30 RPH CW; 2 RPH CW; 20 RPH CW; 2 RPH ACW; 30 RPH CW. 50p each, Post 12p.



**LB4 TRANSISTOR TESTER**

Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with all instructions, etc. £4-50. Post 20p.



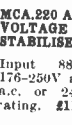
**LB3 TRANSISTOR TESTER**

Tests ICO and B. Pnp/npn. Operates from 9V battery. Complete with all instructions, etc. £3-95. Post 20p.



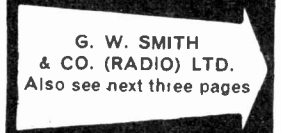
**MCA.220 AUTOMATIC VOLTAGE STABILISER**

Input 88-125V a.c. or 176-250V a.c. Output 120V a.c. or 240V a.c. 200VA rating. £11-97. Post 50p.



**SEND S.A.E. FOR LIST OF SEMICONDUCTORS AND VALVES**

**G. W. SMITH & CO. (RADIO) LTD.**  
Also see next three pages



# MULTIMETERS for EVERY purpose!



**T860 POCKET MULTIMETER**  
High-precision at low-cost.  
Ranges: D.c. 15V, 150V, 1,000V (10,000 O.P.V.). A.c. 15V, 150V, 100V (1,000 O.P.V.).  
D.c. Current 150mA. Resistance 100k ohms.  
\$1.85. Post 15p.

**MODEL 1092 Testmeter.**

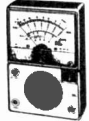
5,000 O.P.V.  
0/3/15/50/300/1,200V d.c.  
0/6/30/100/600V a.c.  
0/300A/300MA  
0/10K/1 meg  $\Omega$   
Decibels -10 to +16 dB  
\$2.75 each. Post 15p.



**HIOKI MODEL 720X**  
20,000 O.P.V.  
Overload protection  
5/25/100/500/1,000V d.c.  
10/20/50/1,000V a.c.  
50 $\mu$ A/250mA. 20K/2 meg. ohm -5 to +62dB.  
\$4.97. Post 15p.

**HIOKI MODEL 730X**

30,000 O.P.V. Overload protection.  
6/30/60/300/600/1,200V d.c. 12/60/120/600/1,200V a.c. 60 $\mu$ A/30mA/300mA. 2K/200K/2 meg. ohm. -10 to +63 dB.  
\$2.50. Post 15p.



**MODEL TE-10**  
20,000 O.P.V. 0/0.6/30/120/600/1,200/3,000/6,000V d.c. 0/6/30/120/600/1,200V a.c. 0/60 $\mu$ A/600mA. 0/6K/600K/6Meg. 60 Meg.  $\Omega$  50pF. 0.2mFd. \$5.97. Post 17p.

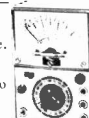
**MODEL TE-200** 20,000 O.P.V.  
Mirror scale, overload protection.  
0/5/25/125/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50 $\mu$ A/250mA. 0/60K/6 meg  $\Omega$ . -20 to +62dB. \$2.95. Post 15p.



**MODEL 500** 30,000 O.P.V. with overload protection  
mirror scale 0/0.5/2.5/10/25/100/250/500/1,000V d.c. 0/2.5/10/25/100/250/500/1,000V a.c. 0/50 $\mu$ A/5/50/500mA. 12 amp. d.c. 0/60K/6 Meg/60 Meg  $\Omega$ . \$2.87. Post paid.



**HIOKI MODEL 750X**  
50,000 O.P.V.  
43 ranges 0.43 to 1,200V d.c. 0.3 to 1,200V a.c.  
0-30 $\mu$ A/300mA.  
0-3K/30 meg ohms. -10 to +17dB.  
\$2.97. Post 20p.



**HT100B4 MULTI-METER**  
Features a.c. current ranges 100,000 O.P.V.  
Mirror Scale, Overload protection.  
0/0.5/2.5/10/50/250/500/1,000V d.c.  
0/2.5/10/50/250/500/1,000V a.c.  
0/10/250 $\mu$ A/2.5/25/250mA/10 amp. d.c.  
10 amp. a.c. 0/20K/200K/2MEG/20 MEG. -20 to +62dB. \$12.50. Post 25p.



**370 WTR MULTIMETER**  
Features a.c. current ranges 20,000 O.P.V.  
0/0.5/2.5/10/50/250/500/1,000V d.c.  
0/2.5/10/50/250/500/1,000V a.c.  
0/50 $\mu$ A/1/10/100mA/1/10 amp. d.c.  
0/100mA/1/10 amp. a.c.  
0/5K/50K/500K/5MEG/50MEG. -20 to +62dB. \$15. Post 25p.



**RUSSIAN 22 RANGE MULTIMETER**  
Model U437 10,000 O.P.V.  
A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2.5/10/50/250/500/1,000V d.c. 2.5/10/50/250/500/1,000V a.c. D.c. current 100mA/1/10/100mA/1A. Resistance 30 ohms/3/30/300K/3m  $\Omega$ . Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE \$2.97. Post 25p.

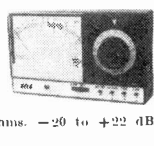


**ROUND SCALE TYPE PENCIL TESTER**

**MODEL TS-88**  
Completely portable, simple to use pocket sized tester. Ranges 0/3/30/300V a.c. and d.c. at 2,000 O.P.V. Resistance 0-20K ohms. ONLY \$1.97. Post 13p.



**LT 601 MULTI-METER**  
New style 20,000 O.P.V. pocket multimeter. 5/25/50/250/500/2,500V d.c. 10/50/100/500/1,000V a.c. 50 $\mu$ A/250A. 6K/6 meg ohms. -20 to +22 dB. \$2.75. Post 20p.



**MODEL TH-12**  
20,000 O.P.V. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/250/1,000V d.c. 0/10/50/250/1,000V a.c. 0/50 $\mu$ A/25/250mA d.c. 0/3K/30K/300K/3 meg. -20 to +50dB. \$4.97. Post 15p.



**MODEL TE-300** 30,000 O.P.V. Mirror scale, overload protection 0/0.6/3/15/60/300/1,200V d.c. 0/6/30/120/600/1,200V a.c. 0/30 $\mu$ A/60mA/600mA/600mA. 0/8K/80K/800K/8 meg. ohm -20 to +63dB. \$2.97. Post 13p.



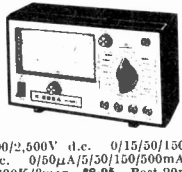
**MODEL PL436**  
20K  $\Omega$ /V d.c. 8K  $\Omega$ /V a.c. Mirror scale. 0.6/3/12/30/120/600V d.c. 3/30/120/600V a.c. 30/600 $\mu$ A/60mA. 10/100K/1 Meg/10 Meg  $\Omega$ . -20 to +46dB. \$2.97. Post 12p.



**TMK MODEL TW-50K** 46 ranges, mirror scale, 50K/V d.c. 5K/V a.c. D.c.: Volts 0.125, 0.25, 1.25, 2.5, 5, 10, 25, 50, 125, 250, 500, 1,000V. A.c.: Volts: 1.5, 3, 5, 10, 25, 50, 125, 250, 500, 1,000V. D.c. Current: 25, 50 $\mu$ A, 2.5, 5, 25, 50, 250, 500mA, 5, 10 amp. Resistance: 10K, 100K, 1 MEG, 10 MEG  $\Omega$ . Decibels: -20 to +81.5 dB. \$2.50. Post 17p.



**MODEL K228A**  
Taut band suspension. Overload protection. Polarity reversing switch. 30/60/120/250/500/1,000V d.c. 0/0.5/2.5/15/50/250/500/2,500V d.c. 0/15/50/150/500/1,000V a.c. 0/50 $\mu$ A/5/50/150/500mA/5A d.c. 0/3K/300K/3meg. \$2.95. Post 20p.



**HIOKI MODEL 700X**  
100,000 O.P.V. Overload protection. Mirror scale. 0/3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1,200V d.c. 1.5/3/6/12/30/60/150/300/600/1,200V a.c. 15/30 $\mu$ A/3/6/30/60/150/300mA/6/12 amp. d.c. 2K/200K/2 Meg/20 Meg ohm -20 to +63dB. \$13.50. Post 20p.



**MODEL G-7080 EN**  
Giant 6in mirror scale, 20,000 O.P.V.  
0/0.25/1/2.5/10/50/250/1,000/5,000V d.c. 0/2.5/10/50/250/1,000/5,000V a.c. 0/50 $\mu$ A/1/10/100/500mA/10 amp. d.c. 0/2K/200K/20 meg. -20 to +50dB. \$13.95. Post 35p.



**U4312 MULTIMETER**  
Extremely sturdy instrument for general electrical use. 687 O.P.V.  
0/0.3/1.5/7.5/30/60/150/300/600/900V d.c. and 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V a.c. 0/300 $\mu$ A/1.5/6/15/60/150/600mA/1.5/6 amp. d.c. 0/1.5/6/15/60/150/600MA. 1.5/6 amp. d.c. 0/200  $\Omega$ /3K/30K  $\Omega$ . Accuracy Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. \$9.50. Post 25p.



# Selected TEST EQUIPMENT

**FTC-401 TRANSISTOR TESTER**

Full capabilities for measuring A, B and IC. npn or pnp. Equally adaptable for checking diodes. Supplied complete with instructions, battery and leads. \$7.50. Post 20p.



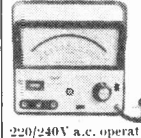
**Models-100TR MULTIMETER/TRANSISTOR TESTER.**

100,000 O.P.V. mirror scale/overload protection. 0/0.12/0.6/3/12/30/120/600V d.c. 0/6/30/120/600V a.c. 0/12/60 $\mu$ A/12/300mA/12 amp. d.c. 0/10 K/1 MEG/100 MEG. -20 to +50dB. 0.01-2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. \$13.50. Post 25p.



**MODEL 449A IN CIRCUIT TRANSISTOR TESTER**

Checks true a.c. beta in/out. Checks Icho. Checks diodes in/out. Checks SCR, etc. Beta H<sub>10</sub>-500 Icho 0-5000 $\mu$ A. 220/240V a.c. operation. \$17.50. Post 25p.



**TE-20D RF SIGNAL GENERATOR**

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated Variable R.F. attenuator, audio output, Xtal socket for calibration. 220/240V a.c. Brand new with instructions. \$15. Carr. 37p. Size 140mm x 215mm x 170mm.



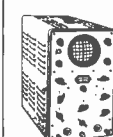
**MODEL L-55 FET V.O.M.**

Input impedance 10 meg ohms. 0/0.3/1.2/6/30/120/600V d.c. 0/3/12/60/120/600V a.c. 0/120 $\mu$ A/120mA d.c. 0/1K/100K/10 meg/100 meg ohms. \$15.97. Post 25p.



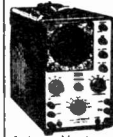
**CJ-5 PULSE OSCILLOSCOPE**

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth 10MHz. Sensitivity at 100kHz V RMS/mm. 0.1-25; HOR. AMP. Bandwidth 300kHz. Sensitivity at 100kHz. V RMS/mm. 0.3-25; Pre-set triggered sweep 1-3,000 $\mu$ sec.; free running 20-200,000Hz in nine ranges. Calibration pistons. 220mm x 360mm x 430mm. 115-250V a.c. operation. \$29. Carr. paid.



**TO-3 PORTABLE OSCILLOSCOPE**

3in tube, V amp. Sensitivity 0.1V p-p/CM. Bandwidth 1.5cps-1.5MHz. Input imp. 2 meg  $\Omega$  25pF V amp. sensitivity 0.9V. p-p/CM. Bandwidth 1.5cps-800kHz. Input imp. 2 meg  $\Omega$  20pF. Time base: 5 ranges 10cps-800kHz. Synchronisation Internal/external. Illuminated scale 140mm x 215mm x 330mm. Weight 15lb. 220/240V a.c. Supplied brand new with handbook. \$40.00. Carr. 50p.



**RUSSIAN CJ-16 DOUBLE BEAM OSCILLOSCOPE**

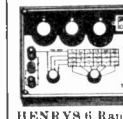
5MHz Pass Band. Separate Y1 and Y2 amplifiers. Rectangular 5in x 4in C.R.T. Calibrated triggered sweep from 0.2 $\mu$ sec to 100 milli-sec per cm. Free running time base 50 Hz-1MHz. Built-in time base calibrator and amplitude calibrator. Supplied complete with all accessories and instruction manual. \$27. Carr. paid.



**TE-16A** Transistorized Signal Generator. 5 ranges 400Hz-30MHz. An inexpensive instrument for the handyman. Operates on 9V battery. Wide easy to read scale. 800Hz modulation. 5 1/2in x 5 1/2in x 3 1/2in. Complete with instructions and leads. \$7.97. Post 25p.

**TRANSISTORISED L.C.R. A.C. MEASURING BRIDGE**

A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 1 $\Omega$ -11.1 meg  $\Omega$ . 6 Ranges  $\pm$ 1%. L1  $\mu$ H - 111  $\mu$ H. HENRY'S 6 Ranges -2%. C. 10pF  $\pm$  1.1  $\mu$ F. 6 Ranges  $\pm$ 2%. TURNS RATIO 1:1/1000-1:1100. 6 Ranges  $\pm$ 1%. Bridge voltage at 1,000cps. Operated from 9V 100 $\mu$ A. Meter indication. Attractive 2 tone metal case. Size 7 1/2in x 5in x 2in. \$20. Post 25p.



**MODEL TE15 GRID DIP METER**

Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 450Hz-280MHz in 6 coils. 300 $\mu$ A meter. 9V battery operation. Size 180mm x 80mm x 40mm. \$12.50. Post 20p.



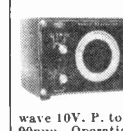
**BEICO AP-5A SOLID STATE SINE SQUARE WAVE C.R. OSCILLATOR**

Sine 18-200,000 Hz; Square 18-50,000 Hz. Output max. 400mA (10 K $\Omega$  load). Operation internal batteries. Attractive 2-tone case 7 1/2in x 5in x 2in. Price \$17.50. Carr. 17p.



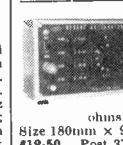
**MODEL MG-100 SINE SQUARE WAVE AUDIO GENERATOR**

Range 15-220,000 Hz. 8ine Wave 19 - 100,000Hz. Square Wave. Output Sine or Square wave 10V. P. to P. Size 180mm x 90mm x 90mm. Operation 220/240V a.c. \$17.50. Post 37p.



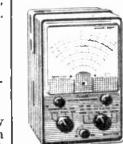
**MODEL AT801 DECIBEL ATTENUATOR**

Frequency range 0-200kHz. Attenuator 0-111dB. 0-10dB step. Impedance 600 ohms. Max. input power 30dBm. Size 180mm x 90mm x 55mm. \$12.50. Post 37p.



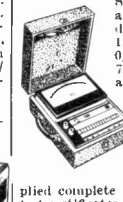
**TE-65 VALVE VOLTMETER**

28 ranges. D.c. volts 1.5-1,500V a.c. volts 1.5-1,500V. Resistance up to 1,000 megohms. 200/240V a.c. operation. Complete with probe and instructions. \$17.50. Post 30p. Additional probes available: R.F. \$2.12; H.V. \$2.50.



**MODEL U4311 SUB-STANDARD MULTI-RANGE VOLT AMMETER**

Sensitivity 330 ohms/Volt a.c. and d.c. Accuracy 0.5% a.c. 1% a.c. Scale length 0/300/750 $\mu$ A/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5/15/30/75/150/300/750V d.c. 0/75/150/300/750V a.c. Supplied brand new with handbook. \$40.00. Carr. 50p.



Supplied complete with test leads, manual and test certificates. \$49. Post 50p.

**G. W. SMITH & CO. (RADIO) LTD.**  
Also see opposite page and next two pages

**UMR-30 RECEIVER**



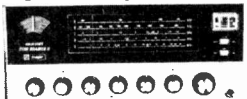
4 Bands covering 550kHz-30MHz. BFO. Built-in Speaker 220/240V a.c. Brand new with instructions. £15.75. Carr. 37p.



**UR-1A SOLID STATE COMMUNICATION RECEIVER**

4 Bands covering 550kHz-30MHz. FET. 8 Meter. Variable BFO for SSB. Built-in Speaker. Bandspread. Sensitivity Control. 220/240V a.c. or 12V d.c. 12 1/2in x 4 1/2in x 7 1/2in. Brand new with instructions. £25. Carr. 37p.

**SKYWOOD CX205 COMMUNICATION RECEIVER**

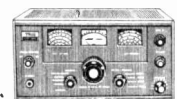


Solid state. Coverage on 5 bands 200-420 kHz and 0.55 to 30MHz. Illuminated slide rule dial. Bandspread. Aerial tuning. BFO. AVC. ANL. "S" meter. AM/CW/SSB. Integrated speaker and phone socket. Operation 220/240V a.c. or 12V d.c. Size 3 1/2 x 2 1/2 x 1 1/2 in. Complete with instructions and circuit. £28.50. Carr. 50p.

**LAFAYETTE HA-600 SOLID STATE RECEIVER**



General coverage 150-400kHz, 550 kHz-30MHz. FET front end. 2 mech. filters, product detector, variable BFO, noise limiter. 8 Meter. Bandspread. RF Gain. 1 1/2in x 9 1/2in x 9 1/2in. 18lbs. 220/240V a.c. or 12V d.c. Brand new with instructions. £50. Carr. 50p.



**TRIO 9B59DS COMMUNICATION RECEIVER**  
4 band covering 550kHz-30MHz continuous and electrical bandsread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW. ANL. Variable BFO. 8 meter. Sep. bandsread dial. IF frequency 455kHz. Audio output 1.5W. Variable RF and AF gain controls 115/250V a.c. Size 7 1/2in x 13 1/2in x 10 1/2in with instruction manual. £49.50. Carr. paid.



**EMI LOUSPEAKERS**  
Model 350. 13in x 8in with single tweeter/crossover, 20-20,000Hz. 15W RMS. Available 8 or 15 ohms. £7.25 each. Post 37p.  
Model 450. 13in x 8in with twin tweeter/crossover. 55-18,000Hz. 8W RMS. Available 8 or 15 ohms. £3.62 each. Post 25p.

**HONEYWELL DIGITAL VOLTMETER VT.100**



Can be panel or bench mounted. Basic meter, 100% (up to 1.999). Input source 1V d.c. but can be used to measure a wide range of a.c. and d.c. volt, current and ohms with optional plug in cards. Specification: Accuracy: ±0.2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1.999). Input Impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100V d.c. Input: Fully floating (3 poles). Input power: 110-230V a.c. 50/60 cycles. Overall size: 5 1/2in x 2 1/2in x 8 1/2in. AVAILABLE BRAND NEW AND FULLY GUARANTEED. £25.50. Carr. 50p.

**SINCLAIR IC-12**



List Price £2.98

OUR PRICE £1.80 P. & P. 10p.

**SINCLAIR EQUIPMENT**



Project 60 Package offers.  
2 x Z30 amplifier, stereo 60 pre-amp, PZ5 power supply. £15.95. Carr. 37p. Or with PZ6 power supply. £18.00. Carr. 37p.  
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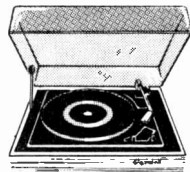


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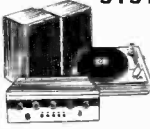


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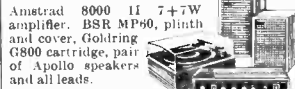


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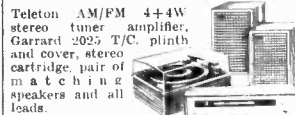
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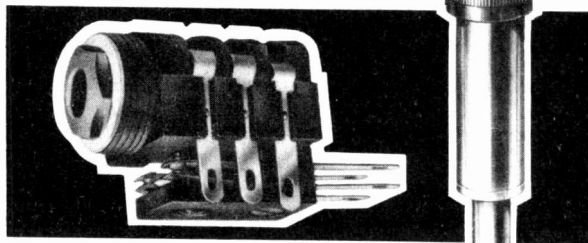
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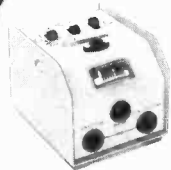
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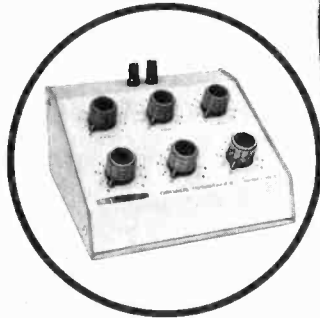
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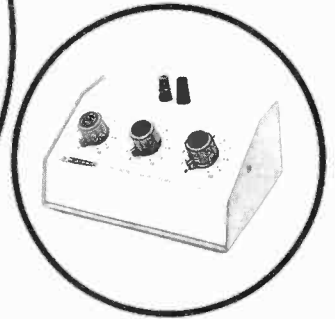
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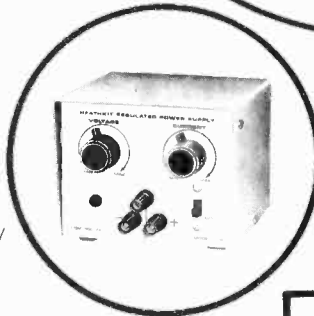
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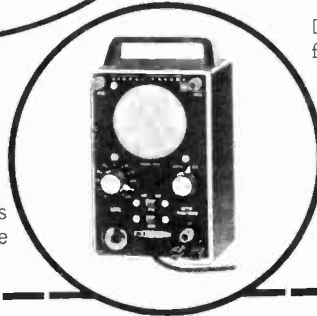


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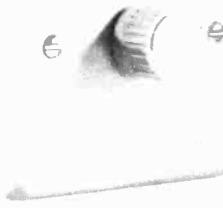
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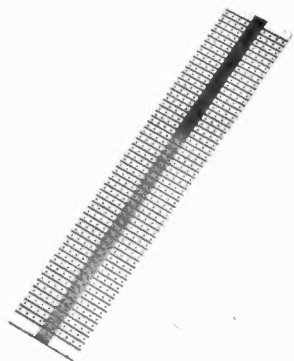
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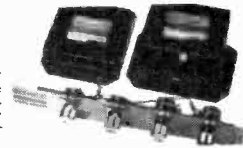


The whole system is complete including superb cabinets in simulated teak—just simply screw together the components and you save pounds! Amplifier is based on the famous Mullard Unilex system. Garrard 2025TC turntable complete with stereo ceramic cartridge, teak simulated plinth and tinted acrylic cover. Plus the big 13in. x 8in. EMI Twin-cone speakers ready for mounting in their elegant cabinets, which simply need screwing and gluing together. All glue and screws supplied. Easy to follow step-by-step instructions guide you quickly and effortlessly to taking the wraps off truly realistic stereo sound.

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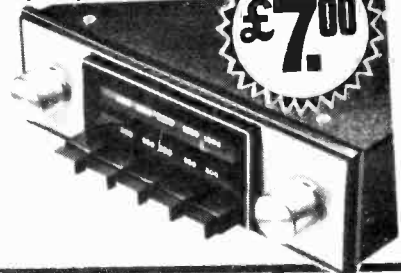
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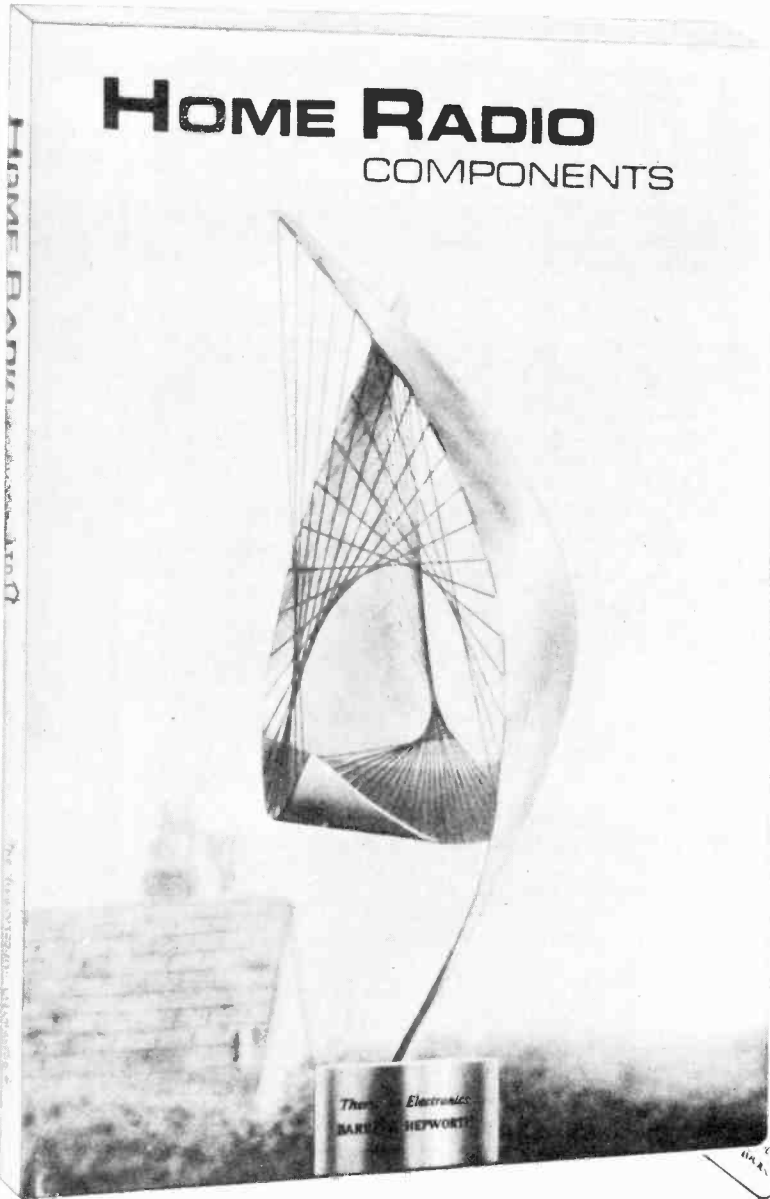


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## THE WHOLE AND THE PARTS

**S**COPE for the home constructor is widening the whole time, both in scale of circuitry and nature of application. Projects once considered highly ambitious and sophisticated are now well within the reach of the average amateur, thanks to the integrated circuit. Circuit arrangements that would be considered quite large in discrete component terms, are now likely to be found playing the part of some individual stage or section within the ramifications of some much more extensive circuit or system.

Despite miniaturisation and close packing, the extent of the circuitry involved in a sophisticated design may add up to a large and unwieldy piece of equipment. In such cases—and the present signs are that they will become more and more commonplace—the answer probably lies in unit or modular construction. This is a well-established practice in large commercial equipments. Now it is beginning to merit serious consideration in the home constructor field, for particular designs.

The modular form of construction can be seen as a further development of the plug-in circuit board arrangement, with carefully selected and clearly definable parts of the overall system assembled within mechanically independent units. The modular system offers a number of advantages. In some instances individual modules belonging to a system may be capable of serving other functions, either while remaining within the parent rack or cabinet, or as free-standing and independent units pressed into service at short notice for some ad hoc experiment or demonstration, for example.

The additional cost in hardware is therefore likely to be fully recompensed by the greater versatility provided by the constituents that go to make up the whole system. The maximum possible utilisation of valuable equipment can be assured. Operational flexibility is, of course, another important attribute of modular construction, as well as greater facility for the subsequent updating or improvement of particular sections of the system in the light of technical progress.

The P.E. Sound Synthesiser demonstrates some of the most valuable and desirable features of the modular approach. This project is certainly ambitious, in amateur terms; yet such is the current interest in the synthesis and manipulation of sound for all manner of divergent uses, that the popularity of this instrument is not in doubt. And it has this additional attraction: many of the modules have other possible applications, alone or in association with other equipment, outside the confines of the main system. The Sound Synthesiser series of articles can be considered in the whole—relating to one large and comprehensive design with great capabilities. Alternatively, the series may be viewed as a collection of separate designs, many of these having interesting possibilities as solo units in the wide and appealing field of creative and experimental sound.—F.E.B.

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# P.E. TRIFFID SINGLE CHIP I.C. RADIO

By F. R. HEATH B.Sc. (Hons.) (Ferranti Ltd.)

NEW CDI integrated circuit technology has enabled Ferranti engineers to produce the smallest radio i.c. device in the world that offers a satisfactory alternative to the superhet. This article will take a brief look at the CDI techniques used to produce this device and then describe in full how you can build a high quality medium and/or long wave portable radio of superior quality for modest cost.

For the constructor there is, at least, a rest from some of the tedious coil-winding operations so often necessary in radio construction. There is no recourse to expensive alignment equipment, as no setting up is required.

This article does not aim to stress an overall small size, such as in a matchbox radio, because the majority of constructors will want a radio with a speaker and cabinet, ferrite aerial, and room for a long lasting battery. To make full use of the superior sound quality available from the radio i.c. these items are essential. Anybody wishing to make a "micro-radio" or a medium and long wave tuner for an existing hi-fi system, will be able to adapt from the design in this article.

The "P.E. Triffid" design has been tried in most parts of the British Isles, from Exeter to Edinburgh, and gives good results on stations which are of normally reasonable signal strength for the area. The only problem (occurring with all t.r.f. designs) is when the receiver is being used very close to the transmitter. In such a case rotation of the rod aerial is necessary to find a null. Although designed for reception of BBC Radio 1, 2, 3 and 4, the set works well on many foreign stations, especially Radio Luxemburg.

## COLLECTOR DIFFUSION ISOLATION (CDI)

CDI is a new bipolar integrated circuit manufacturing technique which possesses the following inherent advantages:

1. Simplicity of processing
2. High component density
3. High switching speed
4. Low supply volts.

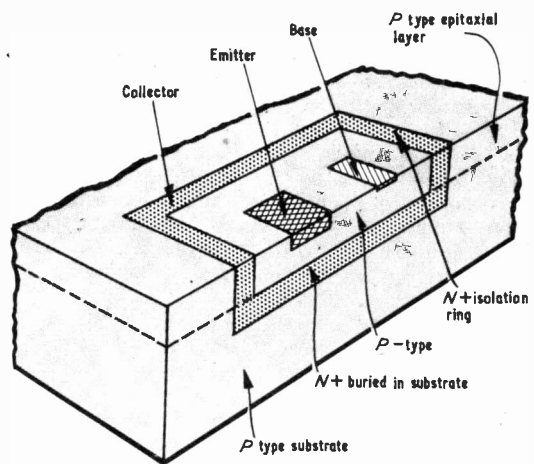


Fig. 1. Cross section view through a CDI transistor

CDI in its basic form, as developed by Bell Laboratories, was limited to a 3V supply voltage. Ferranti carried out a major development programme to achieve a 5V process for compatibility with current logic i.c. systems.

The processes involved in the production of CDI devices are much simpler than for standard bipolar techniques. Only five masks are required which compare directly with MOS processing; four less than for conventional bipolar i.c. processes. The transistor size is much smaller due to the self isolating properties of CDI, and much thinner (1 micron) epitaxial layers can be used in processing.

This simplicity is of direct importance in achieving low cost and yielding large quantities, both factors being passed on to the consumer as cheaper i.c.s.

A cross-section of a CDI transistor is shown in Fig. 1. Buried *n* regions are diffused into a *p*-type substrate wherever transistors, diodes or resistors are required. A thin, high resistivity *p*-type epitaxial layer is then grown over the slice.

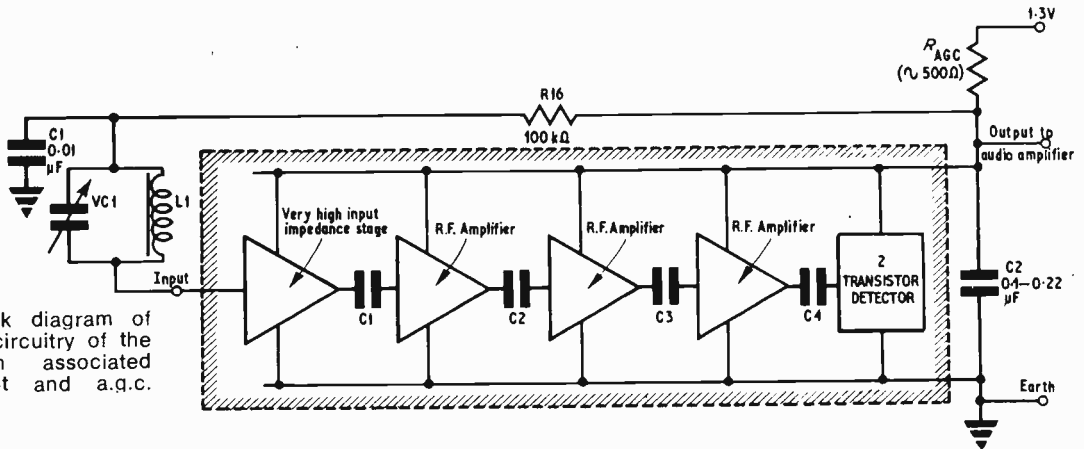
**Table 1: BASIC CDI TRANSISTOR CHARACTERISTICS**

$V_{CBO}$	7.5 volts
$h_{re}$	60
$f_T$	1GHz
$R_{sat}$	10 ohms
$V_{offset}$	5mV
$I_{CBO}$	1.0pA
$h_{fe}$ (inverse)	20
$C_{ob}$	0.3pF

A block diagram of the radio chip is shown in Fig. 2. Basically, the circuit is a 10 transistor t.r.f. tuner which will operate from 150kHz to 3MHz and requires about 1.3 volts power supply. Audio output is typically 30mV r.m.s.

The i.c. requires the minimum of external circuitry and effective a.g.c. action is available. Distortion from the chip is very low (typically 2%), which is three or four times better than in an average superhet. Current requirements for the i.c. are approximately 0.5mA and the characteristics are shown in Fig. 3 and 4 and in Table 2.

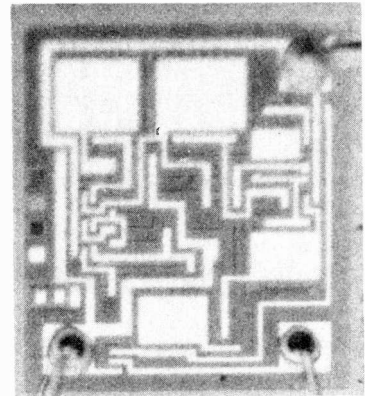
Fig. 2. Block diagram of the interior circuitry of the ZN414 with associated tuned circuit and a.g.c. components



Isolation, deep collector contact, interconnection crossunders, and definition of base and resistor areas are all achieved by a single selective  $n_+$  diffusion through this epitaxial layer. The isolating  $n_+$  diffusion completely surrounds each buried layer island, complete isolation being provided by the  $p$ -type epitaxial layer and the substrate between the  $n_+$  diffused regions. The  $p$ -type epitaxial layer which is completely enclosed is used to form transistor bases and  $p$ -type resistors (medium value resistors  $2k\Omega$  to  $50k\Omega$ ).

Another  $n_+$  diffusion defines the transistor emitters, and can also be used for low value resistors. Contact holes are then cut and the basic aluminium interconnection pattern is evaporated onto the device.

The parameters of CDI devices are shown in Table 1.



### RADIO CHIP DESIGN

The design of the ZN414 radio chip began in November 1970. A basic circuit was produced and then "breadboarded" using discrete CDI devices. As in many basic t.r.f. designs, instability was the major problem. Intensive development work culminated in a design that is stable provided certain external requirements are satisfied.

Many prototype experimental circuits were tried and found to be capable of excellent quality. The first i.c. radio was working in July 1971. The present day radio chips are predictable and consistent.

**Table 2: MAIN CHARACTERISTICS OF THE ZN414**

Supply volts	1.1-1.5 volts
Temperature range	0 to +70°C
Supply current	0.5mA maximum
Frequency range	200kHz-3MHz
R.F. input impedance	1.5MΩ typical
Output impedance	500Ω typical
Sensitivity	100μV r.m.s.
Power gain	70dB typical

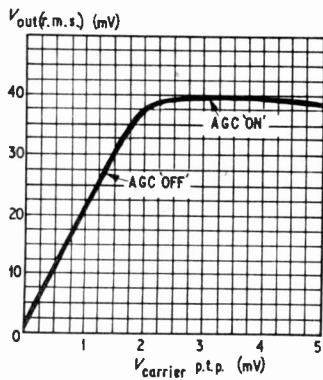


Fig. 3. Graph of voltage gain showing the effective a.g.c. region

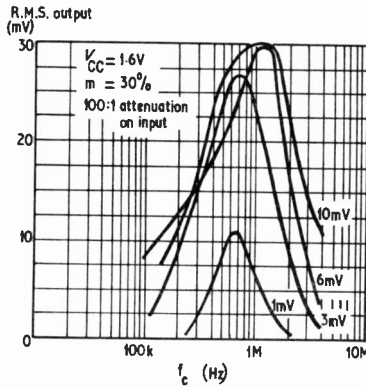


Fig. 4. Bandwidth of the ZN414 on the medium wave band

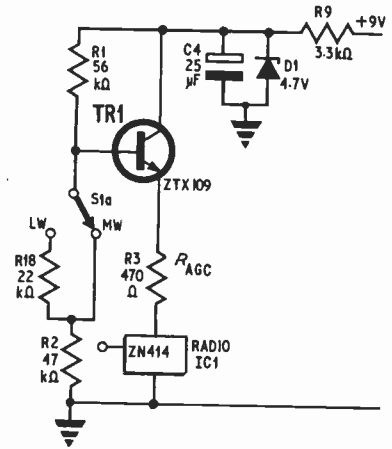


Fig. 5. The integrated circuit is driven from a constant voltage source of 1.3 volts derived from a 9 volt supply

## HIGH QUALITY RADIO SET

To obtain the best possible results from the ZN414, certain rules must be adhered to. All leads in the radio circuitry must be kept short, and the i.c. should preferably be soldered flush to a printed circuit board. The aerial coil should have a high  $Q$  or selectivity will suffer.

The only problem occurs when a very strong station swamps the front end. Here, rotating the set until a null is found will solve the problem. A demonstration radio gave better reception of Radio Luxemburg than a superhet, not because selectivity was better, but because the superhet gave out so many whistles and shrieks that any pleasure from the programme was impossible to achieve.

One other important requirement is to keep the a.g.c. resistor within the range 470 to 1,000 ohms,

A typical case used to house the P.E. Triffid receiver



and for best selectivity keep to the lower end. This means that if the radio is powered from a 9V battery, then a constant voltage source is needed to derive the 1.3 volts necessary. This is done using the circuit shown in Fig. 5.

Fig. 4. shows that the gain of the chip falls off at long wave frequencies. For this reason, a switch is fitted to increase the supply volts (and consequently increase the gain of the chip) on long wave so that the volume is kept approximately the same when the different bands are selected. Fig. 5 shows the circuit changes needed to accomplish this.

## AMPLIFIER AND CASE

The output amplifier and loudspeaker should be of good quality to do justice to the signal from the receiver. Several i.c. amplifiers were tried. All gave some results, but most were tricky to stabilise and did not give the quality needed. For this reason a discrete amplifier was used, low power output at 500mA being suitable for a personal radio. Low cost and battery power consumption are kept to a minimum making this receiver suitable for the inexperienced radio constructor.

Cabinet and speaker design is dependent on personal taste so the following constructional details deal mainly with the circuitry aspect. Most constructors will want to design their own housing for the unit, and there are many cases available to cater for those who do not like woodwork.

The case must not contain large metal parts near to the ferrite rod, as this will damp the  $Q$  of the coil.

## AMPLIFIER DESCRIPTION

The amplifier is not claimed to be a revolutionary design; rather it is intended to be easily built, and of good enough performance to match the radio i.c., whilst maintaining battery current economy and using inexpensive transistors.

The circuit in Fig. 6 shows a class-AB amplifier with a constant current source (TR4) enabling a

NOTE: The earthy side of VC1 (moving section) must be connected to C1/R16.

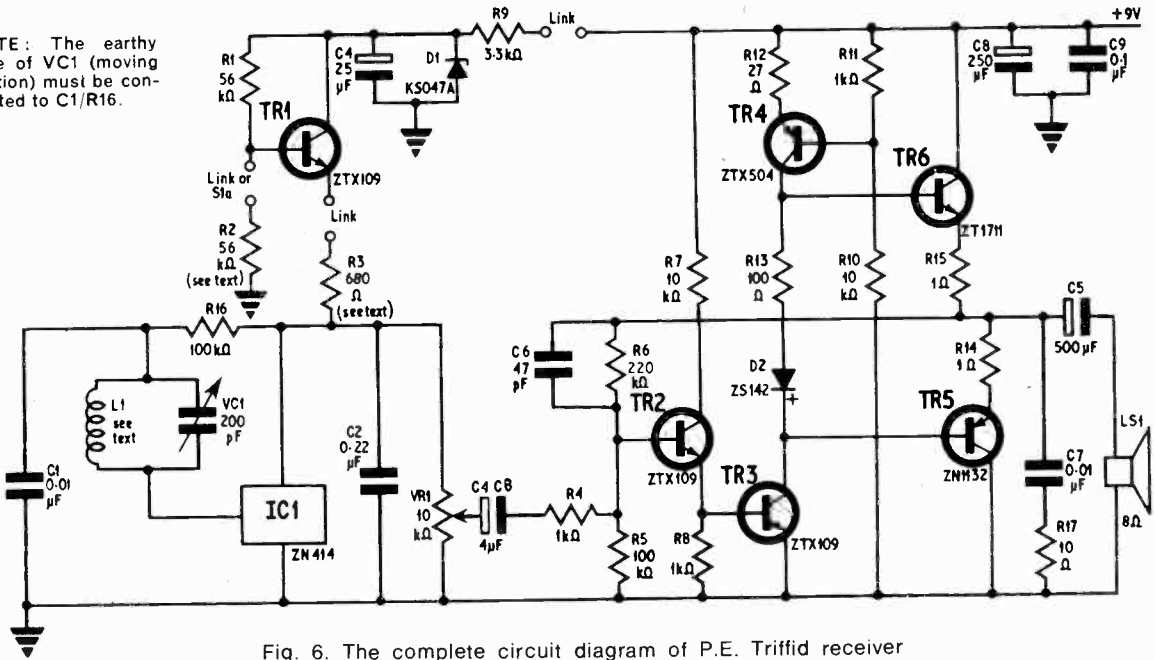


Fig. 6. The complete circuit diagram of P.E. Triffid receiver

higher voltage gain from the drive stage TR2. The current in TR4, and consequently the quiescent current taken by the circuit, is around 5mA. This *pn-p* current source was found to reduce distortion in the circuit. The voltage gain at 1kHz is approximately 80, thus the input sensitivity for full output (5.7 volts before clipping) is 70mV.

The value of R13 may be lowered to give less bias voltage at the expense of distortion. Replacing it with a wire link is recommended if other output transistors are used, or any modifications are tried, as this prevents the possibility of thermal runaway.

If a reduced output power is acceptable, ZTX300 and ZTX500 may be used as the output pair, or BFS60 and BFS96; both sets give good results. Distortion with the standard circuit is one per cent at 1kHz and 2 volts peak output, mainly second harmonic. No crossover distortion can be seen on an oscilloscope trace at 20kHz, indicating that distortion is due mainly to non-linearity in the whole amplifier rather than to crossover "spikes".

No heatsinks are necessary with the recommended output pair. Three layouts of the circuit were tried, all were stable and gave similar results.

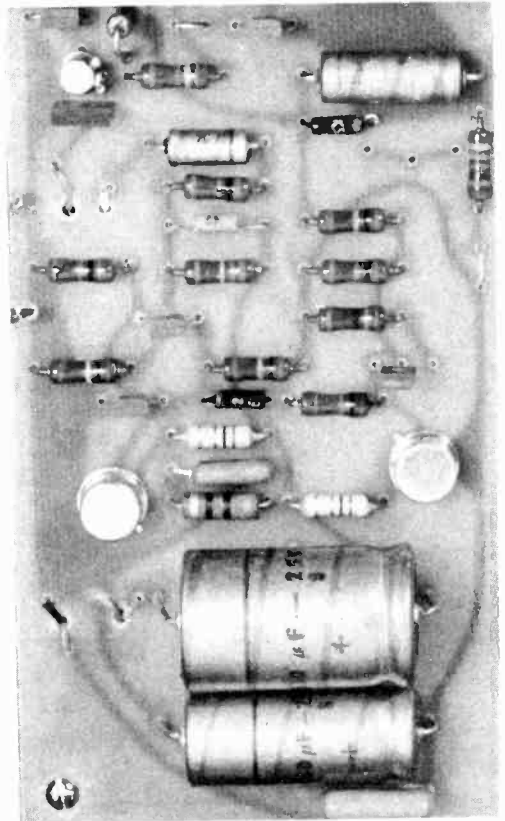
The amplifier is certainly of good enough performance to use as an amplifier for an f.m. tuner, or record player, and experimenters can easily modify the circuit to switch in to another function or functions.

### CONSTRUCTION AND LAYOUT

Provided the layout is carried out as described earlier, almost any method of construction can be used. However, a printed circuit board is recommended as it offers reliably consistent results.

The combined amplifier and radio circuit is shown in Fig. 6, the p.c.b. pattern and layout in Fig. 7. Apart from essentially sound soldered joints, two further precautions must be observed: wires from the coil-capacitor tuned circuit must be kept away

from other circuitry, especially the battery leads and loudspeaker leads; the volume control must be 10kΩ or greater, if it is not to affect the a.g.c. characteristics.



Layout of components on a printed circuit board

# COMPONENTS...

## Resistors

R1 56k $\Omega$	R8 1k $\Omega$	R15 1 $\Omega$ 1W
*R2 56k $\Omega$	R9 3.3k $\Omega$	R16 100k $\Omega$
*R3 680 $\Omega$	R10 10k $\Omega$ 2%	R17 10k $\Omega$
*R4 1k $\Omega$	R11 1k $\Omega$ 2%	R18 22k $\Omega$
R5 100k $\Omega$	R12 27 $\Omega$	R19 220k $\Omega$
R6 220k $\Omega$	R13 100 $\Omega$	
R7 10k $\Omega$	R14 1 $\Omega$ 1W	

All  $\pm 5\%$   $\frac{1}{4}$ W carbon except where stated

## Potentiometer

VR1 10k  $\Omega$  volume control with switch (S3)

## Capacitors

C1 0.01 $\mu$ F
C2 0.22 $\mu$ F
C3 4 $\mu$ F elect 10V
C4 25 $\mu$ F elect 10V
C5 500 $\mu$ F elect 10V
C6 47pF disc ceramic
C7 0.01 $\mu$ F polyester
C8 250 $\mu$ F elect 10V
C9 0.1 $\mu$ F polyester
VC1 200pF single gang tuning

## Integrated Circuit

IC1 ZN414 (Ferranti)

## Transistors

TR1, 2, 3	ZTX109 (3 off)
TR4	ZTX504
TR5	ZN1132
TR6	ZT1711

## Diodes

D1	KS047A
D2	ZS142

## Tuning Coil

L1 85 turns +250 turns 28 s.w.g. enamel wire wound on  $\frac{3}{8}$ in dia. 6in ferrite rod (see text)

## Miscellaneous

LS1	8 $\Omega$ loudspeaker
B1	9V battery style PP9
Printed circuit board (see Fig. 7)	
Case and tuning scale	

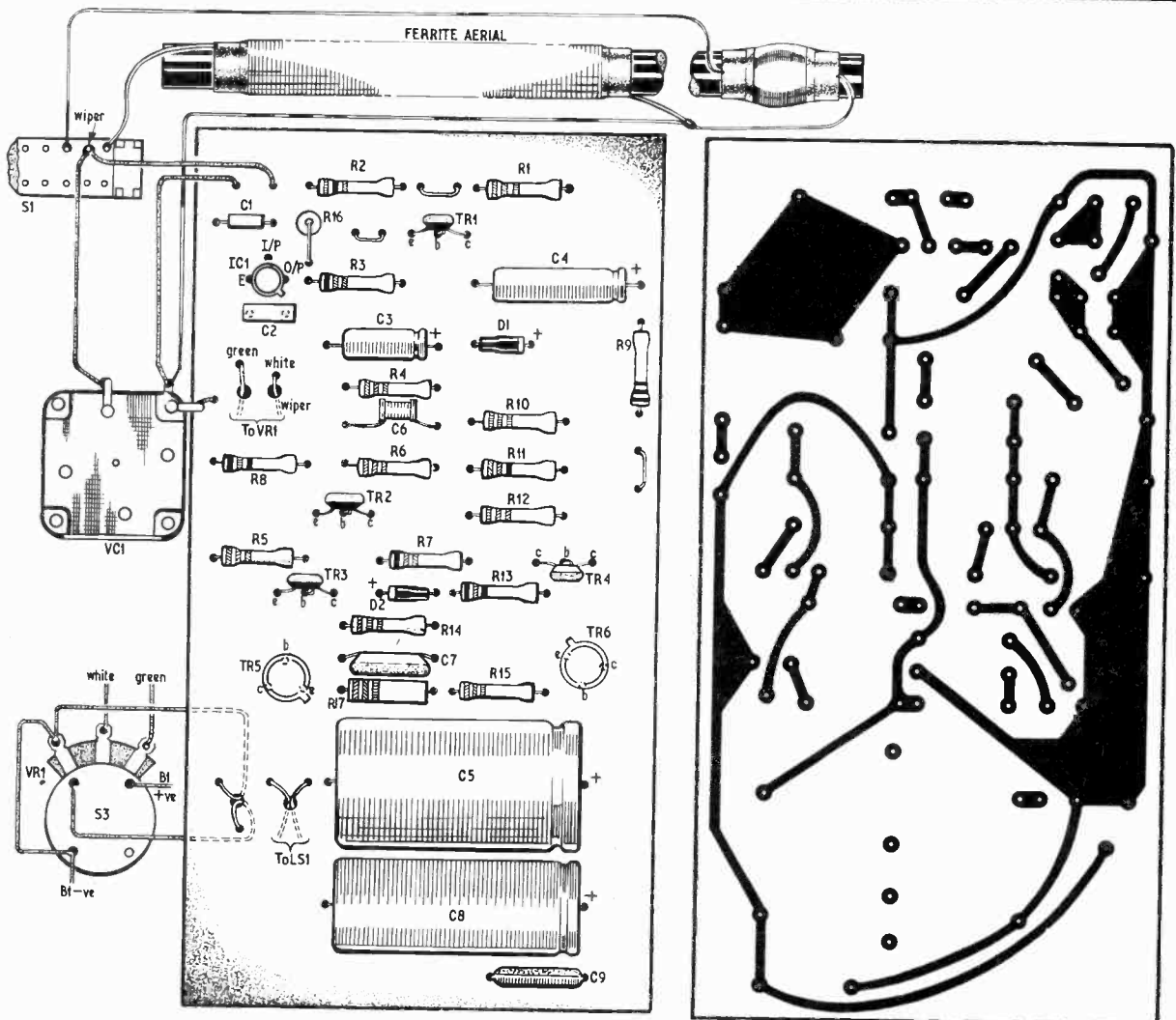


Fig. 7. Component layout and printed circuit board pattern (full size)

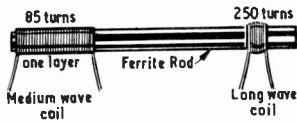


Fig. 8. Coil winding details and waveband selection

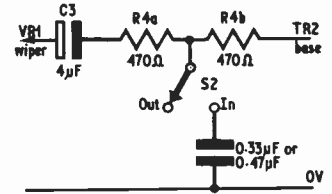
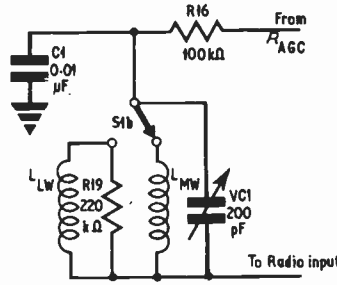


Fig. 9. A tone control circuit is inserted in the position of R4 as shown here with another capacitor

## TUNING COIL

If the tuning range is tending towards the low frequencies, then fewer turns are needed on the coil. For a 6in ferrite rod with the coil feeding a 200pF tuning capacitor, about 85 turns of close wound enamelled copper or litz wire are needed; 28s.w.g. wire is suitable, but nothing is critical here, and adjustments are easy. It is better to wind more turns (say 100) and then remove some until the correct tuned frequency spread is reached. Litz wire gives highest *Q* coils and is highly recommended.

Constructors who wish to wind a long wave coil and fit a wave-change switch will find that, with the values above, the coil will need about 250 turns. Multilayering is best, but again this is not critical. Fig. 8 shows the long wave components necessary.

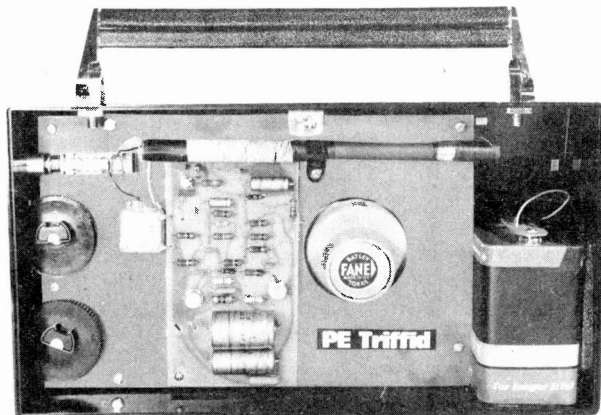
The type of ferrite rod affects the inductance, as does the type of wire, but it is easy to adjust the coil to suit the requirements of the rod obtained. Do not expect to adhere rigidly to the specified coil details for optimum results.

## TESTING

Building the circuit should present no problems if carried out in the following manner:

1. Build up the amplifier unit and volume control, and test it on suitable inputs. If no signal generator is available, see if a hum is produced when the input is touched. The output (before C5) should be at 4.5 volts  $\pm$  0.5 volts.
2. Wire up the radio drive circuit and put a 3.3kΩ resistor between emitter of TR1 and earth. This should have 1.3 volts  $\pm$  0.2V across it.
3. Wire up the radio i.c. and test.

Interior of receiver showing the printed circuit board mounted on a plain board which also has the tuning capacitor, volume control and aerial mounted on it



If instability is encountered, the following procedure is used.

(a). Short the tuning capacitor out, if instability continues then the radio supply voltage may be incorrect.

(b). Radio frequencies generated in the amplifier may be feeding back to the i.c. To cure this a 47pF capacitor may be fitted across the 220kΩ resistor, and/or a 30μH choke placed in the supply before R9. (The link on the board is replaced by the choke.)

(c). Leads to the tuning circuit may need re-routing.

(d). If instability continues then replacing R2 by a 47kΩ resistor, and replacing the link above R2 with a 20kΩ preset, will facilitate greater control of radio supply voltage. This has an additional advantage; as the battery ages and its voltage drops, the set will still give good results (down to 6 volts with this preset in circuit.)

Happily, none of these problems occurs if neat systematic working is done, and normally the radio should work first time.

## TUNING INDICATOR

A tuning indicator is very simply added to the set by inserting a 0-1mA (or 0-500μA) meter between TR1 emitter and the top end of R3. This should read approximately 0.3mA with no signal, but should read higher as one tunes through a station. The maximum reading indicates that the station is properly tuned, and depending on the signal strength, should give a reading around 0.5mA.

In normal circumstances this receiver should not drift and once set, the tuning should not need to be altered.

## TAPE RECORDER OUTPUT

Provided the circuitry of the tape recorder has an input impedance of several tens of kilohms, a screened lead can be taken from the "top" end of the volume control to the tape recorder input socket most suited for a 100mV flat response input signal. Care that the bias circuitry does not interfere with the radio is needed, so a fairly long lead is recommended.

## TONE CONTROL

Fig. 9. shows a recommended tone control, which in its extreme position gives a 6dB/octave roll-off above 1kHz. To fit the tone circuit, the connection between C3 and R4 has to be cut. Apart from this the board is adaptable for the modification. ★

THIS month we describe the construction of a brain rhythm frequency meter and cardiophone.

### BRAIN RHYTHM FREQUENCY METER

The circuit in Fig. 8 can be employed to identify different brain rhythms, and will demonstrate, for example, how alcohol intake affects alpha frequency.

A signal taken from output 1 of the pre-amplifier is amplified by TR3 and squared by the Schmitt trigger TR4 and TR5. Differentiator C15 and VR4 converts the square wave into an a.c. signal of amplitude proportional to frequency. This is rectified and smoothed by D3, D4, and C16, with the resulting d.c. current being measured by ME2. VR4 calibrates the instrument, and VR3 adjusts sensitivity.

The frequency range covered by ME2 is 0-20Hz, and capacitor C8 in the pre-amplifier can be switched into circuit by S3 to give additional top-cut for noise and interference rejection, see Fig. 2.

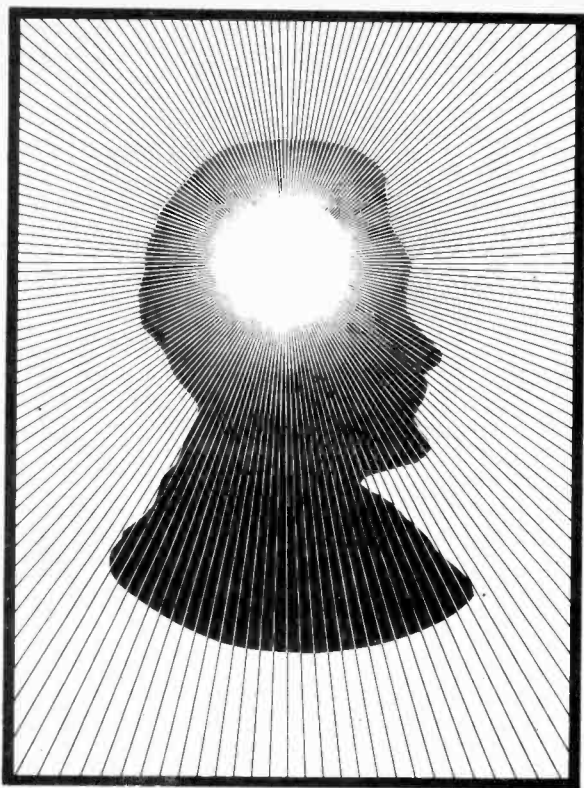
In addition to the frequency meter, a voltage controlled unijunction oscillator TR7, gives an audio output into 8 ohm headphones of frequency proportional to the subsonic brain rhythm frequency, so that the user can sense changes of rhythm with his eyes closed. TR6 controls the charge rate of the unijunction emitter capacitor C17.

If interest is centred on either beta, theta, delta, or slow alpha rhythms, the centre frequency of the pre-amplifier can be modified according to the capacitor value listed in Fig. 3. Alternatively, a three-pole four-way wafer switch can be used to select twin-T filter capacitance values.

### CONSTRUCTING AND USING THE FREQUENCY METER

Constructional details of the frequency meter output module are shown in Fig. 9. A suggested layout in a metal box, similar to that used for the alpha-telephone, will be found in Fig. 10. C16 is mounted on the meter terminals.

Plug headphones into SK4, leave the head electrodes disconnected from SK1 and SK2, and set VR1 and VR2 to minimum resistance, and VR3 and VR4 to maximum resistance. Switch on the

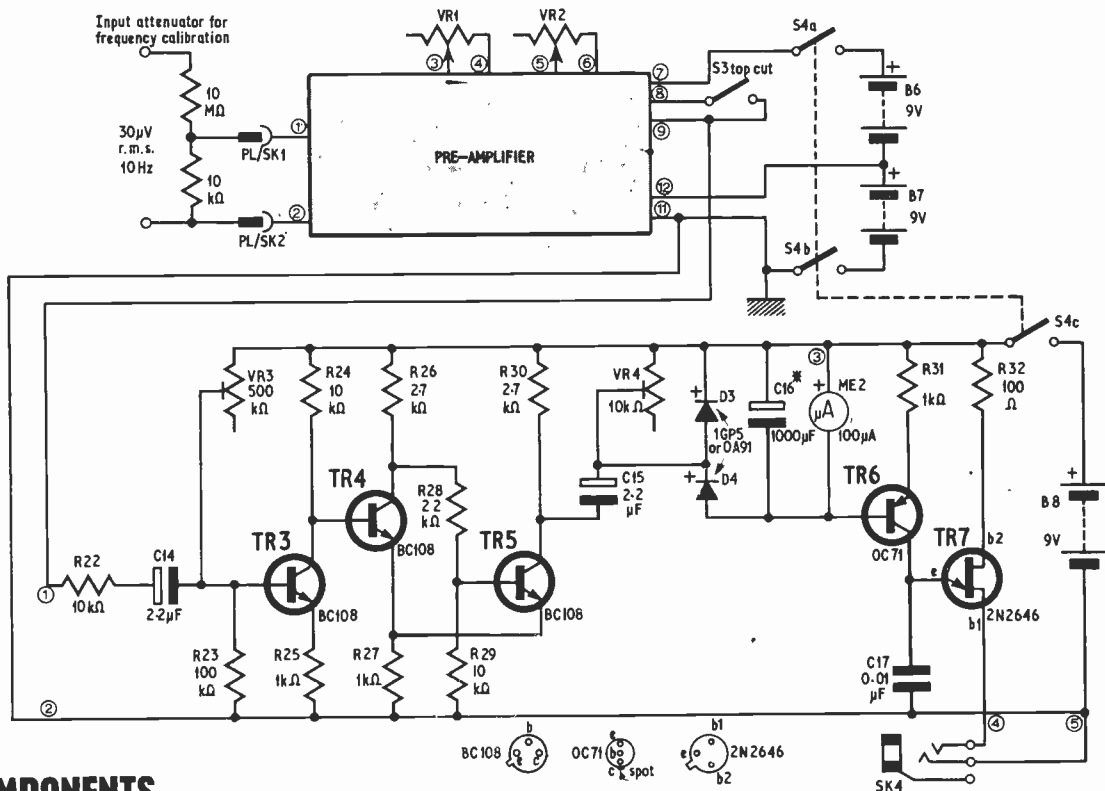


# Biological Amplifier

By D. BOLLEN







## COMPONENTS . . .

### ADDITIONAL COMPONENTS FOR FREQUENCY METER

#### Resistors

R22 10k $\Omega$	R26 2.7k $\Omega$	R30 2.7k $\Omega$
R23 100k $\Omega$	R27 1k $\Omega$	R31 1k $\Omega$
R24 10k $\Omega$	R28 22k $\Omega$	R32 100 $\Omega$
R25 1k $\Omega$	R29 10k $\Omega$	

All  $\pm 10\%$   $\frac{1}{2}$  watt carbon

#### Potentiometers

- VR3 500k $\Omega$  sub-min horizontal pre-set
- VR4 10k $\Omega$  sub-min horizontal pre-set

#### Semiconductors

TR3 BC108	TR6 OC71
TR4 BC108*	TR7 2N2646
TR5 BC108	D3, D4 IGP5 or OA91

#### Capacitors

- C14 2.2 $\mu$ F tantalum 35V
- C15 2.2 $\mu$ F tantalum 35V
- C16 1,000 $\mu$ F elect. 3V
- C17 0.01 $\mu$ F polyester

#### Meter

- M2 100 $\mu$ A edgewise type level indicator

#### Switches

- S3 single-pole, on-off sub-miniature
- S4 3-pole, 2-way wafer

#### Socket

- SK4 3-pole jack

#### Batteries

- B6, B7, B8 9 volt style PP3 (3 off)

#### Miscellaneous

- 8 ohm mono or stereo headphones, electrodes, battery connectors, metal box.

Fig. 8. Wiring of the pre-amplifier to the frequency meter circuit to measure brain rhythm rates

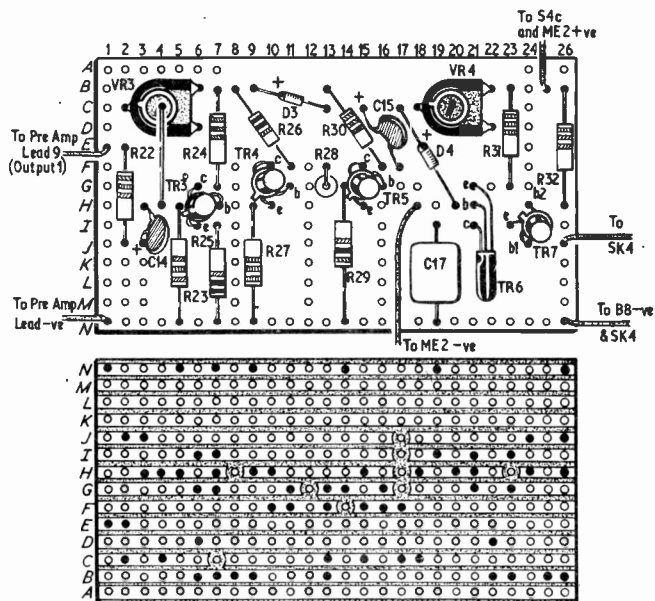


Fig. 9. Layout and wiring of the frequency meter board

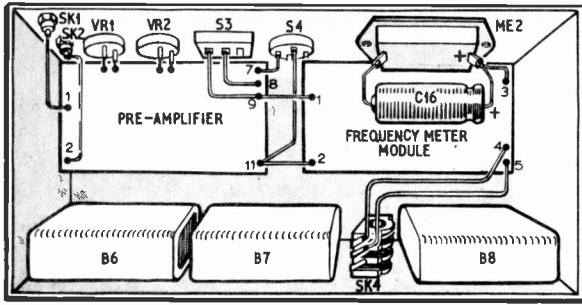


Fig. 10. Suggested layout of components for the brain rhythm frequency meter circuit shown in Fig. 8

instrument and listen for a steady low note in the phones. Advance VR3 until the audio note just starts to rise slightly.

If an accurately calibrated audio oscillator with an output of around 30 millivolts r.m.s. at 10Hz is available, connect this to the pre-amplifier input via a 10 megohm resistor, with a 10 kilohm resistor shunting SK1 and SK2. Set VR1 for a steady deflection of meter ME2, and adjust VR4 for a half full scale reading, corresponding to 10Hz.

In the absence of an audio oscillator, set up the frequency meter for alpha rhythms (with head electrodes on a subject who can generate steady alpha rhythms) and adjust VR4 for a mean meter reading of 10Hz. With the eyes open, ME2 should fluctuate between 2-7Hz, indicating the presence of random brain noise and low level theta.

As an experiment, measure a subject's alpha frequency and then ask them to have a drink (alcoholic). After 15-30 minutes the alpha frequency should fall by several hertz. A whole range of experiments can be conducted with the frequency meter, such as mental reactions to various stimuli, or the effect of dreams on sleep rhythms.

## ELECTRODE SITING

With previous projects the earthed electrode (SK2) was sited on the forehead so that eyeblink signals

could be used to test equipment in the absence of alpha rhythms, but in some investigations eyeblink pulses can be a nuisance. Alpha, theta, and delta signals are best obtained from the back of the head, with the earthed electrode positioned an inch or two from the live electrode. For beta signals the electrodes can be placed on the forehead or near the cheeks, but watch for noise generated by facial muscles and eyes.

If the earthed electrode is placed on the neck, or other parts of the body, while observing brain rhythms, a strong heartbeat pulse will be superimposed, tending to block the brain signals.

## CARDIOPHONE

Stress situations, like running for a bus, attending an interview, sitting an exam, or appearing before an audience, are usually attended by an obvious increase in heartrate, but during the course of an uneventful day the heart also responds to numerous minor stress situations which normally pass unnoticed.

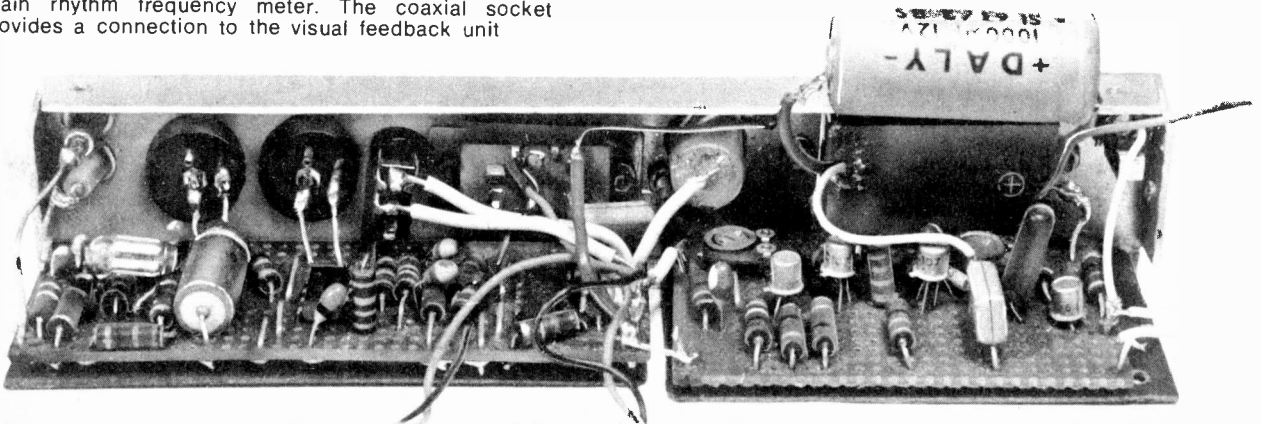
By making the heartbeat clearly audible, it is possible to detect these subtle changes, and perhaps learn to control them. This is really an example of bio-feedback. If the heart speeds up slightly in response to some unconscious stimulus, you become aware of it and seek to reduce it.

Conversely, it may also be possible to induce an artificial state of excitement by consciously trying to increase heartrate, and thereby cause more adrenalin to be released into the system.

In the cardiophone circuit (Fig. 11) transistor TR8 is in series with the emitter supply to a stable multivibrator TR9 and TR10. In the absence of a heartbeat signal, TR8 base is grounded (by R16, Fig. 3) and the multivibrator is therefore switched off. Diode D1 in the pre-amplifier, rectifies a heartbeat signal and applies a positive going pulse to TR8 base, thus switching on TR8 and the multivibrator, and causing a 300Hz audio "bleep" tone to be heard in the earpiece X1.

Switch S5 in Fig. 11 gives additional top cut to suppress mains borne interference.

Brain rhythm frequency meter. The coaxial socket provides a connection to the visual feedback unit



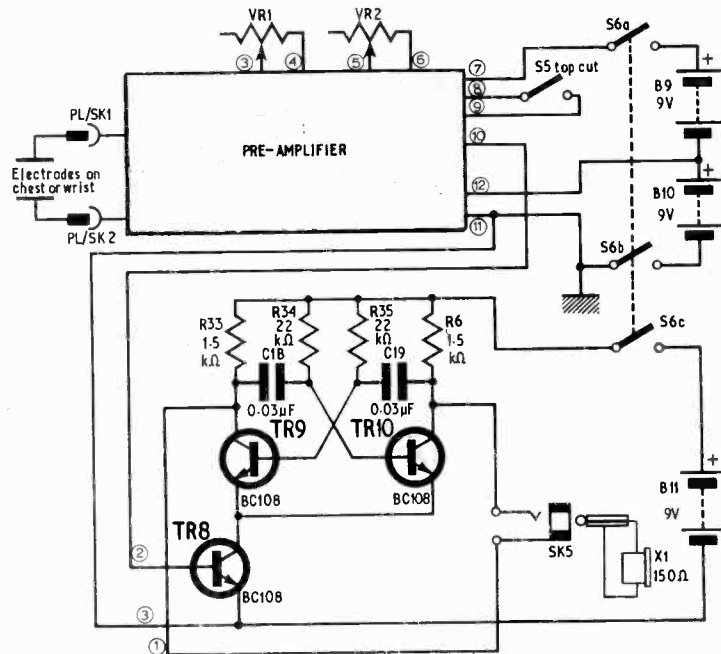


Fig. 11. The pre-amplifier used with a cardio-phone circuit

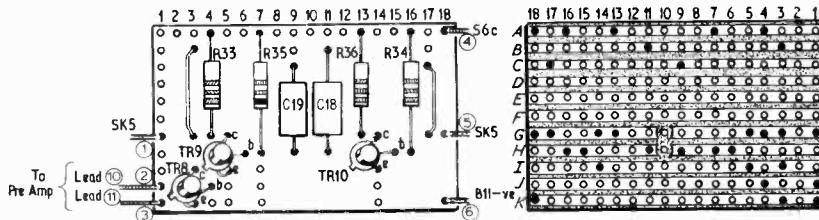


Fig. 12. Layout and wiring of the cardio-phone output module

## COMPONENTS . . .

### ADDITIONAL COMPONENTS FOR CARDIOPHONE

#### Resistors

R33 1.5k $\Omega$   
 R34 22k $\Omega$   
 R35 22k $\Omega$   
 R36 1.5k $\Omega$   
 All  $\pm 10\%$   $\frac{1}{2}$  watt carbon

#### Capacitors

C18 0.03 $\mu$ F polyester  
 C19 0.03 $\mu$ F polyester

#### Transistors

TR8 BC108  
 TR9 BC108  
 TR10 BC108

#### Earpiece

X1 150 ohm magnetic

#### Switches

S5 Single-pole, on-off sub-miniature toggle  
 S6 3-pole, 2-way wafer

#### Batteries

B9, B10, B11 9 volt style PP3 (3 off)

#### Socket

SK5 3.5mm 2 pole jack

#### Miscellaneous

Electrodes  
 Battery connectors  
 Metal box (see text)

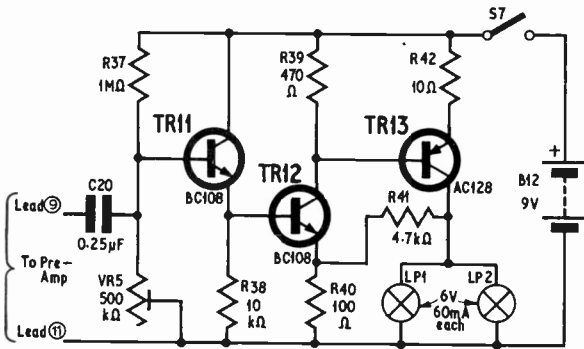


Fig. 13. Circuit of the visual feedback lamp driver

## COMPONENTS . . .

### ADDITIONAL COMPONENTS FOR VISUAL FEEDBACK LAMP DRIVER

#### Resistors

R37 1MΩ  
 R38 10kΩ  
 R39 470Ω  
 R40 100Ω  
 R41 4.7kΩ  
 R42 10Ω  
 All ±10% ½ watt carbon

#### Potentiometer

VR5 500kΩ sub-miniature horizontal mounting preset

#### Capacitor

C20 0.25μF miniature polyester

#### Transistors

TR11 BC108  
 TR12 BC108  
 TR13 AC128

#### Switch

S7 Single-pole, on-off toggle or slide

#### Lamps

LP1, LP2 6V 60mA m.e.s.

#### Battery

B12 9 volt style PP9

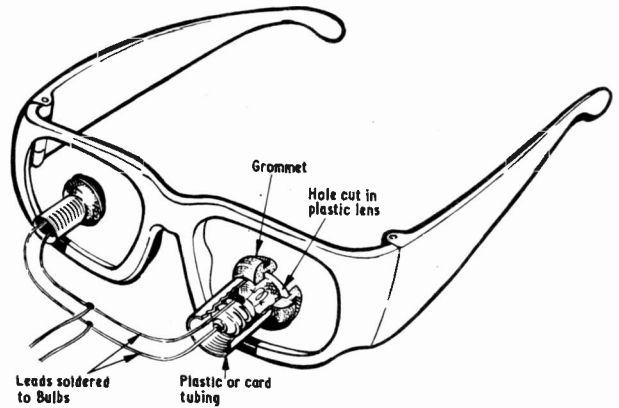


Fig. 14. The method of mounting the lamps in plastic lens sunglasses

## CONSTRUCTING AND USING THE CARDIOPHONE

The cardiophone output module circuit board (Fig. 12) may be housed, along with the pre-amplifier module, in a metal box similar to that used for previous projects. Socket SK5 must be insulated from the box.

Electrodes for use with the cardiophone can either be positioned a few inches apart on the left side of the chest, or one on each wrist, and held in place with elastic straps.

Set VR1 to minimum gain, and VR2 to wideband, with S5 open circuit. Plug earpiece X1 into SK5, the electrode leads into SK1 and SK2, and switch on. If no heartbeat "bleep" is heard, advance VR1. When the heartbeat is masked by interference, close S5, and adjust VR1 and VR2 for a clear signal.

Try using the cardiophone with a friend who is driving a car. The "bleep" rate will increase when negotiating roundabouts, traffic lights, and congested streets, and will rise sharply when overtaking.

## VISUAL FEEDBACK

The lamp driver circuit in Fig. 13 can be employed as an external unit to extend the scope of previous projects. An output taken from the scope of previous projects (output 1) is amplified to a level sufficient to flash two low consumption filament lamps (LP1 and LP2) which are mounted close to the eyes in a pair of cheap plastic lens sunglasses; see Fig. 14.

When driven by brain rhythms, visual feedback will produce an interesting variety of "strobe" effects while leaving the ears free to, say, listen to music or other sound sources.

If the lamp driver circuit is housed in a small plastic box, it can be coupled to the alphaphone, alphascope, frequency meter, or cardiophone, via screened cable to a coaxial socket which connects with pre-amp output 1. VR5 is adjusted so that both lamps just glow when there is no signal. Setting up instructions are otherwise the same as for previous projects.



**Note:** pin 12 in the case interwiring diagram in Fig. 5 (last month) should be designated pin 11 to agree with the practical circuit.

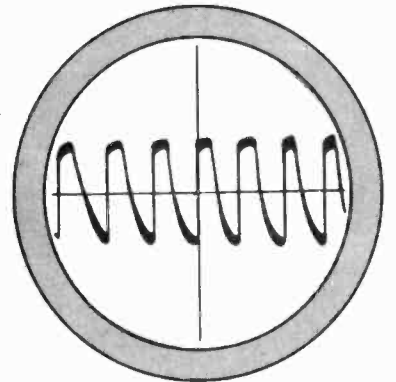
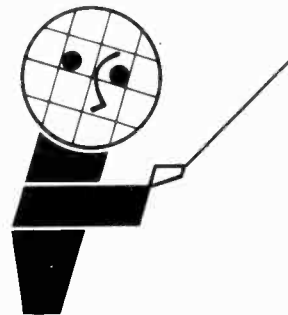


Brain rhythm frequency meter. The coaxial socket provides a connection to the visual feedback unit

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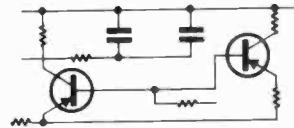
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61	100	5 12	10.2 x 8.9 x 8.3	2.62	52
30	200	9 8	12.0 x 10.3 x 10.0	4.39	52
62	250	12 4	9.5 x 12.7 x 11.4	5.80	67
55	350	15 0	14.0 x 10.8 x 12.4	7.77	82
63	500	27 0	17.1 x 11.4 x 15.9	11.20	20
92	1000	40 0	17.8 x 17.1 x 21.6	20.63	*
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4	150	3 0	8.9 x 6.4 x 7.6	0-115-200-220-240	2.09	36
66	300	6 0	10.2 x 10.2 x 9.5	"	3.89	52
67	500	12 8	14.0 x 10.2 x 11.4	"	5.78	67
84	1000	16 0	11.4 x 14.0 x 14.0	"	10.49	82
93	1500	28 9	13.5 x 14.9 x 16.5	"	15.20	*
95	2000	40 0	17.8 x 16.5 x 21.6	"	19.84	*
73	3000	45 8	17.4 x 18.1 x 21.3	"	26.99	*

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71	2	1	1	7.0 x 6.4 x 5.7	0-12V at 1A x 2	1.33	22
18	4	2	2	8.3 x 7.0 x 7.0	0-12V at 2A x 2	1.86	36
70	6	3	3	10.2 x 7.6 x 8.6	0-12V at 3A x 2	2.24	42
108	8	4	5	10.0 x 8.3 x 8.2	0-12V at 4A x 2	2.48	52
72	10	5	6	7.9 x 10.8 x 10.2	0-12V at 5A x 2	2.94	52
17	16	8	7	12.1 x 9.5 x 10.2	0-12V at 8A x 2	4.54	52
115	20	10	11	12.1 x 11.4 x 10.2	0-12V at 10A x 2	5.78	67
187	30	15	16	13.3 x 12.1 x 12.1	0-12V at 15A x 2	10.67	82
226	60	30	34	17.0 x 14.5 x 12.5	0-12V at 30A x 2	19.61	*

## 30 VOLT RANGE

Ref. No.	Amprs.	Weight lb oz	Size cm.	Secondary Taps	P & P £	P & P p	
112	0.5	1	4	8.3 x 3.7 x 4.9	0-12-15-20-24-30V	1.01	22
79	1.0	2	0	7.0 x 6.4 x 6.0	"	1.35	36
3	2.0	3	2	8.9 x 7.0 x 7.6	"	2.01	36
20	3.0	4	6	10.2 x 8.9 x 8.6	"	2.48	42
21	4.0	6	0	10.2 x 10.0 x 8.6	"	2.94	52
51	5.0	8	0	12.1 x 10.8 x 8.6	"	3.65	52
117	6.0	7	8	12.1 x 10.0 x 10.2	"	4.83	52
88	8.0	10	0	14.0 x 11.7 x 10.0	"	5.64	67
89	10.0	12	2	14.0 x 10.2 x 11.4	"	7.14	67

## 50 VOLT RANGE

Ref. No.	Amprs.	Weight lb oz	Size cm.	Secondary Taps	P & P £	P & P p
102	0.5	1 11	7.0 x 7.0 x 5.7	0-19-25-33-40-50V	1.33	30
103	1.0	2 10	8.3 x 7.3 x 7.0	"	1.94	36
104	2.0	5 0	10.2 x 8.9 x 8.6	"	2.69	42
105	3.0	6 0	10.2 x 10.2 x 8.3	"	3.65	52
106	4.0	9 4	12.1 x 11.4 x 10.2	"	4.83	52
107	6.0	12 4	12.1 x 11.1 x 13.3	"	7.14	67
118	8.0	18 9	13.3 x 13.3 x 12.1	"	9.32	97
119	10.0	19 12	16.5 x 11.4 x 15.9	"	11.68	97

## 60 VOLT RANGE

Ref. No.	Amprs.	Weight lb oz	Size cm.	Secondary Taps	P & P £	P & P p
124	0.5	3 4	8.3 x 9.5 x 6.7	0-24-30-40-48-60V	1.35	36
126	1.0	3 0	8.9 x 7.6 x 7.6	"	1.88	36
127	2.0	5 6	10.2 x 8.9 x 8.6	"	2.94	42
125	3.0	8 8	11.9 x 9.5 x 10.0	"	4.48	52
123	4.0	10 6	11.4 x 9.5 x 11.4	"	5.78	67
120	6.0	16 12	13.3 x 12.1 x 12.1	"	8.37	82
122	10.0	23 2	16.5 x 12.7 x 16.5	"	13.85	*

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86	6.0	5 12	10.2 x 8.9 x 8.3	3.07	52
146	8.0	6 4	8.9 x 10.2 x 10.2	3.49	52
50	12.5	11 14	13.3 x 10.8 x 12.1	5.20	67

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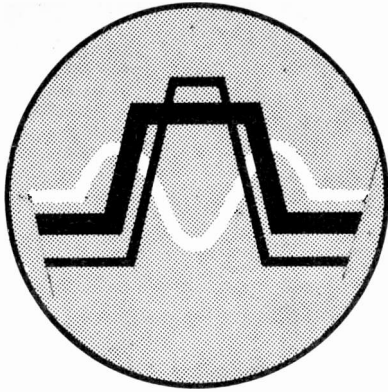
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# Audio Frequency Discriminator

By G.F.A. HOFFMAN de VISME

A CIRCUIT for distinguishing between two notes whose frequencies are very close together and whose amplitudes may differ greatly is shown in Fig. 1. The operation of the circuit does not depend on the use of filters, and notes of any frequency may be distinguished by simple potentiometer adjustment.

The circuit was designed for a project in which it was necessary to distinguish between notes differing in frequency by as little as 20Hz, the mean frequency of the notes lying in the range 300 to 1500Hz. The amplitudes of the notes could differ by as much as a factor of ten, and the notes themselves were not free of distortion. In addition, a certain amount of acoustic noise was present during the experiment.

The requirement was that when the higher pitched note was sounded a bistable should be set, and when, after an unspecified period of silence, the lower pitched note was sounded the bistable should be reset. There was no need for undue speed in the response of the bistable since each note was sounded for some seconds.

Whilst audio frequency filters can be devised to meet the above demands, there are well known difficulties with these as regards the realisation of high  $Q$  at low frequency and as regards tuneability, and sensitivity to signal amplitude. The method described below is a simple alternative which achieves the required objectives without the use of filters or counting techniques.

Although originally designed for a project involving acoustic measurements such a circuit could be used in a variety of practical situations. For example it could be used to enable the driver of a moving vehicle to switch on (and switch off) a stationary warning light of some kind by sounding notes of appropriate frequencies. Alternatively an operator could use the circuit to control a model railway

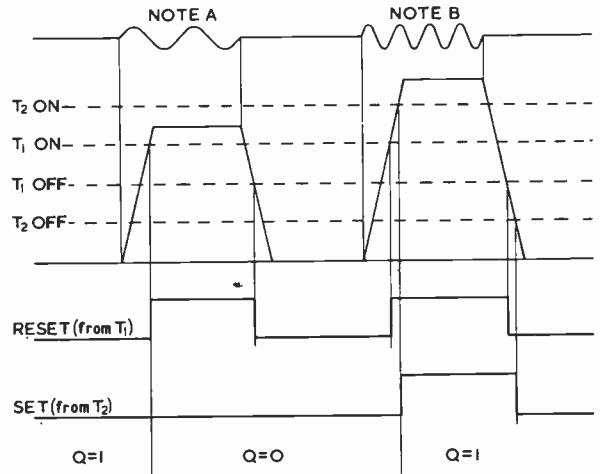


Fig. 2. Trip circuit switching levels and waveforms

acoustically, or, by sounding horns of different frequency, a motorist could open and close his garage doors from his driving seat.

Although the circuit as described here consists of discrete components, every part of it except the emitter followers and pump circuit is realisable using standard integrated circuit modules. In this form the circuit could be made extremely compact.

## PRINCIPLE OF OPERATION

Fig. 1 is a block diagram of the circuit. The audio signal, after amplification, is squared by a Schmitt trigger circuit to yield a wave with sharp leading and trailing edges. The squared signal is applied to a diode pump circuit designed to give a d.c. output

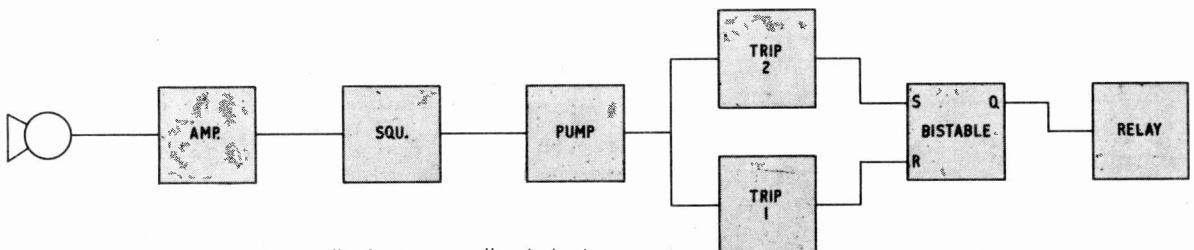
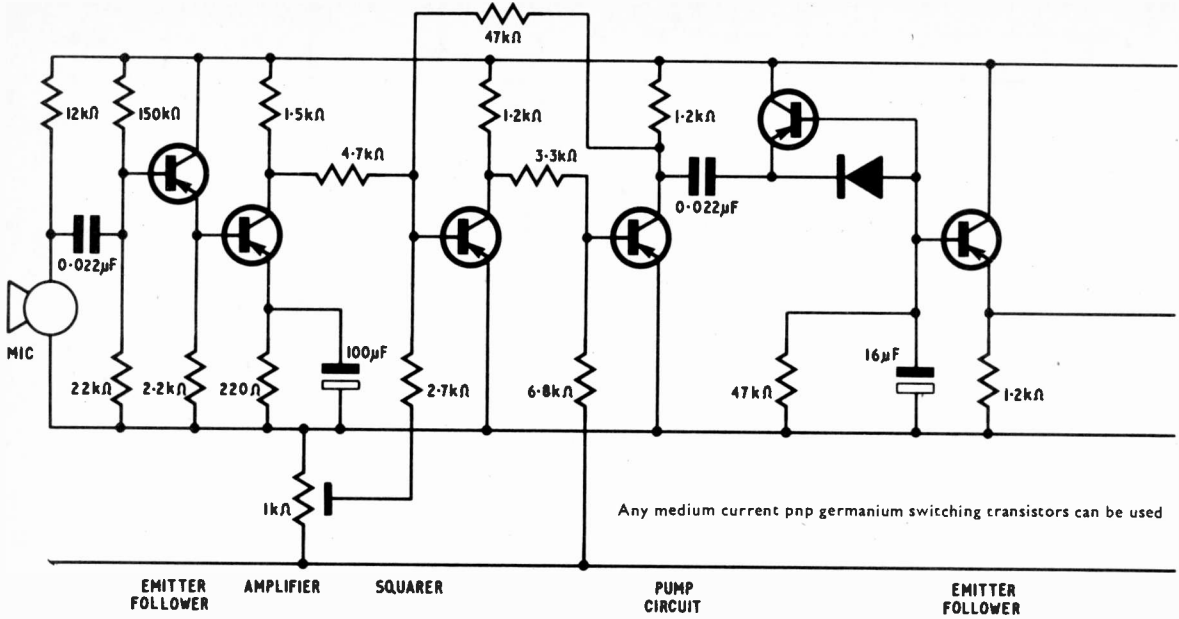


Fig. 1. Block diagram of the audio frequency discriminator

Fig. 3. Circuit diagram of the a.f. discriminator



as nearly as possible proportional to the signal frequency. Thus if a note A is sounded a voltage of, say, 4 volts appears at the output of the pump circuit, while if a higher pitched note B is sounded a voltage of, say, 5 volts appears there. It is required, therefore, that the bistable, if set, should be reset by the 4 volts signal due to note A, and if reset, it should be set by the 5 volt signal due to note B.

To achieve this the pump circuit output is applied simultaneously to two trip circuits. The switching levels of these are so arranged that when note A is sounded only Trip 1 switches, while when note B

is sounded both are switched. The signals from these trips are then used as the reset and set signals, respectively, of a bistable whose output controls a relay. In order to ensure that the bistable remains set after note B has ended the switch-off level of Trip 2 is made lower than the switch-off level of Trip 1. In this way the set signal produced by Trip 2 lasts until after the reset signal from Trip 1 has ended.

Fig. 2 shows the waveforms from Trip 1 and Trip 2 and the corresponding bistable output, resulting from notes A and B respectively.

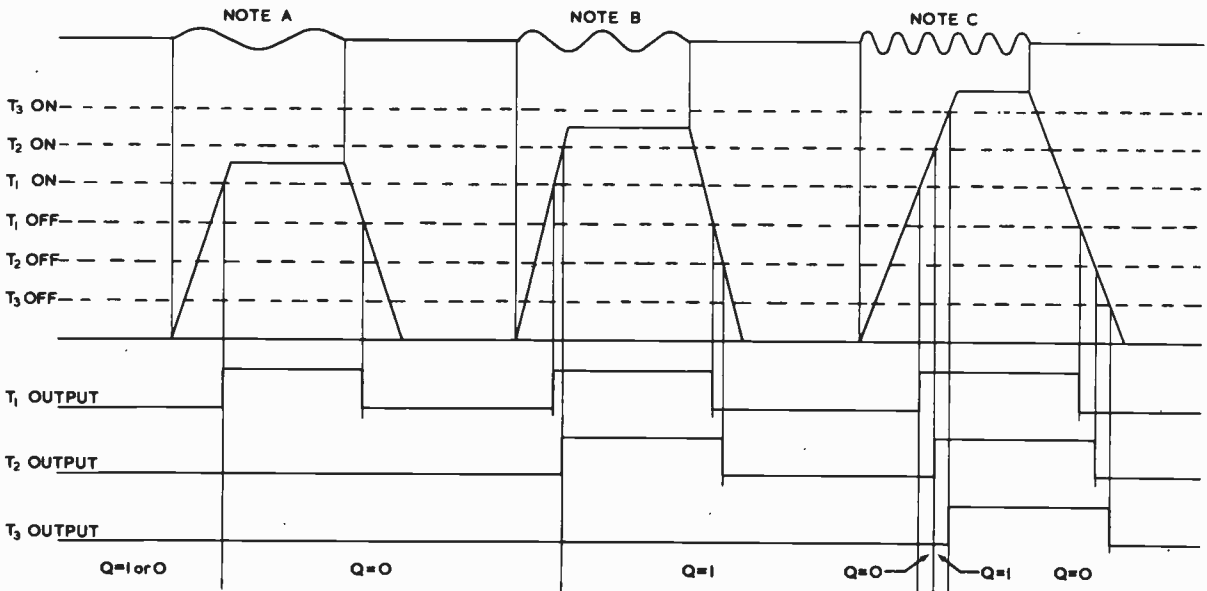
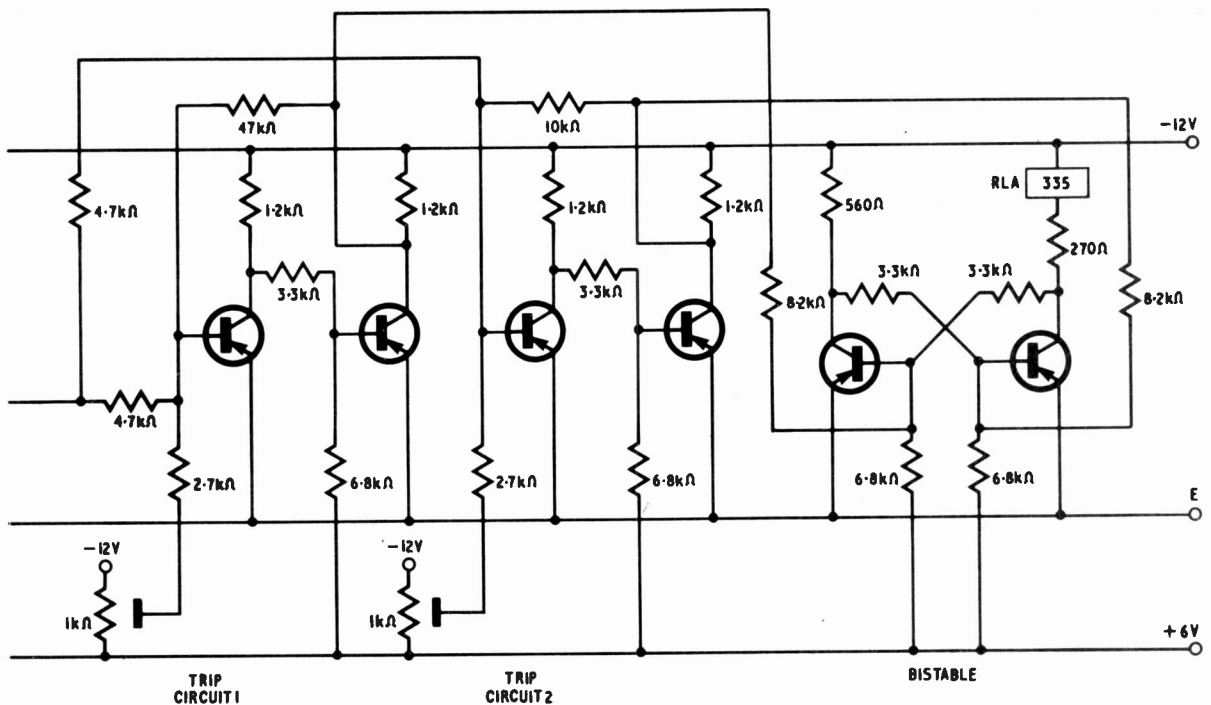


Fig. 4. Trip circuit and bistable outputs from selective discriminator





## CIRCUIT FEATURES

Fig. 3 shows the circuit of the discriminator using all discrete components. Most of the circuitry is conventional, but suitable circuit values are included for the benefit of readers.

The only features worthy of note concern the pump circuit. To ensure a reasonably linear voltage-frequency characteristic from this stage capacitive loading of the previous stage must be small, hence the relatively small coupling capacitor ( $0.022\mu\text{F}$ ), and a transistor must be used in the place of the usual shunt diode. Adequate sensitivity then demands a fairly large shunting resistor ( $47\text{ k}\Omega$ ), which therefore necessitates the inclusion of an emitter follower between the pump circuit and the trip circuits.

A large value ( $16\mu\text{F}$ ) is used for the reservoir capacitor to slow down the speed of the response of the pump circuit and so minimise its sensitivity to background noise.

## PERFORMANCE

The discrimination attainable by the above circuit was found to depend to a large extent on the purity of the notes used as signals. The following table shows how the pump circuit output varies with signal frequency, the signal being provided by a signal generator rather than a microphone:

Frequency (Hz)	300	400	500	600	700
Pump circuit output (volts)	2.7	3.6	4.5	5.3	6.1

By setting the switch-on and switch-off levels of Trip 1 to 3.8 and 3.1 volts, respectively, and those of Trip 2 to 5.3 and 1.6 volts, respectively, it was possible to distinguish signals of frequency 590Hz and 600Hz with complete reliability. Using a good quality microphone and real notes generated by a

loudspeaker the performance was almost as good (570Hz and 590Hz) even though the notes from the speaker were noticeably distorted. With a poor (carbon) microphone, however, the discrimination was much poorer due to frequency jitter at the output of the squarer.

## BAND-PASS FILTERING

The above principle may readily be extended to provide selective discrimination, whereby, if A, B and C are notes of successively higher pitch, A or C reset a bistable which has been previously set by B. In this case three trip circuits are used, the switching levels of Trip 1 being arranged to lie within those of Trip 2, which in turn lie within those of Trip 3. As shown in Fig. 4, note A causes only Trip 1 to switch, note B causes Trip 1 and Trip 2 to switch, while note C causes all three to switch.

When notes A, B and C are sounded in turn the trip circuit outputs pursue sequences as shown in the following table. The required output Q from the bistable is shown alongside, the symbol Q' representing "the previous value of Q":

OUTPUTS	Note A	Note B	Note C
Trip 1	010	01100	0111000
Trip 2	000	00110	0011100
Trip 3	000	00000	0001110
Bistable (Q)	Q'00	Q'0111	Q'010000

From this table it is easy to deduce that the reset signal for the bistable has to be  $\bar{T}_1$  (the inverse of the Trip 1 output), while the set signal has to be  $T_2 + T_3$  (i.e. the inverse of the Trip 2 output OR the Trip 3 output). ★



BY FRANK W. HYDE

### SATELLITE CAMERAS

Cameras that have been developed and used with such great success on satellites and other spacecraft have been mainly devoted to the obtaining of high definition. Similarly with television cameras where the task is much more difficult, the British company EMI have made a major contribution in this field. They developed a low light tube which was used in the *ESRO TD-1* spacecraft launched in March 1972, and was part of a French experiment to map gamma rays from the galaxy. It was the first time that a European camera tube has been used in space.

The tube, known as the Ebitron, was developed at Hayes, Middlesex, by EMI Central Research Laboratories. It is an intensifier vidicon tube measuring 160mm by 64mm and is claimed to be the smallest tube of its type in the world. It formed the "seeing" part of the camera designed by the French company Engins Matra. The camera with its associated equipment is quite light, the camera itself weighing only 1.8kg.

The EMI tube was chosen because of its small size, low weight and its ability to "see" in near darkness. Its ease of operation, fast response, low light requirement made it ideal for recording the sparks caused in a gas chamber by the passage of gamma rays.

As gamma rays pass through the gas filled chamber the gas becomes ionised leaving trains of sparks. These are short lived (a few millionths of a second only) and of low intensity.

A series of mirrors is arranged so that two sides of the chamber can be viewed by the Ebitron thus enabling a three dimensional image to be obtained. The information is

stored and transmitted to earth stations for analysis by computer.

The *TD-1* is the first satellite to scan the whole sky and also the first to be able to operate in full daylight. The picture of the sky is built up over a period of six months from a polar orbit of some 500km altitude. The satellite is one of the most advanced in operation put into space. It was launched on a *Thor-Delta* rocket from the Western Test Range in California.

### ECOLOGICAL STUDIES FROM SPACE

Aboard the Earth Resources Satellite which was launched in July 1972 were cameras designed by RCA for high resolution TV. These cameras can detect crop diseases and pollution sources in the course of making their scanning passes.

The system which consisted of three cameras was designed by the Astro-Electronics Division of RCA at Princeton, N. Jersey. They have produced a picture which is some ten times sharper than the kind that appears on home television sets.

Each camera uses 4,000 horizontal scanning lines for the building of a picture. From a height of some 900km each camera will be able to view the same area of 180km<sup>2</sup>. Each camera observes in a different part of the spectrum, one in red, one in infra-red and the third in green. After transmission to Earth the three images are combined and the composite picture can then be studied.

It is perhaps worthwhile to point out that this technique was used ten years ago by Ian Whitacker when studying the moon. Later other astronomers used the same technique.

Now its use has been extended to the study of the environment and has proved exceptionally valuable. Already the diseased areas of various food crops have been photographed, as well as silt movement from estuaries into the sea and the direction of ocean currents have also been mapped.

One of the advantages of this kind of photography is that the altitude of the satellite gives orthographic pictures so that the proper spacial relationships are directly seen. No corrections are required to show the real condition without the spacial distortion that arises from ordinary mapping.

As the orbit of the satellite is synchronised with the Sun the same lighting conditions exist for each area viewed, thus avoiding distortions that appear when using other methods of carrying cameras aloft which are subject to changing angle of the light of the Sun. The full significance of this aspect can be appreciated when it is understood that only 72 per cent of the habit-

able land has been mapped in detail and of this more than 50 per cent of those that exist are out of date.

The new mapping will now fill in this gap, and not only that, each area will be mapped 18 to 20 times a year.

### INDIA AND SPACE ACTIVITY

India has been very active in the field of space development, as well as in radio astronomy. There are plans afoot to build the first all-India satellite for launch in 1974.

It is expected that the launch vehicle will be Russian and will carry a satellite weighing about 100kg. There will be three experiments on board which have been designed by ISRO (India Space Research Organisation) and will be built entirely in India.

Development is also proceeding on a design for a carrier vehicle expected to be ready by the end of 1974. It is a four stage design similar to the *Scout* rocket. It will be capable of putting a 40kg package into orbit at about 400km altitude.

It is planned that the first firing be made to gain experience. Later launchings will carry on-board experiments. This will be worked up eventually to a coverage for educational purposes.

By 1974 India will have access to the NASA satellite *ATSF* which will be launched in 1973. This will enable India to have the facility to cover some 5,000 villages for educational purposes. India will design and manufacture the small and rugged battery receivers needed and also the 10ft diameter aerials made of chicken wire.

There are two major satellite communications stations in India one at Avi and the other at Ahmedabad. The dishes at these sites are 30m dia. Most of the research is carried out at the National Aeronautical Laboratories in Bangalore. There are divisions there covering Aerodynamics, Propulsion, Materials, Electronics, Instrumentation and Structures.

India suffered a severe blow with the death of their leading scientist Vikam Surabhai in 1971. However, such was the nature of his forward planning that India has today a very successful space research team.

India has contributed quite considerably already to the space programmes of other countries. From the launching sites at Thube near Travandram, which is U.S. sponsored, several hundred launchings have taken place. Rockets, probes, and satellites of British, French, Russian and Indian origin have already been launched from there.

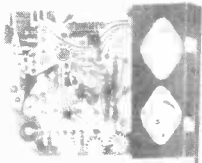
A new site now being completed, the Shrihameola Range, will extend India's future space activities even further.

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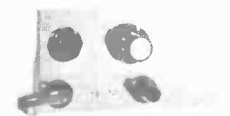


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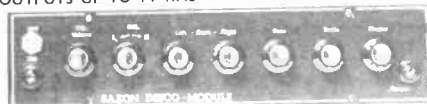
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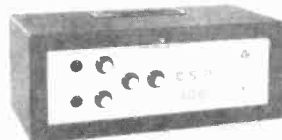
Two decks, and full headphone monitoring. The unit is mains operated and measures 17½in x 3in x 4in deep and is finished with a smart white on black fascia. The controls are: Left/Right deck fader, volume, bass, treble, headphone selector and volume, microphone volume, bass, treble, mains on/off. **THIS IS A MUST FOR THE HOME BUILT HIGH QUALITY DISCO-THEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE.**

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# report from AUSTRALIA

BY J.M.WALDIE

## FM BROADCASTING

The Australian Broadcasting Control Board has been enquiring into the desirability of f.m. radio in Australia and has now issued its findings in a 100-page volume entitled "Frequency Modulation Broadcasting". The board examined some 150 written submissions and 70 formal exhibits, and employed its Technical Services Division to carry out an examination "of every technical problem considered to be possible".

The upshot of this deliberation is to recommend that f.m. broadcasting should be introduced, and this has been endorsed by the Government.

This is, in fact, the third time that official committees in one form or another have examined f.m. radio in Australia. The first was in 1942 and resulted in the installation of four experimental transmitters, operating in Sydney, Melbourne, Brisbane and Adelaide in 1948.

## OBJECTIONS

In 1957, the board conducted a public enquiry and found "very real practical objections to the introduction of f.m. broadcasting". The four stations, which by then were transmitting for some 80 hours weekly using substantially the same material as was included in the more serious of the then two ABC programmes, were closed down in 1961 to allow for expansion of the television services from 10 to 13 channels.

This situation, in which the v.h.f. band is more or less saturated with television and other services, provided a large headache for the enquiry just completed. It was preferable to use the v.h.f. band for the projected radio service for obvious reasons: the technology was well known and the signal propagation would be relatively high. However, this meant the abolition or re-allocation of one or more television channels with obvious disadvantages and the possible need to use bandwidths of as low as 0.4MHz.

The alternative was to use the u.h.f. band, which is relatively uncluttered, but this, too, has disadvantages: no other country uses u.h.f. for f.m., and standardisation should be the aim; the technology

was virtually unknown; the coverage obtainable would be lower than with v.h.f.

However, the die is now cast: the recommended bandwidth (allowing 20 stations to cover each area) is 40MHz and the suggested frequency range is 470-510MHz. Local manufacturers have three years in which to decide on the technical standards for u.h.f. reception and transmission.

## PLANS FOR THE FUTURE

The aim is to provide two national stations, one to transmit the current ABC network for provincial and country areas, and the second, city-based, to provide a second "fine music" network. Commercial stations will also be licensed. Finally, a new type of station will be introduced, on a non-profit basis, to cater for the needs of minority groups. All these stations can transmit stereophonically.

It has been suggested, with just a hint of patriotism, that Australia's venture into u.h.f. broadcasting might just be the shot in the arm that the local manufacturers claim is needed. It will be interesting to see if the Japanese will produce a u.h.f.-f.m./a.m. receiver for the Australian market by 1978.

## AUDIO SHOW

There can be no doubt that hi-fi enthusiasts (at least in Sydney) have an extremely large selection of equipment available to them, if the 1972 Audio Show, held in Sydney on August 9-13, is any guide. It is equally true to say that the average buyer can not be badly off; the manufacturers and importers, in conjunction with Australian hi-fi, must be conscious of a considerable interest to stage an exhibition of this magnitude.

The show actually covered three floors of a moderately large multi-storey motel. The ground floor was relegated to 16 large (silent) displays; two upper floors were used to demonstrate, in over 40 individual suites, the complete range from any one manufacturer or selected combinations.

More than half the equipment shown originated in Japan, with all the major names being present. British exhibitors included Garrard

(the Zero 100 deck was used in many stands), Wharfedale, KEF (who have, along with Leak and Goodmans, commenced local production), Plessey, BSR, and B&W.

## NEW DEVELOPMENTS

Interesting new developments for the cassette enthusiast included the new Sony deck (TC 165) with automatic and continuous reverse facilities, several new decks with in-built Dolby, including National, TEAC, Kenwood and Pioneer, and a C 180 cassette, and an endless loop cassette, both from TDK.

There were many four-channel units demonstrated, but by far the most impressive was one line-up consisting of a four-track TEAC 3340 deck, feeding two JVC PST 1000 stereo graphic equalisers, in turn feeding two phase linear power amplifiers whose 2,800 watts (r.m.s.) output was handled by four ESS transmission line speakers—and this in a room measuring about 12ft x 15ft! Cost—about £4,000, but trade-in's are acceptable.

## OPTICAL COMMUNICATIONS

Australian communications may benefit from a new joint venture by Amalgamated Wireless (Australasia) Ltd., and the Tribophysics Division of the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The CSIRO have developed a new type of optical fibre, consisting of a liquid-filled hollow glass tube.

Although finer than a human hair, the fibre could transmit more information than existing wide-band microwave and coaxial communication links. Using a helium-neon injection laser as a light source, for example, it is claimed that, using the new fibre, previous disadvantages of signal loss over long distances using light guides are overcome.

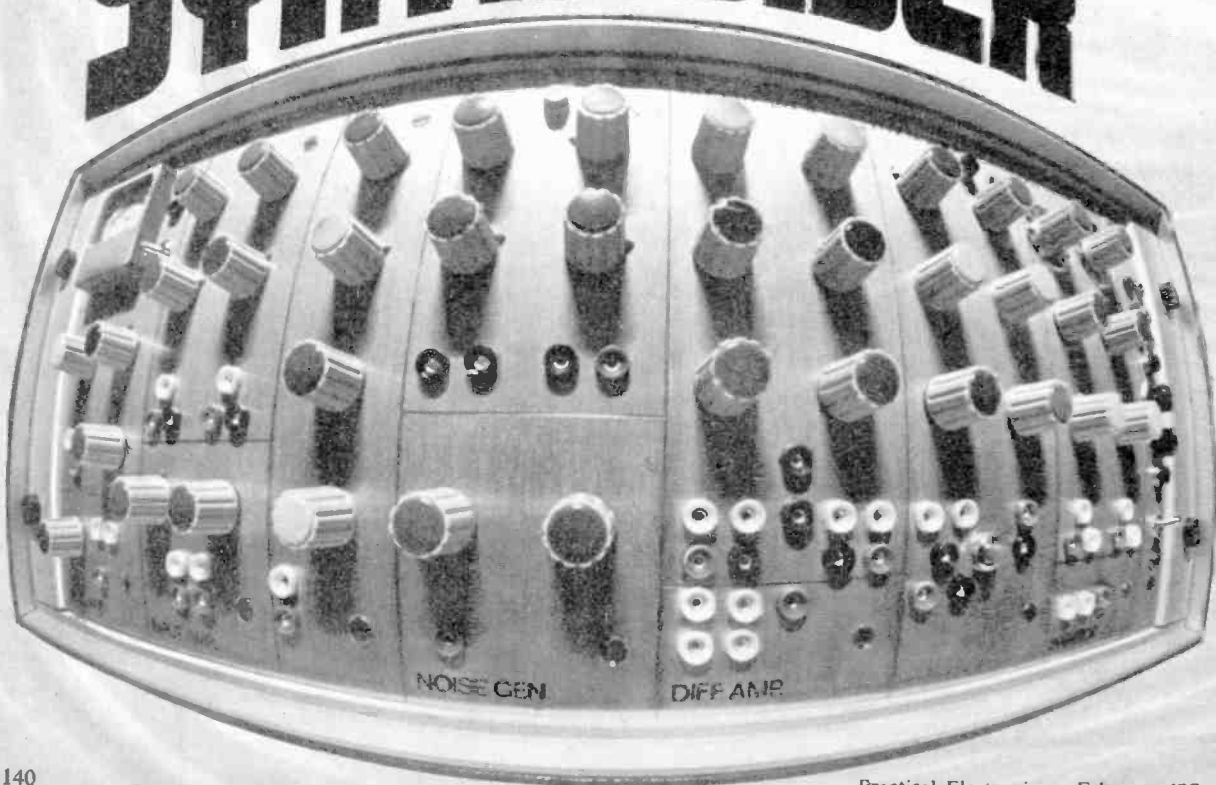
The system has been made available to the Australian Post Office for its research laboratories to evaluate the fibre's potential in the development of Australia's Telecommunications network.

It is certainly a far cry from that eventful day in 1870 when John Tyndall showed that light could be borne by a liquid around corners.

A VERSATILE INSTRUMENT FOR THE COMPOSER,  
MUSICIAN OR KEEN EXPERIMENTER  
IN THE CREATION OF SOUNDS  
IMITATIVE OR UNIQUE

By G.D. SHAW

# SOUND SYNTHESIZER



**T**HE realisation of music and allied effects by means of a variety of electronic devices has been possible for a good many years. The electronic organ, for example, was becoming rapidly accepted a decade before World War II. Of the vast range of electronic instruments now available, however, there are a few which are not aligned to operate around a conventional chromatic scale. Thus, for the performer, the appeal of such instruments would be based primarily on the effect of tone quality, ease of playing and novelty in design.

For the composer, however, the abundance of electronic instruments does little more than provide a range of alternatives to supplement or replace standard instruments of the orchestra. Out of such a situation the idea of *musique concrete* was born. This technique enabled composers to create and experiment with sound forms generated naturally or unnaturally by such unlikely sources as dustbins, rattling teacups, conversation or malplayed musical instruments. Some workers incorporated a system of manually operated oscillators, both groups linking their sound sources to one or more disc cutters or, later, tape recorders.

The task of creating and blending discrete tones into a coherent and recognisable musical work involved so much laborious effort that *musique concrete* established the reputation of being more of a technical exercise than a creative art form. Thus the publication of Moog's designs for voltage controlled amplifiers and oscillators about eight years ago was hailed with enthusiasm in many quarters of the musical world.

Moog's designs crystallised the ideas and requirements expressed by a number of serious composers whose creativity was hampered and frustrated by the confines of the accepted musical disciplines. The possibilities of, and extensions to, Moog's original circuits have led with great rapidity to the inception of a series of variably complex devices having the generic label of "synthesiser".

## THE SYNTHESISER DEFINED

What exactly is a synthesiser? The word "synthesis" is defined as the building up of separate elements into a connected whole and this, very succinctly, describes the function of the synthesiser with respect to the formation of sound structures.

Essentially the instrument consists of a number of sound sources and sound treatments which may be combined together in an enormous diversity of ways to produce an equally varied range of sounds in a number of applications.

1. As a live performance instrument. A considerable company of popular artists and groups use a synthesiser, in one form or another, as a standard item of equipment either to supplement their normal methods of sound treatment or to play as an instrument in its own right.
2. As a sound effects unit. The use of the synthesiser is by no means restricted to musical circles and it is equally at home "producing" creaking doors, artillery fire, explosions, dripping water, birdsong and a virtually unlimited range of sounds similar to those featured in and popularised (for some) by the "Dr Who" series. Thus the tape recording enthusiast, amateur dramatic society, cine club and so on could easily find the synthesiser becoming a useful and indispensable tool.
3. As an audio-visual teaching aid (in conjunction with a good oscilloscope) the synthesiser can provide an invaluable insight into the fundamentals of electronic and acoustic waveform phenomena. In this respect there is a large potential field of application.

## IMITATIVE OR UNIQUE

The term synthesiser carries the implication, for some, that the instrument is of an essentially imitative nature and/or that the sounds produced by it are ersatz. With regard to the former criticism, the degree of control which may be exercised in a well designed synthesiser is such as to allow it to imitate a wide range of musical instruments very effectively.

For the sound effects man, the ability of the instrument to produce imitations of a wide range of naturally occurring sounds is a feature which cannot be lightly set aside.

In answer to the second criticism which implies that the sound forms produced by the synthesiser are, in a sense, unreal—nothing could be further from the truth. The nuance and timbre imparted by the synthesiser to a fundamental tone is no less real than the nuance and timbre imparted, to the same tone, by, say, a trumpet or a violin. In practice, the purity and exactitude of the tonal permutations made available by the synthesiser are frequently inspiring and possess a beauty which is peculiarly their own.

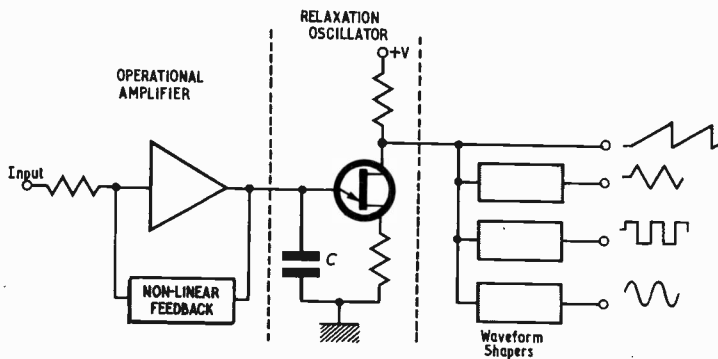


Fig. 1. Block diagram of a voltage controlled oscillator

## VOLTAGE CONTROL

Various forms of voltage control have been known and exploited for a number of years but the application of the principle to the control of synthesiser circuits results in the appearance of a number of unique features. By way of illustration one could scarcely choose better than a form of voltage controlled oscillator based on the design published by Dr Moog. Fig. 1 shows such a device in block form.

The relaxation oscillator is driven by an operational amplifier the output current of which is proportional to the exponential of the input. As the output current increases so also will the rate at which the charge on capacitor "C" reaches the unijunction breakdown voltage. Thus the frequency is increased.

The unijunction sawtooth is fed to a series of waveform shaping circuits which provide a useful number of "in phase" outputs. By means of this system relatively wide frequency ranges may be obtained without the necessity of switched RC or inductively tuned networks.

The general principle of voltage control may similarly be applied to almost any parameter in any of the devices built into the synthesiser, e.g. amplifier gain, filter bandpass or band reject characteristics, degree of reverberation and so on. There are a number of distinct advantages in so doing, these are:

1. Signal and control paths are quite separate from one another. Thus a device may be remotely controlled without compromising the signal in any way.
2. Devices can control one another in a continuously variable manner without the necessity of complicated, expensive and limited-range switching circuits. In certain circumstances a device may control or limit its own output by using part of the signal output as feedback to the control input.
3. By provision of high input impedance to the control circuits each controlling device has a potentially large "fan-out" capability thus making multiple parameter control a possibility.

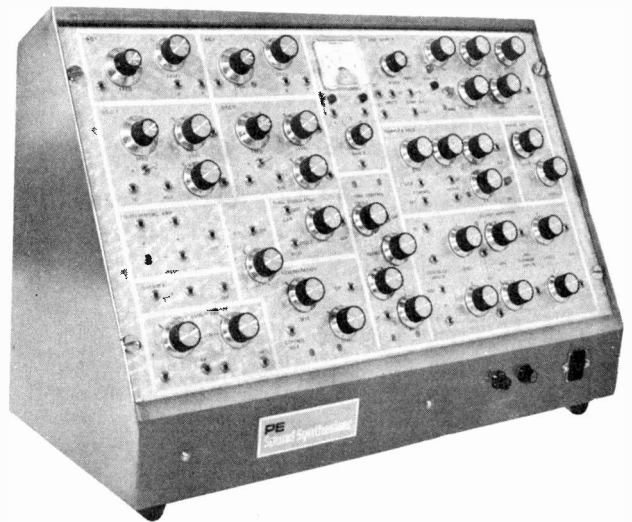
A specific example of voltage control is given later in this article and will serve to underline the flexibility and versatility of the system.

## SYNTHESISER DESIGN

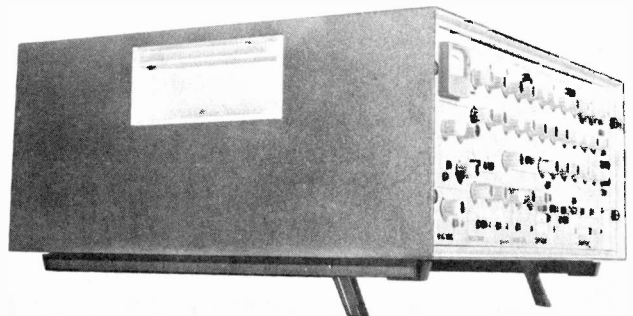
In designing a synthesiser care has to be taken to ensure that the system does not become so complex that it is impossible to operate effectively.

Consequently it is necessary to define the requirements of the instrument and to specify the means by which these requirements may be met. In this respect a form of modular construction offers the distinct advantage that one may start with a simple system and increase the size and complexity as and when required.

As a general rule most sounds have a fairly complex structure comprising a fundamental tone, one or more overtones or harmonics and, in some cases, an element of noise. It is usually the fundamental tone which dominates the sound structure and which provides the primary means by which the sound is observed.



The author's prototype synthesiser is shown above. Below is the final version built in modular form and housed in a Vero metal case





Another important feature concerns the way in which the sound structure is presented. The rapidity with which the sound becomes audible, the maximum volume attained and the rate at which the sound dies away together constitute a pattern, known generally as an envelope, which contributes very largely to the recognition of the sound. Variation in the rapidity of attack and the rate of decay of an otherwise unchanging sound structure can make an enormous difference to the auditory effect of the sound on an observer.

Two other factors play an important part with respect to the recognition of sound. These are timbre and nuance. Timbre is defined as the characteristic quality of sounds produced by each particular instrument or voice, depending upon the number and character of the overtones while nuance relates to the delicacy, or shade of meaning, of a sound.

## ACHIEVING THE REQUIREMENTS

It is a relatively straightforward matter to provide hardware to meet three of the above requirements, i.e. fundamental tones may be provided by one or more oscillators; variation in sound presentation is achieved by means of an envelope shaper while

timbre may be varied by selective filtering and additive mixing, either separately or in combination, together with a degree of reverberation.

Control of nuance cannot, however, be achieved by the application of a discrete piece of hardware but is controlled by the inter-adjustment of practically all the parameters involved in any particular sound structure.

## PROGRAMMED MODULES

The hardware so far considered covers the basic necessities of sound formation but offers nothing that cannot be obtained from a selection of signal generators, reverberation amplifier and integrator, all of which are easily obtainable as discrete units and in a variety of forms. The next stage, therefore, is to devise a means whereby the principal function of the modules may be voltage controlled and to provide the means by which they may be programmed to produce a range of tone patterns or rhythms. Automatic programming may be achieved by provision of one or more ramp or random voltage generators.

If these latter devices are, themselves, made programmable then the possible control signal permutations, with only a small number of modules, becomes

## SPECIFICATION

### *Stabilised Power Supply*

+15V/O/-15V at 750mA per rail.

Max. ripple at 12 per cent overload is less than 15mV.

### *Two Input Amplifiers*

Gain variable from unity to  $\times 50$ .

### *Two Ramp and Pulse Generators*

Frequency range (a) 0.01Hz to 15Hz.

(b) 0.05Hz to 30Hz.

Manual and voltage control. Output voltage is 4V nominal ramp and -4V nominal pulse.

### *Two Triangular/Square Wave Oscillators*

Frequency range (voltage control) less than 1Hz to 16.5kHz. Frequency range (manual control) 5Hz to 10kHz. Output voltage: Triangular 350mV p-p. Square 1V p-p.

### *Two Output Amplifiers*

Variable gain with manual and voltage control. Panning facility between channels. Input level 500mV. Maximum voltage gain +13dB.

### *Reverberation Amplifier*

Variable gain manually controlled. Voltage control of reverberation. Unity gain with reverberation out. Frequency range of spring line -3dB at 80Hz and 4kHz. Input level 500mV.

### *Ring Modulator*

Four quadrant multiplier based on integrated circuit. Frequency response effectively flat from d.c. to greater than 150kHz. Input levels  $2 \times 500\text{mV}$  max. Output level 800mV max.

### *Tone Control*

Tuneable active filter. Effective slope 7dB/octave. Overlapping bass and treble ranges allow extreme effects to be obtained.

### *Envelope Shaper*

Produces an envelope of variable shape and period derived from internal constant voltage source and external trigger. May be triggered manually. Output waveforms variable from pulse, sawtooth, trapezoid, and triangular.

### *Noise Generator*

Provides up to 3.5V white noise. Control of colouration by means of tuneable low pass filter.

### *Sample and Hold*

Random voltage generator which can double as an additional ramp generator. Produces staircase waveforms of formal or random nature. Clock output is provided for synchronisation purposes. Output level -6V max.

### *Differential Amplifier*

Provides additive and/or subtractive mixing facilities. Output level proportional to sum and/or difference of the four inputs provided, maximum 26V p-p.

### *Inverter*

Similar to above but with only two inverting inputs.

### *Meter Unit*

A meter with precision rectifier circuit to read a.c./d.c. signals in two ranges, 0.5V and 1V.

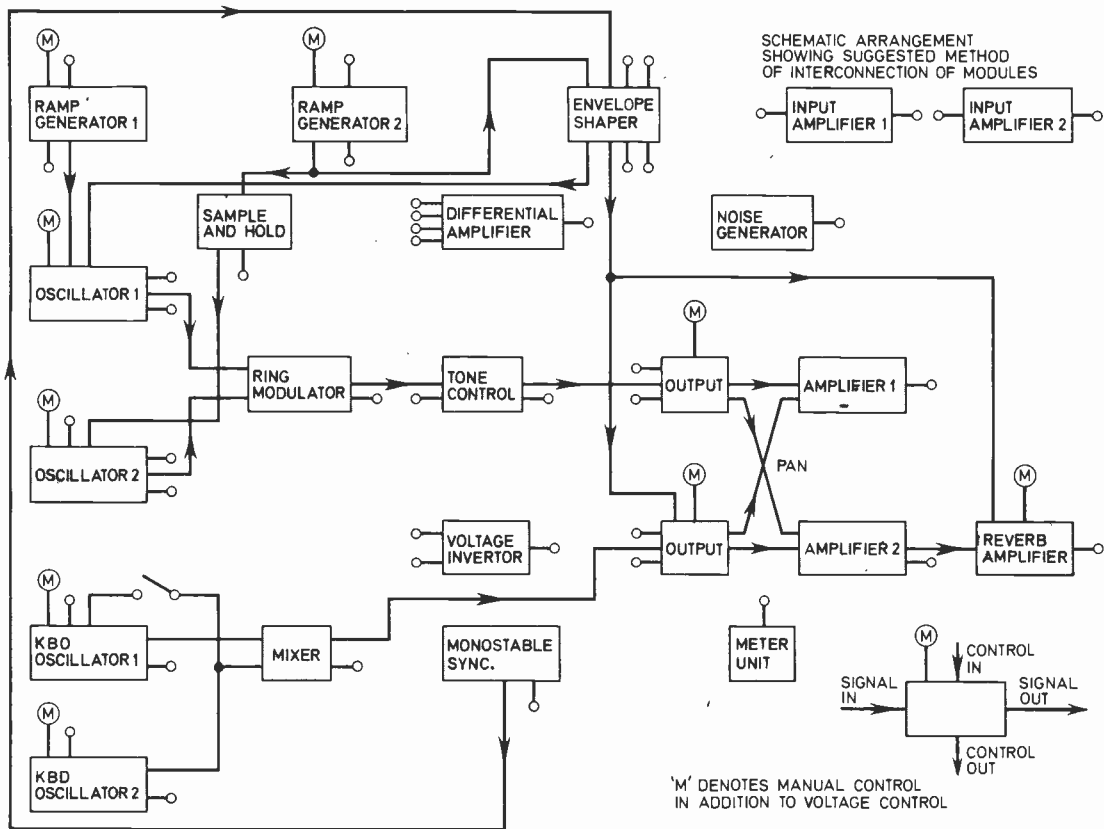
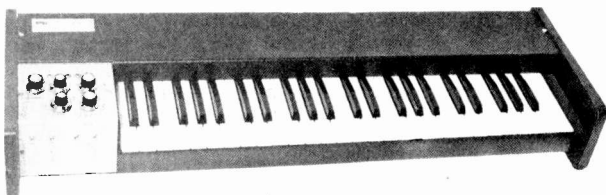


Fig. 2. Block diagram of the synthesiser

very wide indeed. If the frequency range of the ramp generators is sufficiently wide they may themselves be considered as sound sources and used for the direct provision of rhythms.

Similarly, with the control signal suitably attenuated and running at a frequency of between 6-8Hz, a single ramp generator may be used to provide a vibrato modulation to an oscillator thus adding greatly to the interest content of discrete tones.



Synthesiser keyboard with separate sustain, vibrato and oscillator units mounted on the left

### ADDING A KEYBOARD

Perhaps the simplest method of programming the oscillators is by the addition of a keyboard. Since keying provides a range of control voltages to the oscillator the keyboard itself may be considered to be a manually operated staircase generator.

The keyboard may also be used to provide gating and synchronising pulses to initiate treatment or shaping sequences each time a key is depressed.

### SOUND TREATMENTS

The only sound treatment so far given any degree of consideration is that of reverberation. There are, however, a number of others which can provide very useful extensions to the facilities offered by the synthesiser. Up to now the accent has been on synthesis by addition, but, equally, one can synthesise by subtraction.

In this latter case the starting point is a complex sound, such as white noise, from which the required elements are obtained by filtration. There is thus a place for one or more notch and/or band-pass filters the actual characteristics of which may be varied by means of voltage control.

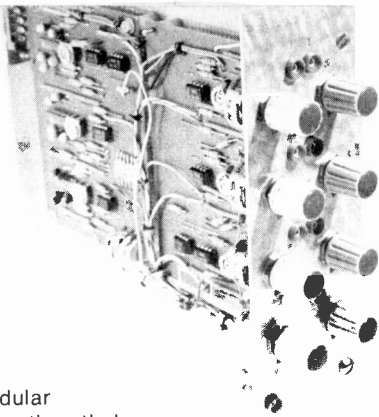
On the simpler side there is also a place for a form of tone control of sufficient range to enable extreme effects to be investigated.

### INTERFACING

Finally, it is necessary to consider the best means of interfacing the synthesiser with external equipment so that it may accept as wide a range of inputs as possible without distortion and, on the output side, provide a similar widely compatible drive.

A block diagram of the synthesiser to be described is given in Fig. 2.

The idea of external connection compatibility for all modules was believed to be a prime requirement in view of the possibility that many constructors may wish to build only a limited number of the



The basic modular form of construction that will be used throughout the series

modules to be described as additions to existing synthesiser projects. In view of this situation it may seem somewhat paradoxical to provide modules labelled input and output amplifiers.

In point of fact these can be connected in virtually any position in a chain of modules the main limitation being due to the possible saturation of the amplifiers due to the input levels being exceeded.

The final stages of the output amplifiers are cross-coupled by "panning" controls thus enabling stereo and "floodsound" effects to be investigated.

### INTERCONNECTIONS

Referring again to Fig. 2, it will be noted that many of the modules are shown with interconnections made between them.

Of the three most widely used systems of module interconnection the one most suited to the modular concept is that in which individual devices are coupled by means of patch cords. The great disadvantage of this system is that a complicated patch can render the front panel controls almost inaccessible.

With a view to relieving this situation modules may be connected internally in the manner in which they are most likely to be used. The actual method of internal connection is really a matter of the individual constructor's preference, those connections shown in Fig. 2 being intended as a guide rather than a mandatory requirement.

### BUILDING THE SYNTHESISER

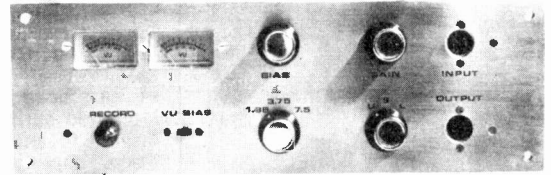
Full constructional details will be given on building the synthesiser shown and an outline specification of the instrument appears in this article.

Extensive use has been made of the 741 operational amplifier since the use of these devices invariably simplifies design and construction in comparison with circuits in which discrete semiconductors are employed. Furthermore, the 741 offers the feature of unconditional stability under almost any operating condition and is protected internally against "latch-up" and output short circuit and is readily available at economic prices from a variety of sources.

The only test equipment requirement is for a good oscilloscope, particularly during the setting up stages. Ideally the scope should be d.c. coupled but, failing this, a high resistance voltmeter will suffice to monitor the v.l.f. performance of the various modules.

*Next month, constructional details for the stabilised p.s.u. will be given.*

# NEXT MONTH



## HI FI TAPE LINK....

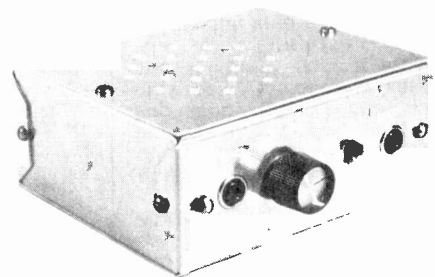
Bring hi-fi quality to your tape deck with this quarter track stereo tape link.

It features separate record and replay amplifiers using modern circuit technology to give low distortion and noise, and accurate replay characteristics.

Tape speeds of  $1\frac{1}{8}$ ,  $3\frac{1}{4}$  and  $7\frac{1}{2}$  inches per second are catered for, and a switch is included for single track mono operation. Setting up requires only minimal circuit adjustments.

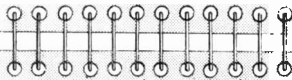
## SIGNAL INJECTOR TRACER

Using a digital integrated circuit in a linear mode makes this Signal Injector and Tracer cheap and easy to build. Extremely useful for fault finding on radios, amplifiers and other audio equipment. A simply built r.f. probe makes the Tracer suitable for high frequency detection.



**PRACTICAL ELECTRONICS**

**March issue on sale February 9**



# INDUSTRY NOTEBOOK

By *Nexua*

## UK PRESENCE AT ELECTRONICA

The giant Electronica exhibition staged in Munich was the last of the great European shows before Britain's entry into the Common Market. And there was every sign that at long last the British were taking the ECM seriously.

One British journal organised a special charter aircraft for the show and took 117 people along, nearly all of them top executives from British companies. The British joint venture group sponsored by the Department of Trade and Industry numbered 55 companies and there were others with stands independently of the official group as well as many British products on stands of German Agents.

The Central Office of Information produced a splendid book "Electronic Components and Equipment from Great Britain" in support of the British effort. It had German text throughout its 62 well-illustrated pages and again this shows Britain waking up to the facts of life, one of which is to address your audience in their own language.

In all, there were 1,600 exhibitors from 22 countries. As this was only the fifth Electronica the growth rate of the exhibition must be regarded as truly startling.

The only gripe I heard in Munich was on prices. Munich has always been pricey by British standards but this year's combination of the floating pound (buying fewer marks) and the aftermath of the Olympic Games which has inflated local costs made our British high street and pub prices look really modest.

## GREAT LEAP FORWARD

The year 1973 should be good for Solartron and the Schlumberger Group, of which Solartron is the U.K. member. I hear that the French companies in the Group have now virtually completed a rationalisation programme in which what was once a rag-bag of smallish companies has now been consolidated into major groupings of considerable strength.

In Britain, Solartron's Farnborough plant was as busy as I'd ever seen it when I called in last month. The Master Series, a range of a dozen digital voltmeters launched earlier this year, was described to me as having made a major impact in the market place with revenues already ahead of schedule. But the big new field is in radio frequency instrumentation and Solartron will be offering equipment for use up to 40GHz.

Another new Solartron activity is frequency synthesizers. This activity was previously concentrated in the Munich plant but now Farnborough engineers are involved in a joint development programme and new models will probably be manufactured in both locations.

Another bright product line is the realistic tank gunnery simulator known as "Simfire" for which Solartron recently won a Ministry contract worth £1.4 million following successful field trials by the 15th/19th Hussars in Germany. The system uses a low-power pulsed laser beam to simulate the firing of the shell and its trajectory. The target is fitted with detectors and if a hit is detected it triggers off a pyrotechnic display on the "killed" vehicle.

Solartron is spending plenty of cash on R and D to bring themselves into a leading position in Europe. Most companies think themselves pretty progressive if they plough back 10 per cent into R and D. The Solartron figure is currently running at 14 per cent on the instrument side of the business.

The biggest Schlumberger business, though, is still in oilfield instrumentation. Worldwide there are 30,000 employees operating in 50 countries.

## LES FOLIES

One of the brightest of the new generation of electronic industry entrepreneurs, Tom Jermyn, has a keen eye for the ladies, in a strictly business sense of course. His company, Jermyn Industries, manufactures semiconductor accessories such as i.c. sockets, transistor pads and heatsinks for which there is a world-wide sale.

Nearly three years ago he set up a sales office in Munich, soon to be followed by another in San Francisco and now he has opened his third in Paris. They all have one

thing in common—all are managed by ladies, and all of them good lookers.

Heading up the Paris office (appropriately located in the rue de Londres!) is multi-lingual Stella Bornstein who now joins Lore von Kleist, Munich, and Janice Pascoe, San Francisco. Stella is as yet untested, having only just started, but Janice and Lore have easily outpaced the performance of the local agents they replaced, Lore for example having built up the German business to 50 per cent of the present Jermyn U.K. turnover.

The point of this story is not so much the girls but how some of our more thrusting companies are getting around the world and really selling.

Incidentally, Jermyn is expanding manufacturing facilities beyond simple semiconductor accessories. Latest product is a 300W triac-controlled light dimmer which fits neatly in place of the common square MK light switch. The dimmer, designed by Jermyn engineers, is also available in kit form for home constructors.

## NEW LINE ON DEFENCE

Defence contracts may be getting harder to come by but they are still very big business. A new line-up of Thorn Automation, the Kelvin Hughes and Aviation divisions of Smiths Industries, and Scott and Electromotors, will be in a stronger position to bid for contracts under the group name Defence Equipment. Between them they employ 11,000 people and have combined assets of £164 million and a turnover of £440 million.

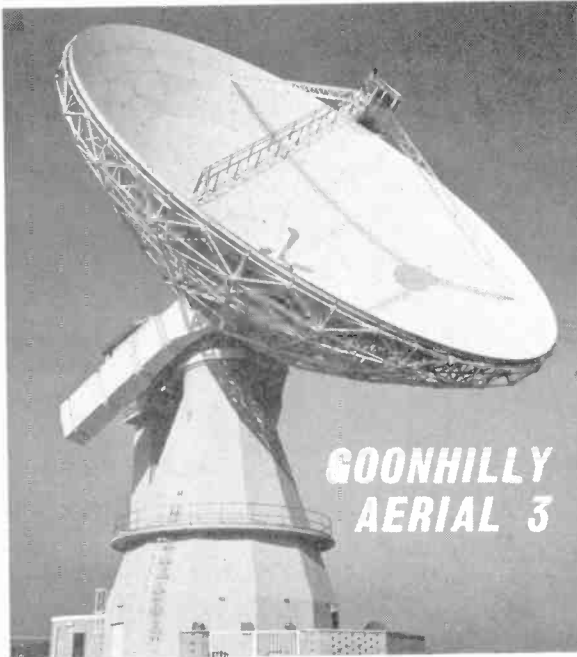
One reason for the link-up is said to be the reduction in size of Ministry R and D establishments and the farming out of work to the larger companies.

## IN TRIPLICATE

Despite all the trials and tribulations experienced during the commissioning of the new air traffic control system at West Drayton, Marconi Radar Systems has finally handed over the £5 million complex after a year of operational trials. The triplicated MYRIAD computer systems operate independently to give a reliability such that the system is only out of action for less than thirty seconds in five years.

Another Marconi achievement was the £1.5 million system for Eurocontrol based at Bretigny, near Paris. This has now also been handed over. Marconi led the international consortium which included Standard Elektrik Lorenz of Germany, and S.A.I.T. Electronics of Belgium. Altogether Marconi has completed 38 major ATC installations in the last decade.

# ELECTRONORAMA



Goonhilly 3, Britain's new £22 million satellite-communication aerial, is significantly different from the two earlier aerials at the Post Office's earth station at Goonhilly Downs. It is specifically intended for tracking satellites in geo-stationary orbit, whereas Goonhilly 1 was designed for tracking fast-moving satellites, and Goonhilly 2 for both sub-synchronous and synchronous orbiting satellites.

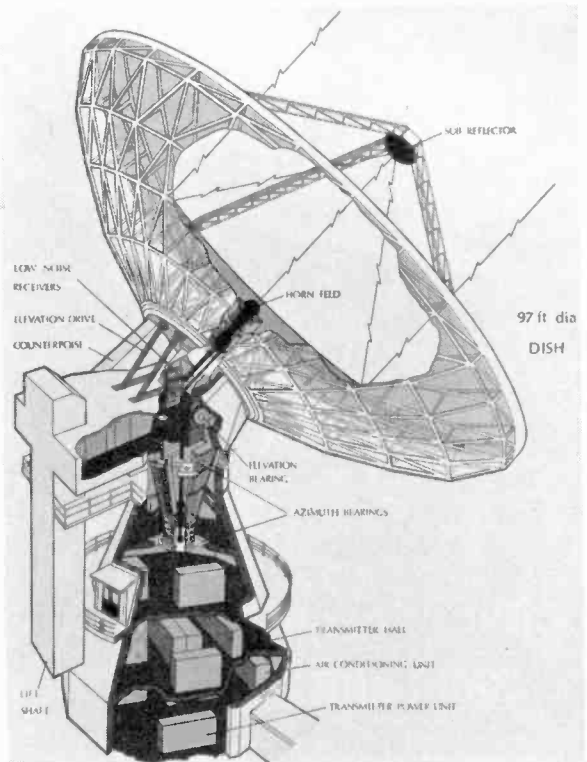
## REFLECTOR

The 29.6-m diameter reflector of Aerial 3, although larger than those of aerials 1 and 2 (26m and 27.4m respectively) for improved performance, is considerably lighter, due to the use of 2mm aluminium sheet for the reflecting surface, instead of stainless and mild steel. The sub-reflector can be tilted under the control of an hydraulic system to deflect the aerial beam by up to 25 minutes of arc in azimuth or elevation without moving the main reflector.

## DRIVE EQUIPMENT

Movement of the main reflector about each axis is effected by twin driving units each having two electric motors. Solid-state control devices are used instead of rotating machines as on aerials 1 and 2.

When the satellite starts to move out of the beam, error signals appear and activate the servo systems which steer the beam to eliminate the tracking error. Tracking can be accomplished by movement of the main reflector with the sub-reflector locked in a central position, or alternatively by movement of the sub-reflector



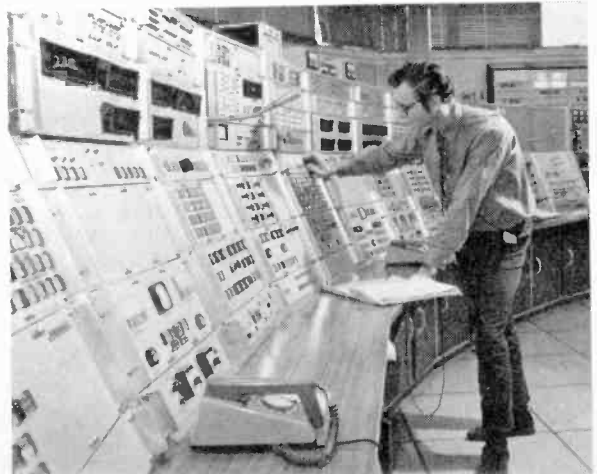
only.

Goonhilly 3 is currently transmitting two and receiving 11 telephony carriers, although it is capable of being expanded ultimately to receive 33 carriers. The transmit carriers are radiated in the band 5.930 to 6.420GHz and received in the 3.705 to 4.195GHz band.

When required, Goonhilly 3 transmits and receives two television carriers, one for vision, the other for sound. It can also operate a transmit and receive contingency carrier arrangement to support services lost during failure of a transatlantic cable.

## RECEIVING SYSTEM

The received signals pass through flexible waveguide to one of a pair of low-noise parametric amplifiers, cooled to 15°K (-258°C) by a closed-cycle gaseous-helium cryogenic system (*bottom left*). The signal from the LNAs, further amplified by 40dB in a travelling-wave-tube amplifier, passes by waveguide down the centre of the king post to a rotating waveguide joint, and is then carried in the waveguide to the central control building (*bottom right*).





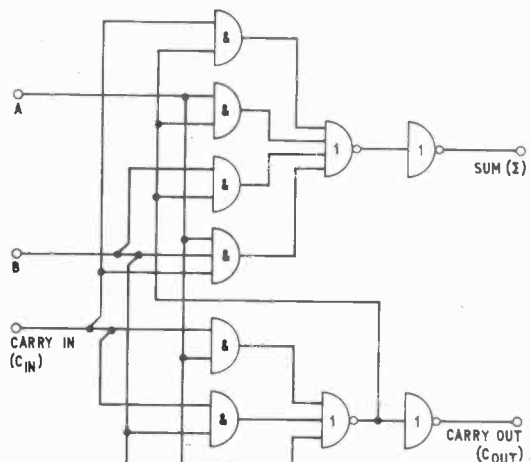
**T**HE BOARD to be described this month is the all important ADDER board which forms the heart of the arithmetic section of the calculator. The name ADDER is a shortened name for what is really an adder/subtractor with carry store, but before going into the design of the board in detail it is necessary to recall some of the principles of binary and B.C.D. addition and subtraction.

### BINARY ADDER

The principles involved in a simple single stage binary full-adder are fairly well known in this, the computer age, but for the sake of completeness it is as well to run over them again here.

Fig. 8.1. shows the logic diagram of a typical binary adder which generates a SUM and CARRY output from the three inputs termed A, B, and CARRY IN. The word "typical" is quite meaningful in this connection because a circuit to perform binary addition can be made up in a number of different ways, the end result being the same, no matter which gating arrangement is used.

The performance of this sort of array is best described in terms of a truth-table which lists the circuit's output response to all possible input conditions, and the truth-table for the ADDER is also given in Fig. 8.1. If any reader is unfamiliar with the basic rules of binary addition, studying the truth-table will tell all.



A	B	C <sub>IN</sub>	Σ	C <sub>OUT</sub>
0	0	0	0	0
1	0	0	1	0
0	1	0	1	0
1	1	0	0	1
0	0	1	1	0
1	0	1	0	1
0	1	1	0	1
1	1	1	1	1

Fig. 8.1. Single binary full adder stage. The truth table defines all the outputs for all combinations of inputs

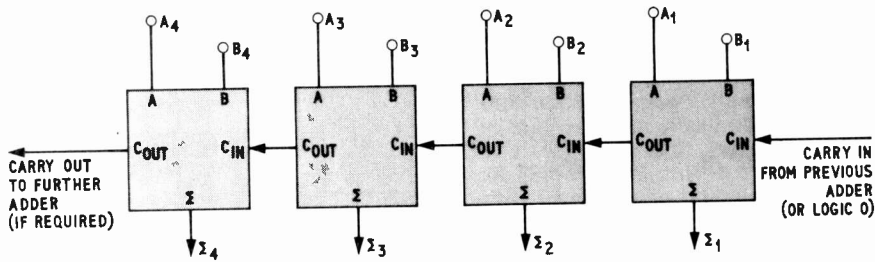


Fig. 8.2. A parallel binary adder to add two four-bit words. Each of the stages in this adder is identical to that shown in Fig. 8.1

### PARALLEL BINARY ADDER

A binary adder stage like that of Fig. 8.1 is of limited use as it stands, being capable of adding together only a single pair of binary digits and a carry, whereas most sums a machine is asked to solve would stretch to a number of pairs of such digits. The simplest way to extend the capabilities of this circuit is to use a number together to form a parallel adder like the one in Fig. 8.2.

Each pair of binary digits in the two numbers to be added has its own adder circuit with the CARRY connected in series down the chain. This method of addition is widely used in binary computers but suffers from the disadvantages of large scale component use and slow propagation of the serial carry which has to "ripple-through" to the last stage before the addition is complete.

A circuit arrangement which only uses a single adder stage to add two n-bit numbers is quite possible if the addition is carried out sequentially, i.e. one pair of digits at a time, in a system such as that shown in Fig. 8.3. This method of binary addition is called "serial addition" and requires a store to "remember" the CARRY from a previous addition so that it may be added in with the next.

The two basic addition methods are both employed in Digi-Cal, with some special modifications to allow operation in the B.C.D. code.

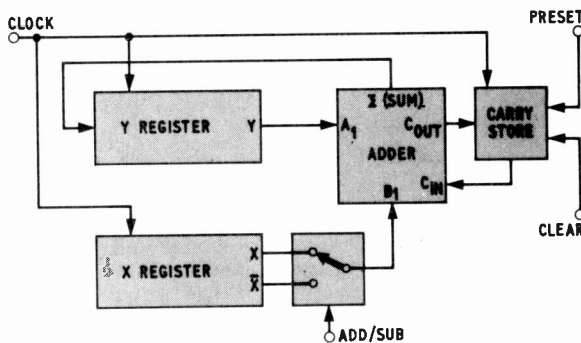


Fig. 8.3. Basic serial binary adder/subtractor. The ADD/SUBTRACT unit presents either the true or complemented output from the X REGISTER to the adder under the control of the FUNCTION CODE A signal

### SUBTRACTION

Once the truth table required of a binary subtractor has been worked out it is quite easy to design a simple logic circuit to perform the operations required, but in practice this is very seldom done, because, by making the number to be subtracted negative, i.e. by complementing it, it is possible to achieve the effect of subtraction in an adder circuit of the types already described.

The principles underlying this method of subtraction are quite straightforward and it can be readily appreciated that adding a negative number is the same as subtracting a positive one. Turning a positive binary number into a negative equivalent is simply achieved by inverting all its digits so that all the ones become zeros and vice versa, and then adding a one in the least significant position, for example

binary three	0011
becomes	1100 plus 1
equals	1101

To show that this process does generate a negative equivalent we can add the result to say binary four:

binary four	0100
plus binary thirteen	1101 (complement of binary three)
equals	0001 which is correct

Note that the carry digit from the most significant stage is disregarded, being only an indication of whether the result is positive (as in this case) or negative (if no CARRY results).

The operation of these principles in a practical circuit can be seen in Fig. 8.3 which is a serial adder system with subtraction carried out by simply feeding the inverted version of the X REGISTER output to the ADDER, and arranging for a carry to be preset into the store before the start of the clock pulse series.

### M.S.I. ADDERS

The TTL medium scale integration process has been used to produce several different binary adder circuits ranging from the very flexible SN7480 single, full adder to the compact SN7483 circuit which contains four complete adders arranged as a four-bit parallel adder. It is this latter device which is used

in the 'Digi-Cal adder circuitry, where the four-bit length lends itself well to use with the binary coded decimal (B.C.D.) arithmetic process.

The SN7483 is used as a basic building block in the adder to be described and before venturing into the intricacies of B.C.D. addition and subtraction it is best to become familiar with its construction and operation in its intended role as a parallel binary arithmetic unit.

The equivalent logic circuit of the SN7483 is shown in Fig. 8.4 and comparison of this logic with Figs. 8.1 and 8.2 will show that this device is connected to add together two, four-bit binary numbers with a CARRY IN to the first (least significant) stage, termed  $C_0$ , and a carry out from the final (most significant) stage termed  $C_4$ .

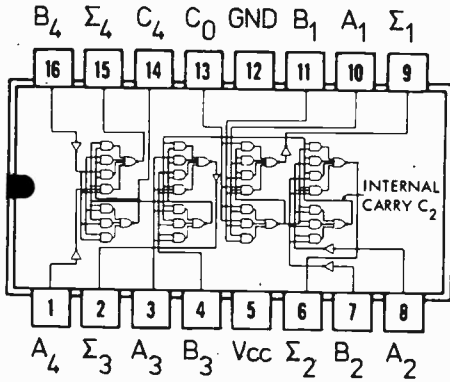


Fig. 8.4. The internal logic of the SN7483 four bit binary adder i.c.

The two four-bit words to be added to indicate the significance of each bit. The carry circuit delays have been reduced as far as possible by internal connection, the use of high-speed type gating, and the elimination of unnecessary inversion circuitry, so that the addition time is kept below 100ns.

### BINARY VERSUS B.C.D.

The numbers stored in the registers of Digi-Cal are represented by groups of four binary digits conforming to the Binary Coded Decimal (B.C.D.) code. This code is not complicated since it is identical to straight binary except that only the values 0 to 9 inclusive are allowed in each four-bit group instead of the values 0 to 15.

With straight binary the word length can be any convenient value, depending on the quantities to be represented, each increment to the word length increasing the range of representable quantities by a factor of two.

In the B.C.D. system however the binary word length must not exceed four bits, and the value of each four-bit word must not exceed 9. Capacity is increased by adding extra four-bit B.C.D. words, each of which increases the range of representable quantities by a factor of ten. As an example of the contrast between the two systems:

0110	equals 6	} (In straight binary or B.C.D.)
1001	equals 9	
01101001	in straight binary equals 105	
0110,1001	in B.C.D. equals 69	

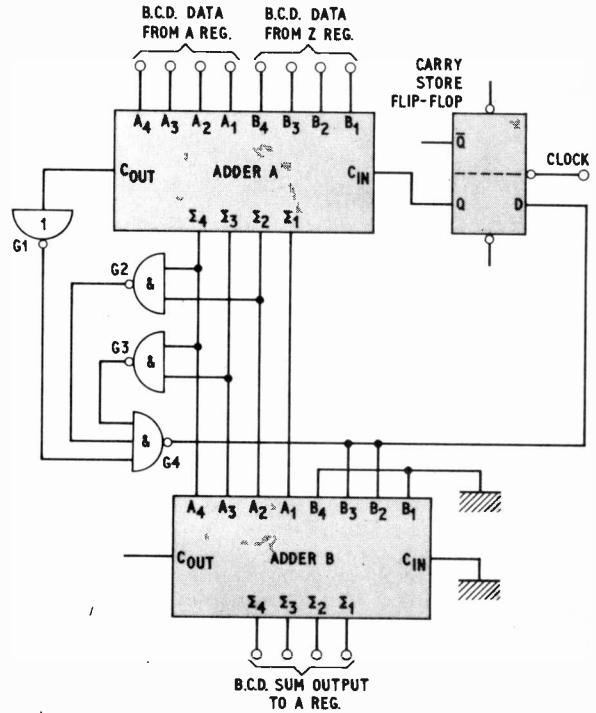


Fig. 8.5. Basic practical B.C.D. adder with a carry store flip-flop

The use of B.C.D. in calculators is desirable because of the simplicity in interfacing the logic with old fashioned human operators who insist on thinking in the decimal number system.

### B.C.D. ADDITION

When two four-bit B.C.D. words and a possible B.C.D. carry bit are added together in a parallel binary adder a total of 19 different (four-bit + carry) sums can be produced. Since the largest quantity representable in the B.C.D. code is 9, it is obvious that the nine most significant sums will require correction, and will be responsible for the generation of a B.C.D. carry bit. A moment's thought reveals that the correction required by sums from ten to 19 is the subtraction of ten, e.g.

7 plus 6 equals 13
subtract 10
equals 3 plus a carry to the next decade.

As we have seen already, the subtraction of ten is readily achieved by adding its complement, which is 0110, or 6 if you prefer, and so the problem reduces to that of detecting sums in excess of nine so that the subtraction can be initiated.

The basic circuit of the B.C.D. adder used in Digi-Cal is shown in Fig. 8.5. Here the two B.C.D. words are added in ADDER A in the conventional binary fashion, the detection for sums in excess of nine being performed by gates G1, 2, 3, and 4. If any such sum is detected G4 feeds a carry to the carry-store



flip-flop and inserts 0110 into ADDER B where it is added to the sum from ADDER A.

The output from the second adder is the corrected versions of sums over nine, but if a carry is *not* required because the sum is less than or equal to nine, ADDER B passes the sum from ADDER A through to its output in an unmodified form due to the addition of 0000 instead of 0110.

### CARRY DETECTION LOGIC

The performance of gates G1, 2, 3 and 4 in detecting sums in excess of nine can be taken for granted if the reader prefers, but for those who would like to know how the gating arrangement was arrived at, and who have some previous logic experience, the design was carried out as follows.

The CARRY OUT from ADDER A is a ready made indication that the sum is in excess of 15, which reduces the problem to that of detecting sums of between 10 to 15 inclusive. To determine the gating required, the sums in question are plotted on a Karnaugh map, as shown in Fig. 8.6.

The Karnaugh map is just a special way of drawing a truth table to make it easy to see what gating will be required to generate a specific function. It has the property that where adjacencies occur in the plots, the particular value, or values which change between the plots can be eliminated from the resulting logic equation.

As can be seen in Fig. 8.6 there are two distinct groups of plots, 10, 11, 14, 15, and 12, 14, 15, 13. In the first group the terms  $\Sigma_1$  and  $\Sigma_3$  change, and can be eliminated. In the second group the terms  $\Sigma_1$  and  $\Sigma_2$  change, resulting in the required gating function of  $(\Sigma_2 \text{ AND } \Sigma_4 \text{ OR } \Sigma_3 \text{ AND } \Sigma_4) \text{ OR } (C_{out})$ .

This function could be realised using two two-input AND gates and a three-input OR gate, but as the standard gating function of TTL is NAND it is possible to invert  $C_{out}$  NAND  $\Sigma_2$  and  $\Sigma_4$  and  $\Sigma_3$  and  $\Sigma_4$ , and feed these inverted functions to a further NAND gate which carries out the NOR function because of the inverted nature of its inputs.

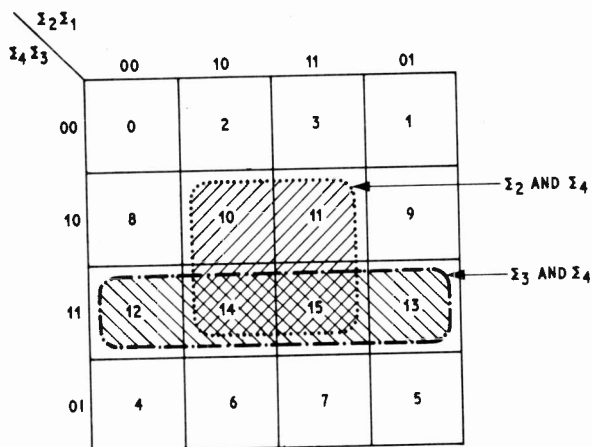


Fig. 8.6. The Karnaugh map used to determine the gating required to detect the sums from 10 to 15 inclusive

### B.C.D. SUBTRACTION

The B.C.D. ADDER just described cannot be used for subtraction as it stands, and the method of addition of complements is complicated by the fact that it is not the straight binary complement which is required, but the decimal complement which can be defined as 10 minus the number to be subtracted. In practice the generation of the "tens complement" causes problems with the carry logic, and it is preferable to generate the "nines complement" by subtracting from nine and then use the carry logic to add in a 1.

The generation of the "nines complement" of the data from the Z REGISTER requires the addition of the circuit shown in Fig. 8.7, which employs yet another SN7483 quad adder.

The principle behind this "nines complementer" is that the binary complement of the input data is added to binary nine to produce nine minus Z, but since the binary complement of a number is its inverted version plus 1, in practice the circuit adds the inverted Z data to binary 10 thus taking care of the extra 1 required by the complement.

The inversion of the z data is carried out in an SN7486 quad exclusive-OR gate, which, when connected as shown, allows a true version of the input data through to the output when the common control input is a logic 0, and an inverted version when the control is a logic 1.

This useful property of exclusive-OR gates, along with the fact that it is the control input which inserts the required 1010 into the adder, allows the "nines complementer" to either pass the z data unmodified when FUNCTION CODE A is a logic 0 indicating an addition is required, or pass the "nines complement" of the z data when the FUNCTION CODE A line is a logic 1 indicating that subtraction is required.

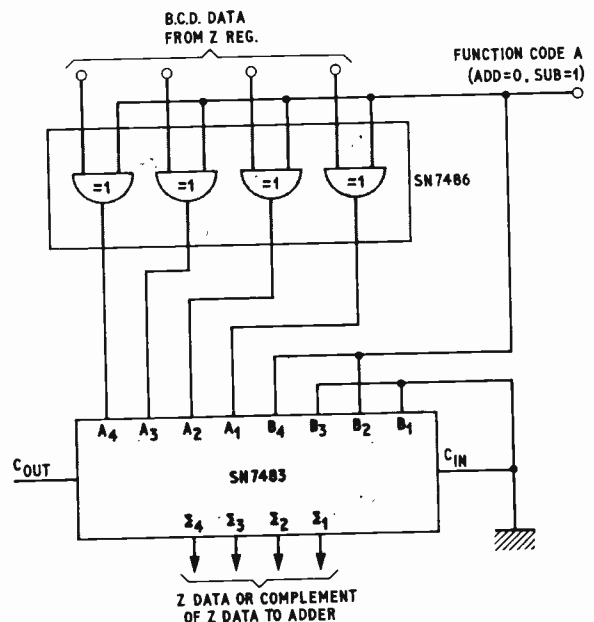


Fig. 8.7. B.C.D. nines complementer. This generates the output 9 minus Z when subtraction is required

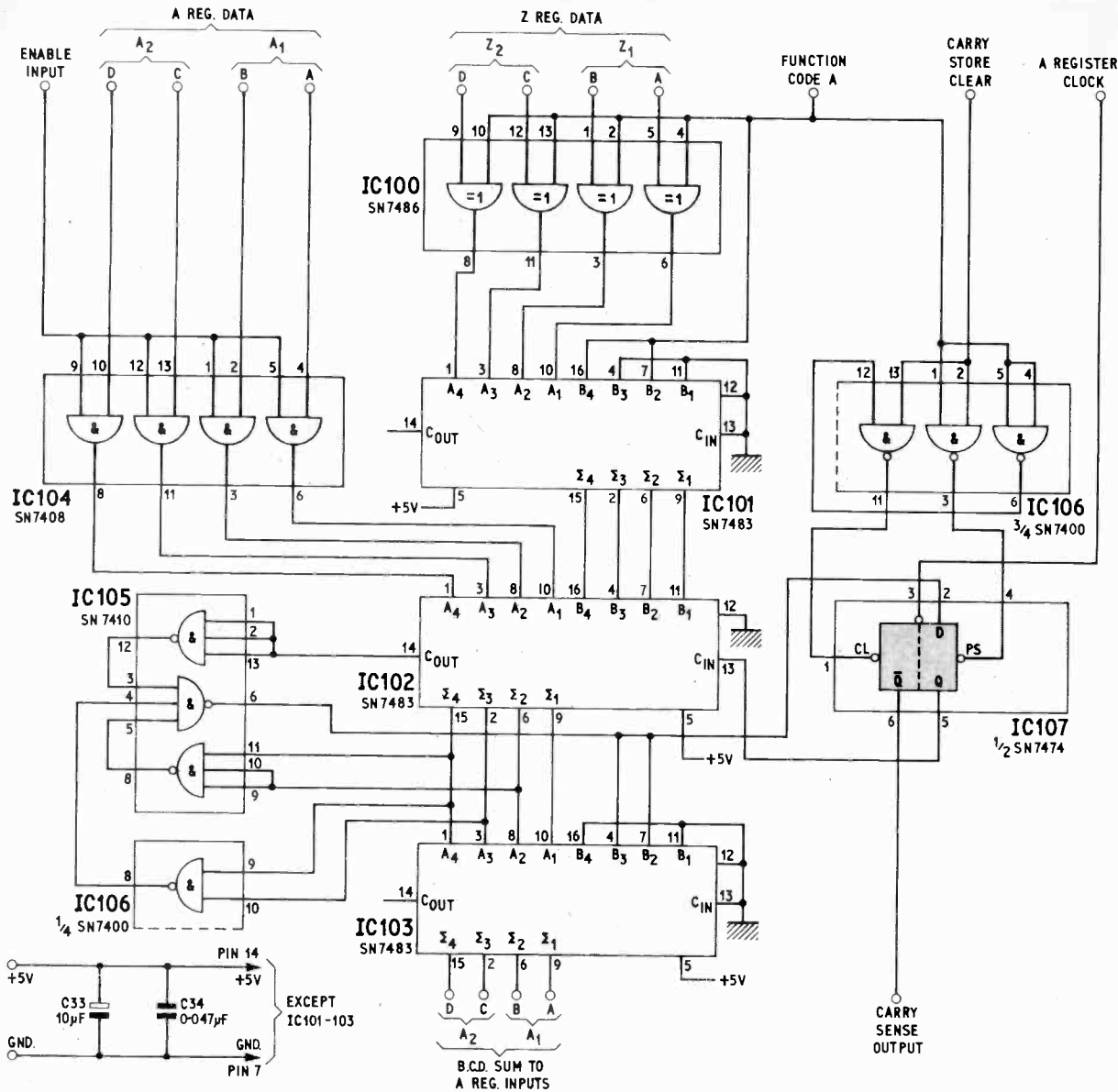


Fig. 8.8. Complete circuit diagram of the ADDER board

The details of the subtraction process are quite hard to grasp at first but the process may be easier to understand after working through the following example (right).

Note that the borrow function which would be generated if the answer to a subtraction is negative is stored in the carry store in the opposite sense to that of a carry in addition, i.e. a 1 stored means no borrow, and vice versa.

### FULL CIRCUIT DIAGRAM

The complete circuit of the Digi-Cal adder/subtractor is shown in Fig. 8.8. This circuit is made up of a combination of the ADDER and COMPLEMENTER circuits already covered, with the addition of IC104 and gating for the CARRY STORE PRESET/CLEAR input.

A Register data	1000	(equals 8)
B Register data	0110	(equals 6)
Carry store	1	No borrow from previous subtraction
Function Code A	1	Subtraction

### START ADDITION

Invert z data	1001	
Add to 1010	0011	
Add to A data plus carry input	1100	B.C.D. carry generated
Add 0110	0010	Equals 2, the required answer

# COMPONENTS . . .

## ADDER BOARD

### Capacitors

C33 10 $\mu$ F 15V elect.  
C34 0.047 $\mu$ F

### Integrated Circuits

IC100 SN7486  
IC101-IC103 SN7483 (3 off)  
IC104 SN7408  
IC105 SN7410  
IC106 SN7400  
IC107 SN7474

### Printed Circuit Board

Type DL109/22 (Shirehall)

IC104 is an SN7408 quad AND gate which is connected as an A REGISTER data inhibit, requiring its common ENABLE input to be a logic 1 before the A data is allowed through to the ADDER.

The purpose of this i.c. is to allow flexibility in the programming possibilities and, particularly, to inhibit data recirculation when the A REGISTER data is being normalised after a multiplication sequence.

The normalisation process was covered last month, and readers may recall that after multiplication, the A data are shifted to the right by the number of decimal places selected on the thumbwheel.

If the inhibit gates were not fitted the data which were to be discarded during normalisation would

recirculate and appear at the most significant end of the A REGISTER. The ENABLE input is controlled by the programme.

The purpose of the gating in the CARRY STORE PRESET and CLEAR inputs is to allow for the fact that a BORROW is stored in the opposite sense to a CARRY, requiring the store to be preset before a subtraction, and cleared before an addition. Since there is a single CARRY STORE CLEAR signal from the programme, the FUNCTION CODE A input is used to control two, two-input NAND gates which steer the CLEAR signal to the correct side of the CARRY STORE flip-flop.

The only other part of the circuit worthy of note is the CARRY SENSE output which is used to inform other parts of Digi-Cal of the state of the CARRY STORE, one of its uses being to stop subtractions when a BORROW is produced after any tenth clock pulse during division, i.e. it senses when the A REGISTER contents are negative.

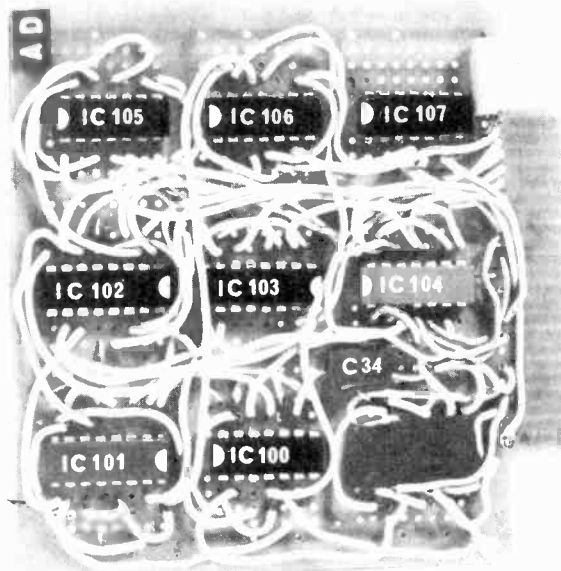
## CONSTRUCTION

The construction and wiring of the ADDER board is quite straightforward since the circuit is housed on the usual Dualinlet card, in this case a DL109/22.

On this board almost all of the connections are carrying high speed data signals which must have a high integrity, and for this reason it is necessary to keep wiring as short as possible to minimise problems caused by line reflection.

The component layout and edge connector wiring is shown in Figs. 8.9 and 8.10.

## ADDER BOARD



CARRY CLEAR	23
CLOCK	24
D	25
C	26
$\Sigma$	27
OUT	28
A	29
D	30
A	31
INPUT	32
B	33
A	34
GND	35
5V	36
spare	37
CARRY SENSE	38
ENABLE	39
spare	40
D	41
C	42
Z	43
INPUT	44
B	45
A	46
spare	47
FUNG CODE A	48

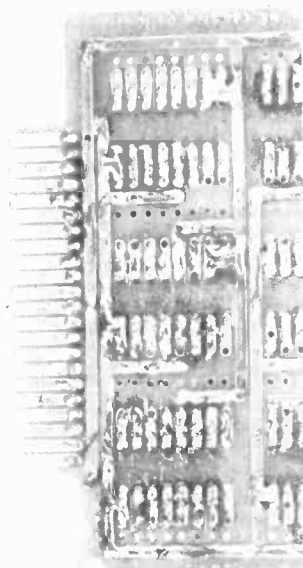


Fig. 8.9. Layout of the components on the DL109/22 printed circuit board

AD

1	23	CARRY CLEAR (fr prog)
2	24	CB/40
3	25	A2/1
4	26	A2/22
5	27	A1/1
6	28	A1/22
7	29	A2/10
8	30	A2/11
9	31	A1/10
10	32	A1/11
11	33	GND
12	34	+5V
13	35	not used
14	36	CB/30
15	37	ENABLE (fr prog)
16	38	not used
17	39	Z2/19
18	40	Z2/20
19	41	Z1/19
20	42	Z1/20
21	43	not used
22	44	FUNC CODE A (fr kbd)

Fig. 8.10. Function of the edge contacts for the ADDER board

## TESTING

Checking out this board in isolation is relatively easy since it is possible to check the sum responses to various dummy control and data inputs. The data values can be inserted by wiring each of the four data lines from the separate sources to ground, or leaving them open circuit, to simulate a particular B.C.D. number.

Providing the ENABLE and FUNCTION CODE A lines are also properly activated, a B.C.D. answer should appear on the SUM outputs from IC103, and a CARRY/BORROW signal at the D input of IC107. The CARRY STORE CLEAR input can also be tested in combination with FUNCTION CODE A, monitoring the result at the Q or  $\bar{Q}$  output of the flip-flop.

Constructors who have followed the assembly sequence suggested will also be able to try the first complete calculations on their machine by judicious application of dummy control signals which would normally emanate from the programme.

Numbers entered into the ENTRY REGISTER can be transferred to the Z REGISTER by operation of the (cleared) A REGISTER by momentarily grounding the START CLOCK input to board CB. This process requires a large number of temporary control signals to be wired in, and may be daunting to some readers: the prospect has been suggested only to enable the more adventurous to experiment with the way the programme board (to be described next month) will be required to carry out the process of addition and subtraction automatically. Those who do attempt this type of test will learn a great deal about the intimate workings of Digi-Cal.

**Note:** In Part 4 (Oct. 72), Fig. 4.2, C13 on IC21 should be marked C9, and C8 should be 10 $\mu$ F not 22 $\mu$ F

**Next month: Programme Board**

# NEWS BRIEFS

## COMPUTER '72

**T**AKING both the Grand and National Halls at Olympia, the COMPUTER '72 exhibition (December 4 to 8) attracted over 200 international companies who had data processing services to offer. The organisers of this show, the Business Equipment Trade Association, described its purpose as "explaining the benefits of electronic data processing to commercial and industrial management", thus the exhibition presented services rather than the actual hardware itself, though peripherals were much in evidence.

One of the most attractive stands was that of the Post Office. The display was a symbolic representation of their Datel services in multicoloured plastics, with some exhibits showing data transmission techniques of the past.

On the hardware side, Hewlett-Packard presented their new minicomputer, Model 30. This computer is no larger than a good sized teletype terminal and provides an economical alternative to time-sharing, operating in BASIC, the language most used for time-shared systems. It has an internal cassette store with a capacity of 24,000 numbers. Its readout is via an 80 character alphanumeric display, though a printer is an optional extra.

As well as the main exhibition some light relief was provided by Honeywell who presented the winning entries to the Observer Colour Magazine children's "Paint-a-Computer" competition. Also on display was the Honeywell/Roland Emett forget-me-not computer. On the NCR stand a simulated game of cricket was being played through one of their computers and results were presented as the "game" progressed.

The bringing together of a large number of companies in this way is obviously a great service to management and the success of this and future shows is assured.

## High Speed Printer Using a Laser

**A** NON-IMPACT printer capable of writing 1,000 lines per minute is being developed by R.C.A. for the U.S. Army. The new printer uses a laser to transfer digital communications alphanumerics onto ordinary paper.

The printer is called the Material Transfer Recorder (MTR) and uses a dye-coated plastic ribbon scanned by the laser beam to record the messages on the ordinary paper.

There are no keys as in normal mechanical printers thus wear problems and maintenance are greatly reduced. Also the printer is almost silent because of the lack of impact.

Through its data interface the MTR can receive any type of digital signal from a wide variety of sources including satellite ground terminals. It can receive this information at the rate of 20,000 words per minute.

The MTR is easily transportable and can be used in the field in a van or any other military shelter.

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↓	2%	10Ω-1MΩ	E24	3p	0-8p
↓	10%	1Ω-3.9Ω	E12	1p	0-8p
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↓	10%	1Ω-10Ω	E12	6p	5-5p

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AC127 12p	AF127 20p	BF115 25p	OC42 12p	2N3704 13p
AC128 12p	AF139 32p	BF173 20p	OC44 12p	2N3705 12p
AC131 12p	AF178 32p	BF177 28p	OC45 12p	2N3706 11p
AC132 12p	AF180 40p	BF178 32p	OC70 12p	2N3707 12p
AC176 12p	AF181 40p	BF179 32p	OC71 12p	2N3708 10p
AC187 22p	BC107 9p	BF180 32p	OC72 12p	2N3709 11p
AC188 22p	BC108 9p	BF181 32p	OC81 12p	2N3710 11p
AD140 50p	BC109 9p	BF194 15p	OC82D 12p	2N3711 11p
AD149 15p	BC147 13p	BF195 15p	2N2904 20p	2N4062 12p
AD161 33p	BC148 13p	BF197 15p	2N2926G 9p	40360 35p
AD162 36p	BC149 13p	BF200 32p	2N2926O 9p	40361 35p
AF114 20p	BC157 14p	BFY50 20p	2N2926G 9p	40362 40p
AF115 20p	BC158 14p	BFY51 20p	2N2926G	40408 40p
AF116 20p	BC159 14p	BFY52 20p	10p	ZTX302 15p
AF117 20p	BC187 22p	BU105 225p	2N3054 58p	ZTX500 15p
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BY10	800V	6A	25p	5p
BZ13	200V	6A	20p	5p
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IN4004	400V	1A	8p	5p
IN4007	1000V	1A	12p	8p

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3 1/2 x 5	24p	24p
17 x 2 1/2	24p	24p
17 x 3 1/2	27p	27p
17 x 5 (plain)	75p	57p
17 x 3 1/2 (plain)	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)	—	42p
2 1/2 x 3 1/2 (plain)	—	11p
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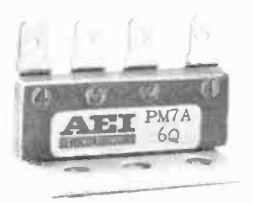
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	250 PM7A4Q
	375 PM7A6Q



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# Designing with

# Integrated circuits

BY A. FOORD

## 5 OPERATIONAL AMPLIFIERS WITH POWER STAGES

SOME instrumentation or audio applications may require a greater output current capability than that provided by an integrated circuit on its own. The simplest way to achieve this is to include an emitter follower inside the feedback loop, as in Fig. 5.1.

Since the output is compared with the input the effect of the 0.7 volts base-emitter bias voltage is reduced by the feedback. If the input is zero then the output of the integrated circuit will be 0.7 volts, allowing the output of the arrangement to remain at zero, as shown in the diagram. Short circuit protection can be given by R3 and the gain is determined by R1 and R2 in the usual way.

Since this is a class-A circuit it is not suitable where load currents of hundreds of milliamps are required, and other booster circuits must be designed on the lines of class-B audio power stages. A straightforward class-B output stage is shown in Fig. 5.2.

### UNITY GAIN OUTPUT PAIR

When load currents of several amps are needed a higher current gain output stage is required; one possible combination for one half of an output stage is shown in Fig. 5.3. It has several advantages, including good d.c. stability, and consists of two common emitter stages with 100 per cent negative feedback from the collector of the power transistor to the emitter of the driver transistor. This gives an overall voltage gain of unity and a high current gain.

For a positive going signal TR1 conducts, increasing the drive to TR2 which also conducts. Hence both transistors operate in class-B, apart from a small quiescent current.

For a collector current of 30mA it was found that a typical silicon power transistor required a base-emitter bias voltage of 0.56V. This seems lower than might be expected for a silicon transistor until we remember that 30mA is a small part of the 5A or so to which a power transistor can be driven.

(Indeed it is the range of currents over which a power stage has to be driven that causes many of the problems associated with this area).

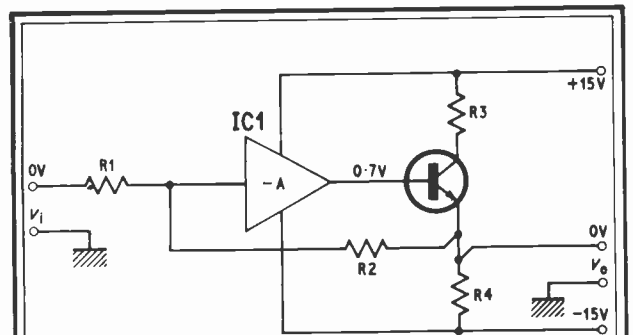


Fig. 5.1. An operational amplifier with a class-A emitter follower output

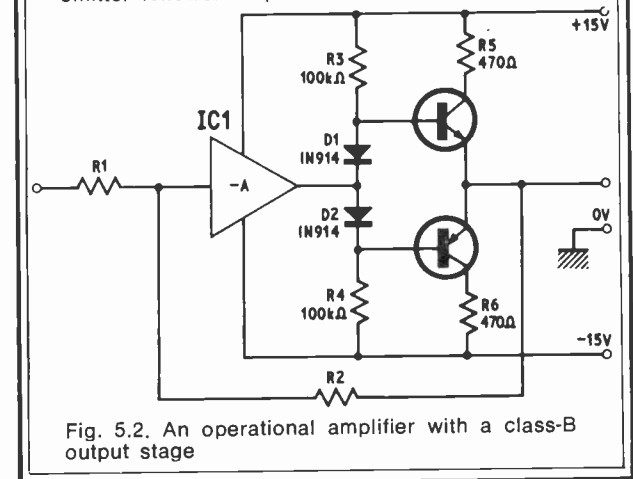


Fig. 5.2. An operational amplifier with a class-B output stage

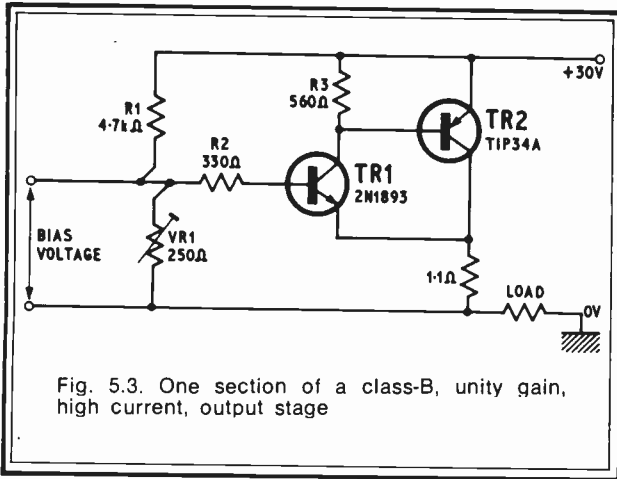


Fig. 5.3. One section of a class-B, unity gain, high current, output stage

The base-emitter voltage of the driver transistor was 0.65V for a 5mA collector current, and this becomes the input bias voltage required under quiescent conditions. For the other combination of a *pnp* driver and an *npn* power transistor the bias was 0.71V, and these values are typical.

### PRECAUTIONS IN MEASURING CURRENTS

The quiescent current of the output transistor can only be measured in its collector lead if the d.c. conditions are not to be disturbed. Alternatively,

the change in total supply current can be measured as the bias resistor is increased and the power transistor conducts.

Great care should be taken in making such tests because one careless move could result in a damaged meter or a heavy current through the transistors. A current limited power supply provides an extra measure of safety.

### 30 WATT POWER AMPLIFIER

If the unity gain power stage previously discussed is used, then the maximum output swing is limited to about 20V peak-to-peak from the integrated circuit. This would provide up to 5 watts into 8 ohms. Where more power is required the output stage can be modified to provide a small gain, five times is enough.

A complete power amplifier circuit is shown in Fig. 5.4. The required voltage gain is provided by the integrated circuit, supplemented by the output stage, while current gain is provided by the class-B output stage. The small signal driver transistor and the potentiometer allows the quiescent current to be set.

With the potentiometer at maximum resistance the transistor is bottomed and no current flows in the output stage. As the slider is brought towards minimum resistance the transistor takes less current and the collector current of the output transistors can be set to (say) 50mA.

There is 100 per cent overall negative feedback at d.c. to maintain the output close to earth potential under no signal conditions. Direct coupling to the

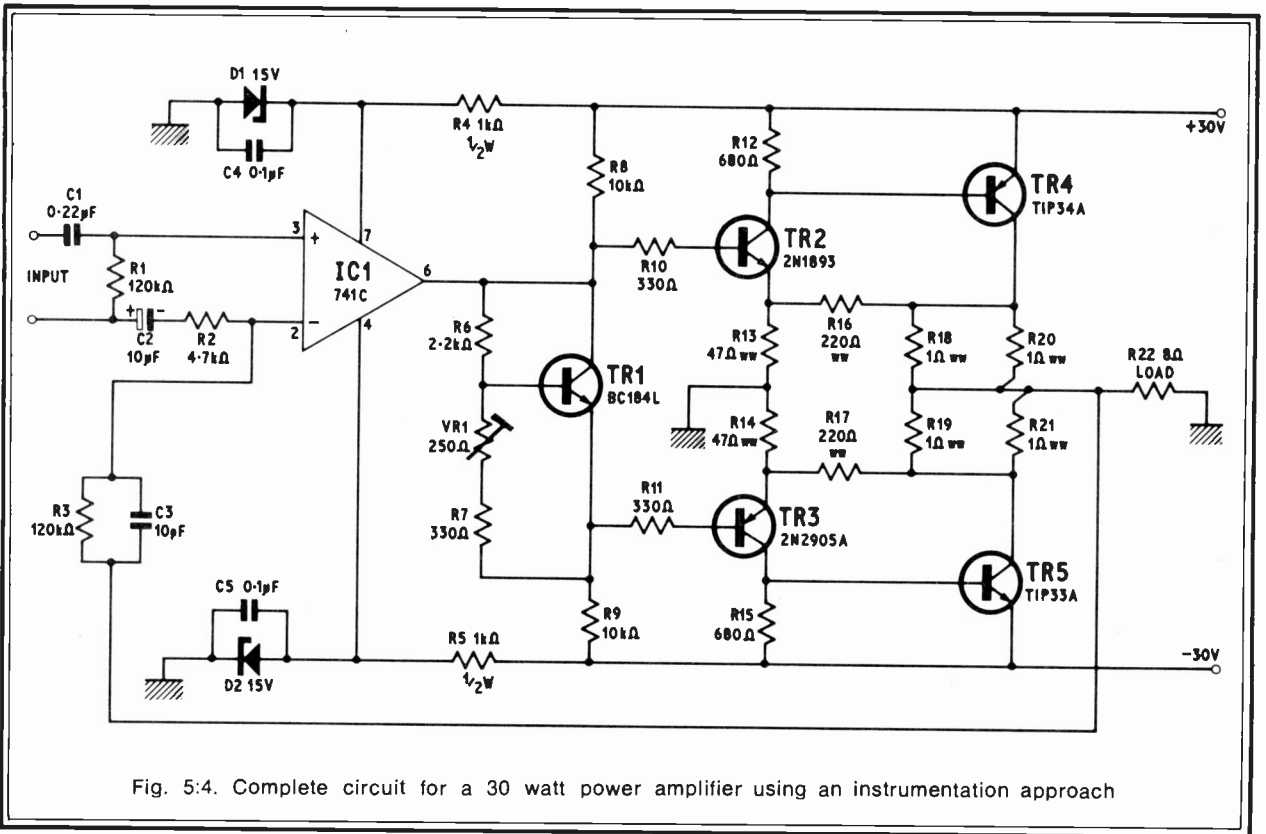


Fig. 5.4. Complete circuit for a 30 watt power amplifier using an instrumentation approach



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load allows a good low frequency response without using a large coupling capacitor. However, it could be argued that we have moved it back to the supply to obtain the centre tap.

The a.c. feedback sets the gain to 26 times or 28dB. If the BC184 transistor is mounted on the same heat sink as the power transistors, it will tend to compensate for variations in quiescent current if they become warmer. The 330 ohm resistors limit the maximum drive if the load is accidentally shorted. When used as shown in the diagram the BC184 can be considered simply as a low value impedance.

Since in these circuits the power stages appear inside the feedback loop, extra care must be taken with frequency compensation to achieve closed loop stability. Measurements on a prototype show that distortion should be better than 0.2 per cent at 30 watts at 1kHz.

## CONSTRUCTION

It is essential that the 10 $\mu$ F capacitor is a low leakage tantalum type because if a leakage current flows through this component there will be a d.c. offset at the output which could cause a quiescent current to flow in the load.

The output offset voltage could be measured before the load is connected, or if a small d.c. current flows through the load as it is connected, this would be indicated by an unbalance in the current drawn from each supply. The offset should be small, less than 10mV. Each power transistor should be mounted on a heat sink of thermal resistance 2.8°C/watt or better. Each driver transistor should also have a small heat sink.

## CONCLUSIONS

The final circuit given for a 30 watt power amplifier should be regarded as experimental because it has not been fully toleranced as regards transistor and integrated circuit variations. Some adjustment might be necessary for the 10pF capacitor in order to obtain the best possible square wave at 10kHz. For instrumentation applications the circuit can easily be direct coupled so that its response extends down to d.c.

**Part 6 will look at basic memory circuits**



# BOOK REVIEWS

## SEMICONDUCTOR DIODE LASERS

By R. W. Campbell and F. M. Mims  
Published by Foulsham-Sams  
192 pages, 9in  $\times$  5½in. Price £1.90

OPTOELECTRONICS is a field which is attracting a great deal of attention at the present time but semiconductor diode lasers are still very much in the development stage. Though the large manufacturers are producing them it appears that the price is still a prohibitive factor in their widespread use. One of the authors points out that "laser specifications of recent years should generally be reasonably accurate" showing that even the manufacturers are still not totally confident in the devices.

This new book originating in America (but with the usual Foulsham-Sams introduction for English readers) is thus directed more towards the researcher and experimenter than the constructor.

The opening chapters give a description of the development of the laser diode with a description of light generation processes in both lasers and ordinary light emitting diodes (l.e.d.s). For those who have not met semiconductor lasers before, they differ from l.e.d.s in that they emit *coherent* light in an intense beam. The structure of lasers is different from l.e.d.s and they are usually used in the pulsed mode.

Probably the main interest in the book will be in the practical laser diode driving circuits. Perhaps the most interesting design is of a laser transmitter and receiver using pulse frequency modulation which can be used for voice communication at up to 3½ miles range. Of course, sophisticated optics are needed to achieve such a range and this side of the design is not neglected.

For the interested amateur or the researcher this book provides an excellent introduction to semiconductor lasers and the techniques needed to use them.

S.R.L.

## SEMICONDUCTOR DATA HANDBOOK

Published by the General Electric Company, U.S.A.  
1,538 pages, 8½in  $\times$  10½in. Price £2.30.

THIS massive 1,538 page handbook embraces the full range of semiconductor devices manufactured by the General Electric Company. It contains data sheets, circuits application tips and hints, equivalent and device selector guides and indexes to application notes and technical publications.

Devices covered include silicon and germanium transistors from small signal to power types; signal and tunnel diodes and power rectifiers; unijunction switches and triggers; s.c.r.s and triacs; optoelectronic devices; voltage regulators, differential and Darlington amplifiers; selenium components; transistor and diode chips; military and high reliability types and associated mounting hardware.

The Semiconductor Data Handbook can be obtained from Jermyn Distribution, Vestry Estate, Sevenoaks, Kent.

# PATENTS REVIEW...

## ELECTRONIC METRONOME

In BP 1 280 117 Andre Paquet of France details a simple but probably reliable electronic metronome for producing synchronised sound and light signals.

In his circuit (see Fig. 1) the inventor uses a bi-stable multivibrator which can be switched from one of its states to the other by a time constant circuit R1, VR1, C1. In fairly conventional manner the capacitor C1 is charged via R1, VR1 to a voltage V (defined by R3 and R4) at which TR1 and TR2 transistors conduct. In this state the capacitor C1 discharges and a negative pulse is passed via C2 to the multivibrator. There follows a change of state of the multivibrator which energises the coil L1 and the lamp LP1 and the coil L2 and the lamp LP2 alternately in a "flip-flop" manner.

In one design the coils attract cores which strike a metal plate to produce a sound output. In another design, a sound output is produced by a loudspeaker connected in series with a thyristor controlled by an RC circuit.

Regulation of the range of frequency to be covered is by adjustment of the frequency control VR1. The other adjustment is of the absolute value of the frequency at a predetermined point on the potentiometer—usually this is the minimum frequency required.

The main advantage claimed is that as the value of a potential U on the base of TR1 is defined with respect to V by  $\frac{R4}{R3 + R4}$  the period P between switching operations will depend only on the slope of the exponential of the charging

curve of the capacitor C1, i.e. on  $(R1 + VR1) \times C1$ , which is adjustable, of course, by means of the potentiometer.

Thus (discounting leakage currents) the frequency of switching of the multivibrator is independent of the voltage of the power source and thus the metronome will not speed up or slow down according to battery condition.

## COUNTING STACKED ARTICLES

WHEN flat articles such as envelopes, paper sheets or packages are stacked, counting them can be extremely difficult. The main problem is that very low contrast gradients exist between adjacent stacked articles and so photoelectric sensing devices produce such poor signal-to-noise ratios that the final count is hopelessly unreliable.

One way round the problem is simply to weigh the stack and another proposal has been to enhance the signal from the photoelectric sensors by some means, such as a high pass filter. But so far (at least according to Spartanic Limited, of Illinois, USA, in BP 1 280 311) the overall results have been poor.

In this new British patent Spartanic suggest counting the discontinuities between adjacent stacked articles by an array of sensors having an effective thickness less than that of the stacked articles.

The sensors are photoelectric and (see Fig. 1) an area of the stack of articles is illuminated by means of a lens focusing light from a d.c. source. The axis of illumination ( $\alpha 1$ ) is adjustable so as to give the maximum contrast possible at the article edges. A pair of cross coupled photoelectric

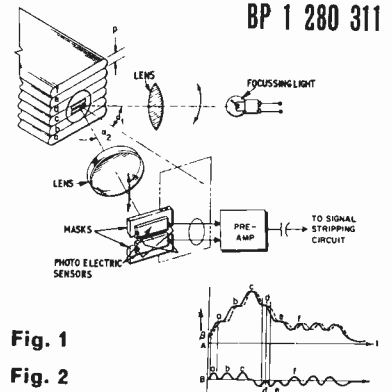


Fig. 1

Fig. 2

sensors are fronted by adjustable guillotine masks and an objective lens so that they scan a pair of areas lying both within the width (p) of a single stacked article. The axis of scan of these sensors ( $\alpha 2$ ) is also adjusted to give the maximum possible contrast.

The sensor output is applied to a high gain amplifier which produces a square wave output in response to small deviations in brightness from an average value. In this way the gaps between articles are detected and counted when the stack is moved past the sensors.

If a number of these sensor arrays are used, circuitry is provided for automatic subtraction from the count in respect of each array above one; using a larger number of sensor arrays will improve the signal characteristics when the available contrast is very low.

Circuit Fig. 2 shows the kind of wave form that can be expected when the stack of articles is moved past the sensor array. The letters a to f are used to denote the separate articles in Fig. 1.

Each of two sensors connected in parallel opposition produce a wave form as shown in the top part of Fig. 2 (at A) and their composite output wave train is as shown in the lower part of Fig. 2 (at B). The result is thus good ambient brightness rejection and resolution.

The patent contains many details of more sophisticated systems based on this general approach and among other suggestions for improving sensitivity is the proposal that a sensor array be assisted by a diffraction grating and a drum cam which is rotated to move the sensor and lens carriers until the vertical bars observed are at a minimum.

## BP 1 280 117

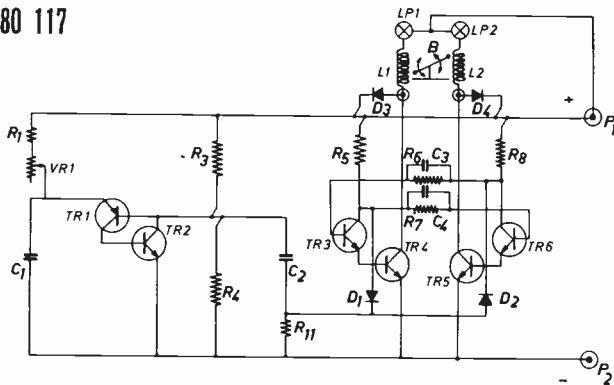


Fig. 1

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2N274	15p	2N3402	12p	2N5459	33p	AF180	50p	BC327	24p	BF821	22.10
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2N376	11	2N3405	27p	3N139	11.36	AF239	41p	BC338	18p	BF862	92p
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2N388A	40p	2N3415	10p	3N141	89p	AF279	54p	BCY31	40p	BFW10	61p
2N456	20p	2N3416	15p	3N142	54p	AF280	54p	BCY32	60p	BEW11	61p
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2N708	13p	2N3710	90p			BC107	14p	BCY71	22p	BFX88	20p
2N709	25p	2N3711	11			BC108	13p	BCY72	18p	BFX89	45p
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2N718	21p	2N3713	11.05			BC113	13p	BCY78	22.40	BFY11	45p
2N718A	30p	2N3714	11.16			BC114	12p	BCY89	80p	BFY17	45p
2N720	50p	2N3715	11.28	40050	78p	BC115	15p	BCY89	35p	BFY18	50p
2N721	55p	2N3716	11.30	40251	81p	BC116	18p	BCZ11	50p	BFY19	40p
2N914	17p	2N3717	22.35	40309	33p	BC116A	15p	BD115	76p	BFY20	50p
2N916	17p	2N3718	24.10	40310	50p	BC117	11p	BD116	76p	BFY29	40p
2N918	30p	2N3775	24.18	40360	44p	BC118	11p	BD117	75p	BFY37	45p
2N919	20p	2N3776	25.95	40361	48p	BC119	27p	BD123	65p	BFY41	45p
2N929	14p	2N3777	24.84	40362	44p	BC121	23p	BD124	60p	BFY43	42p
2N930	14p	2N3778	22.95	40363	89p	BC123	20p	BD130	57p	BFY50	16p
2N1090	25p	2N3779	23.15	40389	46p	BC125	15p	BD131	40p	BFY51	16p
2N1091	25p	2N3780	24.60	40394	56p	BC126	20p	BD132	60p	BFY52	16p
2N1131	20p	2N3781	23.87	40395	50p	BC132	30p	BD135	43p	BFY53	14p
2N1132	20p	2N3782	23.37	40406	44p	BC134	11p	BD136	49p	BFY56	38p
2N1184	21.27	2N3789	21.76	40407	33p	BC135	11p	BD137	55p	BFY64	41p
2N1302	16p	2N3790	21.90	40408	50p	BC136	15p	BD138	63p	BFY75	40p
2N1303	25p	2N3791	22.06	40409	52p	BC137	15p	BD139	71p	BFY76	22p
2N1304	20p	2N3792	22.06	40410	50p	BC138	30p	BD140	83p	BFY77	24p
2N1305	20p	2N3794	21.90	40411	69p	BC140	10p	BDY10	11.25	BFY78	36p
2N1306	22p	2N3819	28p	40467A	89p	BC141	40p	BDY11	11.25	BFY79	60p
2N1307	22p	2N3820	47p	40468A	44p	BC142	24p	BDY17	11.50	BFY39	50p
2N1308	25p	2N3823	50p	40600	69p	BC143	21p	BDY18	11.75	H8X19	13p
2N1309	25p	2N3824	75p	40601	67p	BC144	24p	BDY19	11.97	H8X20	14p
2N1483	90p	2N3825	23p	40602	46p	BC145	21p	BDY20	92p	H8X21	20p
2N1507	24p	2N3854	16p	40603	58p	BC147	11p	BDY38	65p	H8X26	34p
2N1613	20p	2N3854A	16p	40604	46p	BC148	10p	BDY60	80p	H8X27	34p
2N1631	35p	2N3855	16p	40636	21.10	BC149	13p	BDY61	85p	H8X27	34p
2N1637	30p	2N3855A	16p	40673	56p	BC153	18p	BDY62	75p	H8X28	25p
2N1638	27p	2N3856	16p	40675	35p	BC154	14p	BF115	23p	H8X29	47p
2N1671	41	2N3856A	16p	40677	18p	BC157	14p	BD117	43p	H8X30	68p
2N1701	11.10	2N3858	16p	40683	15p	BC158	14p	BF119	58p	H8X39	79p
2N1702	22.15	2N3858A	16p	40684	25p	BC159	11p	BF121	25p	HSX60	54p
2N1711	17p	2N3859	16p	40685	20p	BC160	11p	BF123	25p	HSX60	54p
2N1893	34p	2N3859A	16p	40686	20p	BC167B	13p	BF125	25p	HSX76	15p
2N2102	30p	2N3860	16p	40687	11p	BC168B	11p	BF127	27p	HSX77	25p
2N2147	70p	2N3866	70p	40692	20p	BC168C	11p	BF152	20p	HSX78	25p
2N2148	60p	2N3877	25p	40693	30p	BC169B	13p	BF153	20p	BSW70	28p
2N2192	40p	2N3877A	22p	40694	20p	BC172K	13p	BF154	16p	BSY24	20p
2N2192A	40p	2N3878	11.22	40695	20p	BC178	11p	BF158	15p	BSY25	15p
2N2193	40p	2N3879	11.91	40696	14p	BC179	13p	BF159	22p	BSY26	15p
2N2193A	42p	2N3900	20p	40697	22p	BC172	11p	BF160	15p	BSY27	15p
2N2194	27p	2N3900A	21p	40698	25p	BC182	10p	BF161	35p	BSY28	15p
2N2194A	30p	2N3902	20p	40699	20p	BC182L	10p	BF163	30p	BSY38	15p
2N2195	37p	2N3903	20p	40700	18p	BC183	9p	BF166	35p	BSY39	15p
2N2195A	18p	2N3904	17p	40701	20p	BC183L	9p	BF167	18p	BSY31	25p
2N2188A	18p	2N3905	21p	40702	20p	BC184	11p	BF173	19p	BSY32	25p
2N2219	20p	2N3906	20p	40703	28p	BC184L	10p	BF177	25p	BSY33	25p
2N2219A	20p	2N4036	40p	40704	25p	BC186	25p	BF178	25p	BSY54	30p
2N2220	20p	2N4037	35p	40705	15p	BC187	25p	BF179	30p	BSY56	79p
2N2221	20p	2N4038	12p	40706	15p	BC204	11p	BF180	30p	BSY65	15p
2N2219A	22p	2N4059	90p	40707	20p	BC205	11p	BF182	32p	BSY78	40p
2N2222	20p	2N4060	11p	40708	18p	BC206	10p	BF183	40p	BSY79	40p
2N2222A	25p	2N4061	11p	40709	13p	BC207	10p	BF183	40p	BSY790	45p
2N2368	11p	2N4062	11p	40710	18p	BC208	9p	BF184	17p	BSY92A	25p
2N2369	12p	2N4302	25p	40711	42p	BC209	10p	BF185	17p	BU104	11.42
2N2369A	15p	2N4303	32p	40712	55p	BC211	30p	BF194	14p	BU105	22.25
2N2646	11p	2N4313	32p	40713	17p	BC212K	12p	BF195	15p	C111	58p
2N2647	11.20	2N4914	87p	40714	17p	BC212L	12p	BF196	15p	C112	18p
2N2711	12p	2N4915	95p	40715	31p	BC214L	14p	BF197	15p	C424	15p
2N2712	12p	2N4916	11p	40716	96p	BC236	16p	BF198	15p	C425	36p
2N2713	17p	2N4917	17p	40717	40p	BC237	8p	BF199	18p	C426	25p
2N2714	17p	2N4918	50p	40718	50p	BC238	8p	BF200	35p	C428	25p
2N2904	18p	2N4919	50p	40719	25p	BC239	9p	BF223A	14p	C444	25p
2N2904A	25p	2N4920	60p	40720	60p	BC251	20p	BF225J	19p	DN1	58p
2N2905	25p	2N4921	50p	40721	11.23	BC252	19p	BF225J	19p	DN3	62p
2N2905A	18p	2N4922	55p	40722	63p	BC253	23p	BF237	22p	GET111	45p
2N2906	25p	2N4923	60p	40723	9p	BC257	9p	BF238	22p	GET113	20p
2N2907	25p	2N4927	90p	40724	51p	BC258	9p	BF244	16p	GET114	20p
2N2907A	25p	2N4928	11.80	40725	13p	BC259	13p	BF245	33p	GET115	20p
2N2913	75p	2N4929	22.23	40726	27p	BC262	18p	BF246	48p	GET120	25p
2N2923	12p	2N4930	22.25	40727	23p	BC263	23p	BF247	49p	GET535	20p
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# INGENUITY UNLIMITED

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

## SOUND/LIGHT MODULATOR

READERS may be interested in my version of a sound/light modulator shown in Fig. 1. It is entirely adjustable and works out to be very cheap compared with other modulators which incorporate frequency band splitters and sync pulse generators.

Sensitivity is controlled by VR1, and resistor R1 is to protect the transistor in the instance of the bulb filament shorting. The value of R1 was 100Ω rated at ½ watt which can be lowered depending on the bulb used. A 6V 0.06A or 0.1A bulb can be used quite satisfactorily.

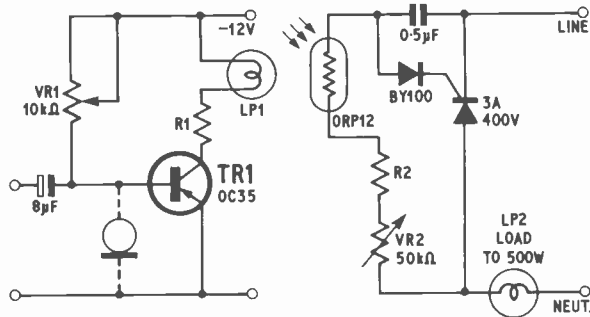


Fig. 1. Circuit diagram of the sound/light modulator. The value of R2 was found to vary between 15 to 27 kilohms according to the load

If a microphone is to be used it should be of the carbon type and connected in the circuit as shown (dotted) in Fig. 1.

If the circuit is to be built in a cabinet or case the lamp should be positioned approximately ¼ in away from the l.d.r. (ORP12).

For a load greater than 500W the handling current of the thyristor should be increased. The potentiometer VR2 controls the brilliance of lamp LP2.

This circuit is open to a great deal of experiment, for instance three circuits could be built with the potentiometer in each adjusted to different stages to make a three channel unit.

The input is completely isolated from the mains.

C. Walker,  
London, S.W.9

## TOUCH SWITCH

THE circuit in Fig. 1 detects voltage changes caused by the proximity of the hand on a sensitive plate or contact, causing a relay to operate. The characteristics of the circuit may be tailored to a particular application by choice of component values.

Typical component values are shown in Fig. 1. The transistors and diodes are general purpose silicon types. The relay coil resistance should be about 700 ohms to 1.5 kilohms, and the supply should be easily capable of operating the relay but not exceeding 25V.

Resistor R1 may be decreased to about 2.7 megohms if the circuit is required to operate only when contact is made to the input by one's fingers. Conversely, as a proximity detector the value of the resistance may be increased.

If the battery drain is an important factor, the resistor R2 may be increased so that the quiescent current is only a few microamps. Sensitivity may be increased by reducing the value of R2. If the sensitivity is increased too much the relay will remain permanently operated.

If the circuit is required to remain operated for some time after triggering, the value of C1 may be increased. The delay before the relay releases is

about one second per microfarad. As the capacitor is charged up through R2, it may be necessary to reduce the value of R2 to give speedy operation.

The circuit may be used in a wide variety of applications such as burglar alarms, doorbells, practical jokes, and is particularly useful for switches which have to be found in the dark.

P. K. Webb,  
Malvern, Worcs.

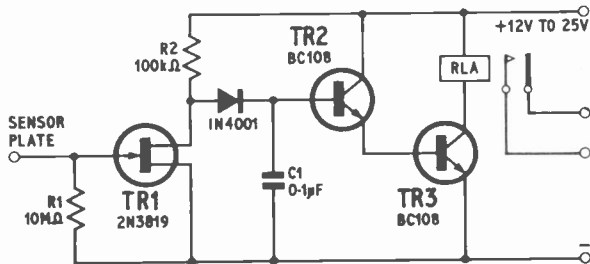


Fig. 1. Circuit diagram of a simple proximity switch

# MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned.

## CATALOGUES

It is at this time of the year that we take stock of all of our component catalogues and usually receive all the new editions. Judging by the amount of catalogues we have already received and those acquired during the past year it seems a good time to mention just some of the many excellent catalogues in our files.

It seems that as more and more components are becoming available generally, particularly the more specialised types, as electronic techniques forge ahead so we are receiving a greater number of catalogues and firms are tending to specialise in particular fields.

Typical of this trend is **LST Components** who, through the component explosion, have found it increasingly difficult to maintain their excellent personal service to both the home constructor and the trade. Not wanting to lower their high standards they recently formed a new company called **Arrow Electronics Ltd.**, to deal exclusively with the home consumer market. The parent company is now dealing with the trade only.

The new company have recently issued an excellent catalogue containing items from i.c.'s to switches. Copies of the catalogue can be obtained from Arrow Electronics Ltd., 7 Coptfold Road, Brentwood, Essex.

Another firm who tends to specialise, in this case in integrated circuits, is **Bywood Electronics**. Their catalogue lists such items as a Digital Clock Chip, LSI Calculator i.c.'s and several LED devices (including liquid crystal types).

The Bywood catalogue is available from Bywood Electronics, 181 Ebbens Road, Hemel Hempstead, Hertfordshire.

From the other side of the coin **GSPK (Sales) Ltd.**, who are well known trade distributors, have recognised the vast demands for components from the consumer side and have set up a special retail counter at their office. Also, they issue a very good mail order catalogue and are offering a great many

of their components which are not normally available to the constructor, unless ordered in large quantities, on a one-off basis.

Copies are available from **GSPK (Sales) Ltd.**, Hookstone Park, Harrogate, Yorkshire.

A catalogue we strongly recommend to our readers is the **Audio Pack Trade Reference Catalogue** from **Tape Recorder Spares Ltd.** This catalogue costs 35p, including postage, and covers over 600 items marketed under the name of "Audio Pack".

The catalogue seems to cover practically every conceivable arrangement for connecting up audio equipment. A special section is devoted to Garrard spares.

This catalogue is certainly an excellent audio spares reference source and should be very near the top of any "Catalogues Wanted" list. Copies are available from **Tape Recorder Spares Ltd.**, 206-210 Ilderton Road, London SE15 1NS.

Finally, as proof of the component growth **Home Radio Components** have had to completely change the format of their catalogue.

The new 240-page catalogue contains over 8,000 items, 1,500 illustrations and still maintains the usual high standards of previous editions. The cost of the catalogue is 75p, including postage, but contains 10 redeemable vouchers worth 5p each when used as directed.

Included with the catalogue is a price supplement which will be updated from time to time and each page will have the date stamped on it. At the bottom of the price supplement is a note to the effect that "when the supplement is six months old 10 per cent should be added to any item purchased and a new supplement be requested". Upon investigation it was pointed out that this was to avoid any unnecessary delay in dispatching of orders. Any difference between the remittance and the current price of goods ordered will be returned as a credit note with the option of a cash refund.

The Home Radio catalogue is probably one of the most useful reference sources for components on the market and copies can be obtained from Home Radio (Components) Ltd., 240 London Road, Mitcham, Surrey CR4 3HD.

## SYNTHESISER MODULES

Commencing in this issue is the first part of the P.E. Synthesiser which we are sure will generate tremendous interest amongst our readers. This synthesiser will be described in great detail over the next few months and each circuit function will be described and complete constructional details given.

For those readers who do not wish to understand or construct



Two of the Dewtron synthesiser modules from D.E.W. Ltd.

each individual circuit as the series progresses but prefer to connect up "black boxes" (modules) then the Dewtron Project X Synthesiser modules from **D.E.W. Ltd.**, may be worth looking into.

The Project X modules are completely sealed units which have a two year guarantee against failure and their range includes a voltage controlled oscillator, sample, hold and envelope shaper unit and a ring modulator module. The Project X Synthesiser is in NO way connected with the P.E. Synthesiser.

A list of modules and other musical effects units with prices are available from **D.E.W. Ltd.**, 254 Ringwood Road, Ferndown, Dorset.

## SLIDER CONTROLS

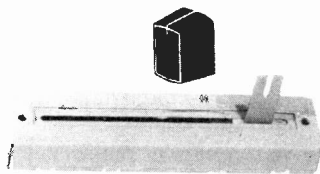
Whilst on the subject of effects units we often get requests for the slider type of controls which are used extensively in effects units. To date, these type of controls have been difficult for the home constructor to obtain and a compromise has had to be made by using standard rotary potentiometers.

A range of slider potentiometers is now available direct from **DJ Electronics (Hackney) Ltd.** or from most component retailers. The sliders, complete with knob and fixing screws, are available as single or double gang types in both logarithmic and linear configurations.

A range of mounting plates are available separately and enable the constructor to make up numerous configurations. The plates are offered as single-way, double or triple-way.

The cost of the sliders are expected to be 61p for single gang types; and 81p for double gang. The mounting plates will cost 25p for single-way, 36p for double-way and 45p for three-way.

Addresses of nearest stockists can be obtained from **DJ Electronics (Hackney) Ltd.**, 122 Balls Pond Road, London, N1 4AE.



Slider control from DJ Electronics



# Build yourself a TRANSISTOR RADIO

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10 TRANSISTORS. 9 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 600mW transistors. Car Aerial and tape record 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 controls. Attractive case in black with silver blocking. Size 9in x 7in x 4in.

Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS

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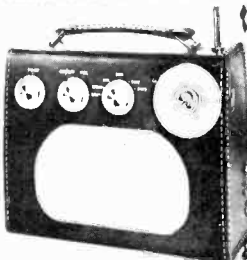
P.P. & INS. 50p  
(OVERSEAS P. & P. £1)



## ROAMER EIGHT

Mk. I

NOW WITH VARIABLE TONE CONTROL

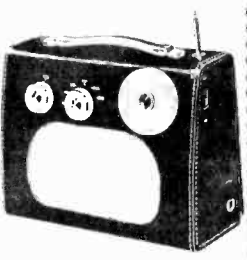


7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch, 5 transistors plus 3 diodes. Fine 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 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£6.98** P.P. & INS. 45p  
(OVERSEAS P. & P. £1)

## ROAMER SEVEN

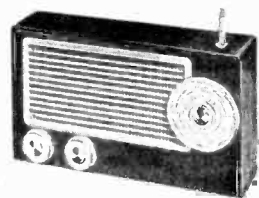
Mk. IV



7 TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Extra medium waveband provides easier tuning of Radio Luxembourg, etc. Built-in ferrite rod aerial for MW and LW. Retractable 4 section 24in chrome plated telescopic aerial for SW. Socket for car aerial. Powerful push-pull output. 7 transistors and 2 diodes, including micro-alloy R.F. transistors. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

TOTAL BUILDING COSTS **£5.98** P.P. & INS. 45p  
(OVERSEAS P. & P. £1)

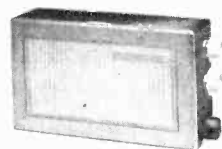
## ROAMER SIX



6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2. TRAWLER BAND PLUS AN EXTRA MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages—6 transistors and 2 diodes including micro-alloy R.F. transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Easy build plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS **£3.98** P.P. & INS. 30p  
(OVERSEAS P. & P. £1)

## POCKET FIVE



3 TUNABLE WAVEBANDS: MW, LW, TRAWLER BAND WITH EXTENDED MW BAND FOR EASIER TUNING OF LUXEMBOURG, ETC. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5 1/2in x 1 1/2in x 3 1/2in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS **£2.29** P.P. & INS. 23p  
(OVERSEAS P. & P. 63p)

## TRANSONA FIVE

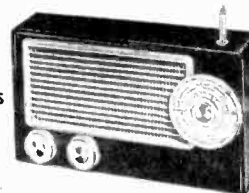


5 TRANSISTORS AND 2 DIODES

3 TUNABLE WAVE BANDS: MW, LW AND TRAWLER BAND. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6 1/2in x 4 1/2in x 1 1/2in. Easy build plans and parts price list 10p (FREE with parts).

TOTAL BUILDING COSTS **£2.50** P.P. & INS. 24p  
(OVERSEAS P. & P. 63p)

## TRANS EIGHT



8 TRANSISTORS AND 3 DIODES

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

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| TRANSONA FIVE | <input type="checkbox"/> | ROAMER SIX   | <input type="checkbox"/> |
| POCKET FIVE   | <input type="checkbox"/> | EDU-KIT      | <input type="checkbox"/> |

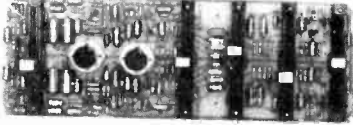
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P.E. 50

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**DESIGNS PUBLISHED IN P.E.**

- AURORA (Apr./Aug. 71)** Multichannel Sound Controlled Light S/c's (excl. SCR's), Rs, Cs, Cores, Pots, 8 ch., £17.75; 4 ch., £10.15. Slider Pots and Knobs alternative extra, 8 ch., £3.70; 4 ch., £2.20. Power Supply (supplies 8 chans.), unswitched, £2.85; stab., £3.65. PCB (4 1/2in x 5 1/2in) for Pre-amp and 4 Chans. incl. all pots, £2.35. PCB (4 1/2in x 6 1/2in) for PSU, Sync Gen, 8 cores, 8 SCR's, £1.35.
- A.F. SIGNAL GENERATOR (Nov. 72)** S/c's, Rs, Cs, Pots, Sw's £2.25. PCB (2 1/2in x 4in) also holds Sw's, 90p.
- BIOLOGICAL AMPLIFIER**—Details on request.
- CALLERCORD (Jul./Aug. 72)** Automatic Answering Machine S/c's, Rs, Cs, Pots, Switches, Relays, Transformer, £12.15. PCB (4in x 7 1/2in) holds circuit, relays, edgeconnectors, £1.50. Parrot Tape Recorder, £6.95. Pips Gen with PCB, £1.50.
- DOOR BELL YODELLER (Apr. 71)**—S/c's, Rs, Cs, Pots, £4.20. Transformer, £1.30. Loudspeaker, £1.30. PCB (3in x 3 1/2in), 90p.
- ELECTRONIC PIANO (Sept. 72/Jan. 73)** Pre-Amp—Rs, Cs, Pots, £1.90. PCB as published, £1.20. Power Supply—Rs, Cs, £1.15. PCB as published, 95p. Pitch 1-12—Rs, Cs, £2.10 each set. Pitch 13—Rs, Cs, £1.50. Pitch PCB as published £1.85 each. Discounts for Qty.
- GEMINI STEREO AMP (Nov. 70/Mar. 71)** Stereo Sets and PCB's Pre-Amp—S/c's, Cs, Pots, Maka-Sw's—with 1/2W 25% M.O. Rs, £13.45—with 1/2W 5% C.F. Rs, £11.20—with 1/2W 5% C.F. Rs, £10.75—with Slider Pots and Knobs extra, £1.65. PCB (3 1/2in x 10 1/2in) for kits with 1/2W M.O. or 1/2W C.F. Rs. Holds pots and Maka-Sw's, £2.10. Main Amp—Rs, Cs, Pots, £4.30. PCB (3 1/2in x 5in), £1.40. PSU—Rs, Cs, Pot, £3.70. PCB (2in x 4in), 75p.

- GEMINI STEREO TUNER (Apr./Jun. 72)** Rs, Cs, Pot, £3.20. PCB as published, £1.80.
- LOGICAL RADIO CONTROL (Dec. 71/Jan. 72)**—Sets incl. Rs, Cs, S/c's and Pots (where req.) but excl. I.C's. Coder 1 and Clock Pulse Gen., £2.95. Coder 2A, £2.80. Coder 2B, £3. Decoder, 55p. PCBs as pub., 75p each.
- MODEL SERVO CONTROL (Feb./Mar. 72)**—Sets incl. Rs, Cs, S/c's and Pots (where req.) but excl. I.C's. Servo Amps: "A", £1.40; "B", £2.55; "C", £1.30. Fail-Safe, 65p. PCBs as published: "A" and "B", 60p each; "C" and Fail-Safe, 50p each.
- MICROPHONE MIXER (Apr. 69)**—S/c's, Rs, Cs, Pots, £2.90. Slider Pots and Knobs extra, £1.15. PCB (3 1/2in x 4 1/2in)—holds pots, £1.20.
- PHOTOPRINT PROCESS CONTROL (Jan./Feb. 72)** Finds exposure, controls timing, stabilises mains voltage. S/c's, SCR, LDR, Rs, Cs, Pots, Relay, Sw, T/former, £7.60. PCB (3 1/2in x 5 1/2in) also holds pots, relay, Keypswitch, £1.20.
- SOUND SYNTHESISER**—Details on request.
- TAPE NOISE LIMITER (Feb. 72)**—Mono Circuit S/c's, Rs, Cs, Pot, PCB (1 1/2in x 3in), £2.20. Regulated Power Supply (will feed 2 units) and PCB (1 1/2in x 2 1/2in), £3.20.
- ULTRASONIC TRANSMITTER-RECEIVER (May 72)** Rs, Cs, Pot, S/c's, T/ducers, Relay, £9.95. Dual PCB (2in x 5 1/2in), 75p.
- VERSATILE LIGHT EFFECTS UNIT (Jun. 72)**—Single Channel Sound Controlled Light—also has built-in variable strobe generator. S/c's (excl. SCR), Rs, Cs, Pots, T/formers, Keypswitch, £8.85. PCB (5 1/2in x 5 1/2in) also holds Pots, Sw, T/former (T/T/T), £1.50. Slider Pots and Knobs (excl. 25R Lin.—Rotary only), £1.10 extra.

## SOME OTHER DESIGNS AVAILABLE

- REVERBERATION UNIT (Practical Wireless Nov.—Dec. 72)** S/c's, Rs, Cs, Slider Pots, T/former, 9in Spring Line Unit £9.70 (with rotary pots £8.55). (With 16in Unit extra £3.20). PCB (2in x 1 1/2in) also holds sliders (compatible with publ. panel) £1.20.
- 8 WATT AMPLIFIER (Practical Wireless Nov. 72)** Main Amplifier—Rs, Cs, Pot (Mono Set), £1. PCB (2 1/2in x 3in) (Mono), 60p. Pre-amp—S/c's, Rs, Cs, Pots, Maka-Sw., Mono, £2.50; Stereo, £5.20. Slider Pots and Knobs extra, Mono, £1.26; Stereo, £1.52. PCB (3 1/2in x 7 1/2in) (Stereo)—also holds all pots and Maka-Sw., £1.50.
- I.C. 21W STEREO AMPLIFIER (Radio Constructor July 71)** Rs, Cs, Pots, I.C's complete with heatsinks, £7.50. PCB (4 1/2in x 5in)—(Stereo) also holds Pots, £1.20. Power Supply, £2.85. Slider Pots and Knobs extra, £1.35.
- AURORA AUXILIARY CONTROL UNIT (2 variable frequency strobe generators and 4 variable amplitude frequency generators)** Rs, Cs, Pots, S/c's £3.25. Slider Pots and Knobs extra, £2.34. PCB (3 1/2in x 5 1/2in) holds all generators plus pots, £1.35.
- THYRISTORS (400V P.I.V.)** 1A 50p. 3A 55p. 7A 70p. 16A 95p.

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DM160 Dynamic uni-dir, ball metal	3-75	5in 1200ft 60p 7in 1800ft 80p	
VD130 50K/600 ohm uni-dir, ball metal	4-50	3 1/2in 900ft 49p 3 1/2in 1200ft 55p	
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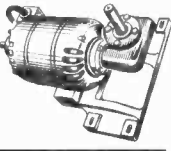
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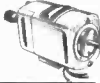
**PARVALUX Type: SD1S/86896/OJ**  
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### MOTOROLA MAC 11/6 PLASTIC TRIAC 400 PIV. 10 AMP

Now available EX STOCK. Supplied with full data and applications sheet. Price £1.05. P. & P. 7p. Suitable DIAC (RCA 40583) 30p each.

## STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation.

**EXPERIMENTERS' ECONOMY KIT**  
Speed adjustable 1 to 30 flash per sec. All electronic components including Veroboard S.C.R. Unijunction Xenon Tube and instructions £6.30, plus 25p P. & P.

**NEW INDUSTRIAL KIT**  
Ideally suitable for schools, laboratories, etc. Roller tin printed circuit. New trigger coil, plastic thyristor. Speed adjustable 1-80 f.p.s. approx. i output of Hy-Light.

**HY-LYGT STROBE MK III**  
Designed and produced for use in large rooms, halls and the photographic field and utilises a silica tube, printed circuit, also a special trigger coil. Speed adjustable 0.20 f.p.s. Light output approx. greater than many (so called 4 joule) strobes. £12.00. P. & P. 50p. SPECIALLY DESIGNED.

### THE 'SUPER' HY-LYGT KIT

Approx. four times the light output of our well proven Hy-Light strobe. Incorporating:

- Heavy duty power supply,
- Variable speed 1-13 flash per sec.
- Reactor control circuit producing an intense white light.

Never before a Strobe Kit with so HIGH an output at so LOW a price. ONLY £20 plus 75p P. & P.

**ATTRACTIVE, ROBUST, FULLY VENTILATED METAL CASE** specially designed for the Super Hy-Light Kit including reflector £7.00 P. & P. 45p.

For Hy-Light Kit including reflector. £4.00. 7-inch POLISHED REFLECTOR. Ideally suited for above Strobe kits. Price 53p. P. & P. 13p or post paid with kits.

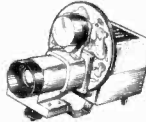
### RAINBOW STROBE FOUR LIGHT CONTROL MODULE

In response to numerous requests, we now offer a mains operated fully isolated short-circuit-proof ready-built module, with variable flash rate. It will operate four of our Hy-Light or Super Hy-Light Strobes in either 1, 2, 3, 4 sequence; 2+2; or all together. Fantastic effects with or without colour filters. Modules can be connected together to operate 8 or 12 Strobes. Will work on long runs of up to 50 yards, so that your Strobes can be spaced out for maximum effect. Size of module is 5 x 6 1/2 in. easily fitted into your own equipment, or into a separate case. Thoroughly tested and reliable. Complete with full connection instructions. Price: £18.50 plus 25p. P. & P. Send S.A.E. for details.

### COLOUR WHEEL PROJECTOR

Complete with oil-filled colour wheel. 100 watt lamp. 200/240V AC. Features extremely efficient optical system. £18.50 + 35p. P. & P. 10p.

**6 INCH COLOUR WHEEL.**  
As used for Disco lighting effects, etc. Price £5.75 inc. p. & p.



### BIG BLACK LIGHT

400Watt. Mercury vapour ultra violet lamp. Outer bulb designed to absorb visible light and transmit u.v. rays. Extremely compact and powerful source of use. Innumerable industrial applications also ideal for stage, display, discos, etc. P.F. ballast is essential with these bulbs. Price of matched ballast and spare bulb £16.00. P. & P. 50p. Spare bulb £7.00. P. & P. 30p.



### BLACK FLUORESCENT U.V. TUBES

4ft. 40 watt. Price £5.80 incl. P. & P. (For use in standard bi-pin fluorescent fittings). MINI 9 in. 6 watt black light U.V. tube.

## Superior Quality Precision Made NEW POWER RHEOSTATS



100 WATT. 1 ohm, 10A; 5 ohm, 4.7A; 10 ohm, 3A; 25 ohm, 2A; 50 ohm, 1.4A; 100 ohm, 1A;  
250 ohm, 0.7A; 500 ohm, 0.45A; 1 kΩ, 280 mA; 1.5 kΩ, 230mA; 2.5 kΩ, 2A; 3.5kΩ, 5 kΩ, 140mA;  
Diameter 3/16 in Shaft length 3/16 in, dia. 1/16 in. All at £1.65 each. P. & P. 7p.

50 WATT. 1/5/10/25/50/100/250/500/1/1/2/5/5kΩ. All at £1.15 each. P. & P. 7p.

25 WATT. 10/25/50/100/250/300/500/1/1/1/5/2/5/3/5/5kΩ. All at 90p each. P. & P. 7p.

Black Silver Skirted knob calibrated in Nos. 1-9. 1/4 in. dia brass bush. Ideal for above Rheostats. 18p ea.

## RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

Col (1)	2	3	4
Coil ohms			
52	3-6	2 c/o	63p*
410	10-18	4 c/o	73p*
600	12-24	4 c/o	78p*
d.c. volts	700	16-24	4M 2B
	700	16-24	4 c/o
Col. 3	700	15-35	2 c/o HD
Contracts	700	16-24	6M
	700	6-12	1 c/o HD
Col. (4)	700	20-30	6 c/o
Price	1,250	24-36	4 c/o
HD =	2,500	36-45	6M
Heavy duty	2,400	30-48	4 c/o
Incl. Base	9,000	40-70	2 c/o
Post paid	15k	85-110	6M
			50p*

**12 VOLT D.C. RELAY 140 ohm coil**  
Type 1: Three sets c/o contacts rated at 5 amps. 78p incl. P. & P. (Similar to illustration below.)  
Type 2: One set of c/o contacts, 60p incl. P. & P.  
Type 3: 4-8 volt, 3 c/o HD, 67 ohm coil. 78p.

### 'DIAMOND H' 230 VOLT A.C. RELAYS (Unused)

Three sets c/o contacts rated at 5 amps. PRICE: 50p. P. & P. 10p. (100 lots £40 including P. & P.)



**230 VOLT A.C. RELAYS MFG. KEY SWITCH**  
One set c/o contacts rated at 7.5 amps. Boxed. PRICE: 40p. P. & P. 5p. (100 lots £32 inc. P. & P.)

**MINIATURE LATCHING RELAY**  
Manufactured by Clare-Elliott Ltd. Type F. 2 c/o permanent latching in either direction. Coil 1150 ohm, 15-30 Volt D.C. Size 1/2" high, 1/2" wide, 1/2" thick. Complete with 3" leads. New 73p, incl. P. & P.

## UNISELECTOR SWITCHES

**NEW 4 Bank 25 Way**  
24V d.c. operation. £5.88. P. & P. 25p.

**6 Bank 25 Way**  
24V d.c. £6.50. P. & P. 25p.

**8 Bank 25 Way**  
24V d.c. operation. £7.62 plus 25p. P. & P.



### 'HONEYWELL' PUSH BUTTON PANEL MOUNTING MICRO SWITCH ASSEMBLY

Each bank comprises a c/o rated at 10 amps 240V. A.C. Black knob in. Fixing hole 1/2 in. ONE bank 30p; THREE banks 40p; THREE banks 55p; incl. P. & P. Quot. for quantity.



### 'HONEYWELL' LEVER OPERATED MICRO SWITCH

15 amps 250 volt A.C. c/o contacts. Types N39, N95, N100, N101 NEW in maker's carton. PRICE: 10 for £1.90 incl. P. & P.



### Very special offer MICRO SWITCH

5 amp c/o contacts. Fitted with removable metal panel assembly. Ex. P. 20 for £1 inc. post. (Min. order 20.)



**AMMETERS NEW!** 2 1/2 in. Flush round. Available in D.C. Amps 1, 5, 15, 20 or A.C. Amps 1, 5, 10, 15, 20, both types £1.75 incl. P. & P. 0-300V. A.C. £1.90 incl. P. & P.



## INSULATION TESTERS NEW!

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L 8 in, W 4 in, H 6 in. Weight 6 lb. 1,000V, 1,000 megohms, £34.00 carriage paid. 500V, 500 megohms, £28 incl. P. & P.



### 50 in 1 ELECTRONIC PROJECT KIT

50 easy to build Projects. No soldering, no special tools required. The kit includes Speaker, Meter, Relay, Transformer, plus a host of other components and a 56-page instruction leaflet. Some examples of the 50 possible Projects are: Sound Level Meter, 2 Transistor Radio, Amplifier, etc. Price £7.75. P. & P. 30p.

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### TRANSFORMERS

all with 0-250 Volt primaries  
**Miniature**  
MM16 6V, 500mA + 6V, 500mA  
MM12 12V, 250mA + 12V, 250mA  
MM20 20V, 150mA + 20V, 150mA  
£1.29 plus 13p p. & p.  
**L.T.**  
LT1 6.3V, 1.5A—75p plus 18p p. & p.  
LT2 6.3V, 3A—87p plus 26p p. & p.  
LT3 12V, 1.5A—87p plus 26p p. & p.  
LT4 12V, 3A—£1.32 plus 30p p. & p.  
LT5 9-0-9V, 0.5A—75p plus 21p p. & p.  
LT6 12-0-12V, 1A—95p plus 26p p. & p.

**Multi-tapped**  
MT30/2 0-12-15-20-24-30V, 2A—£1.95 plus 30p p. & p.  
MT60/1 0-5-20-30-40-60V, 1A—£2.10 plus 30p p. & p.  
MT60/2 0-5-20-30-40-60V, 2A—£2.95 plus 34p p. & p.

**Charger**  
CT/01 1A—£1.05 plus 26p p. & p.  
CT/02 2A—£1.30 plus 30p p. & p.  
CT/03 4A—£1.60 plus 30p p. & p.  
Secondaries—0.5-11-17V.

**Speaker Matching** 3-8 16Ω  
Example: 16Ω speaker to 8Ω amplifier. 90p plus 20p p. & p.

### SEMICONDUCATORS, etc.

Zeners—400mW, 15p; 1.5W, 22½p  
L.D.R.—CRP12, 56p  
S.C.R.—400 P.I.V., 3.0A, 57p  
Bridge rectifier—40 P.I.V., 1.5A, 50p  
Bridge rectifier—200 P.I.V., 2.0A, 50p  
Transistor sockets—7p  
D.I.L. I.C. sockets—14 pin, 20p; 16 pin, 20p  
IN4001—50 P.I.V., 1.0A, 6p  
IN4002—100 P.I.V., 1.0A, 7p  
IN4003—200 P.I.V., 1.0A, 8p  
IN4004—400 P.I.V., 1.0A, 9p  
IN4005—600 P.I.V., 1.0A, 12p

### ALUMINIUM BOXES

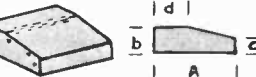
with lids and screws  
**Type L. W. D. Price p. & p.**  
GB7 \* 5½in 2½in 1½in 38p 15p  
GB8 \* 4in 4in 1½in 38p 15p  
GB9 \* 4in 2½in 1½in 38p 15p  
GB10 \* 5½in 4in 1½in 44p 18p  
GB11 4in 2½in 2in 38p 13p  
GB12 3in 2in 1in 33p 13p  
GB13 6in 4in 2in 52p 18p  
GB14 7in 5in 2½in 63p 19p  
GB15 8in 6in 3in 74p 26p  
GB16 10in 7in 3in 92p 26p  
\* These sizes fit standard veroboards

### EQUIPMENT CASES

in plain aluminium with sloping front panel.  
**Type H. W. D. Price p. & p.**  
SFI 2in 5½in 2½in 45p 12p  
SF2 2in 7½in 3½in 60p 16p  
SF3 2in 9½in 4½in 75p 19p  
Stove—enamelled silver-grey hammer finished, 25p extra.

### CONSOLE CASES

in plain aluminium, ideal for mixers, instruments, etc.  
**Type W. A. B. C. D Price p. & p.**  
in in in in in  
GB20 B 9 3½ 2 3 £1.42 30p  
GB21 10 9 3½ 2 3 £1.58 30p  
GB22 12 9 3½ 2 3 £1.72 30p



### VEROBOARD

Size	0-1 matrix	0-15 matrix
2½in x 3½in	12p	16p
2½in x 5in	24p	25p
3½in x 3½in	24p	25p
3½in x 5in	27p	29p
17in x 2½in	75p	57p
17in x 3½in	£1.75	75p

Pins—either size, packet of 36, 18p

### ELECTROLYTICS

1µF 450V	19p	1,000µF 25V	27p
2µF 450V	20p	1,000µF 50V	42p
4µF 450V	24p	2,000µF 25V	39p
8µF 450V	17p	2,000µF 50V	53p
16µF 450V	18p	2,500µF 25V	45p
25µF 25V	7p	2,500µF 50V	60p
25µF 50V	10p	3,000µF 25V	48p
32µF 450V	27p	5,000µF 25V	60p
50µF 50V	10p	5,000µF 50V	£1.10
100µF 25V	10p	8-8µF 450V	18p
100µF 50V	11p	8-16µF 450V	20p
250µF 25V	14p	16-16µF 450V	27p
250µF 50V	17p	16-32µF 450V	63p
500µF 25V	18p	32-32µF 450V	49p
500µF 50V	25p	50-50µF 350V	38p

### MINIATURE ELECTROLYTICS

1µF 63V	6p	47µF 16V	7p
2.2µF 63V	6p	47µF 25V	6p
3.3µF 63V	6p	68µF 16V	6p
4.7µF 63V	6p	100µF 10V	6p
8µF 40V	7p	220µF 16V	7p
10µF 25V	6p	330µF 16V	11p
10µF 64V	7p	470µF 10V	11p
16µF 40V	7p	1,000µF 16V	19p
33µF 16V	6p	1,500µF 16V	23p

### CASSETTE OWNERS!

For Philips and similar cassette recorders.  
PU12 Power unit for connection to 12V or - E car electrical systems, giving 7½V, stabilised output. **£3.25**  
PU14 As above but switched for 6V, 7½V or 9V output. **£5.10**  
PP75 Mains power supply, output 7½V d.c. **£1.95**  
All units are complete with cable and plug.

### CASSETTES

Top quality British made, low noise, complete with transparent library cases—C60—40p; C90—55p; C120—70p

### BATTERY ELIMINATORS

suitable for transistor radios and similar light current equipment  
PP6 Input 240V a.c. Output 6V d.c.  
PP9 Input 240V a.c. Output 9V d.c.  
Price £1.50 plus 12p p. & p.

## ILLUSTRATED CATALOGUE

Post Free 15p

### CONTROLS, Log. or Lin.

Single, less switch, 15p  
Single, D.P. switch, 24p  
Tandem, less switch, 40p  
5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ

### RESISTORS

Carbon  
All 5%, high-stability, E12 values. ¼W, 1p; ½W, 1½p; 1W, 4p; 2W, 6p  
Wire-wound  
5W, 10p; 10W, 12p

### SWITCHES

Toggle switches, standard size.  
SW20—S.P.S.T. 18p; SW21—D.P.D.T. 23p.  
Push Button, miniature, SW1—13p.  
Wafer switches (rotary)—24p each.  
SW4—1 pole, 12 way. SW5—2 pole, 6 way.  
SW6—3 pole, 4 way. SW7—4 pole, 2 way.  
SW8—4 pole, 3 way.

### BONDED ACRYLIC FIBRE

B.A.F. wadding, 18in wide, 1in thick. The ideal lining for speaker enclosures. 30p per yard. p. & p. one yard 12p; each extra yard 4p.

**TYGAN** top quality loudspeaker covering material. Please send 6p for samples, sizes and prices.

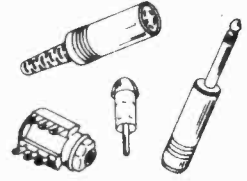
### MAGNETIC COUNTERS

Brand new, neat, 48 volt, 5 digit counters. 60p



### PLUGS

Car aerial 14p  
Co-axial 9p  
D.I.N. 2 pin (speaker) 10p  
D.I.N. 3 pin 13p  
D.I.N. 4 pin 14p  
D.I.N. 5 pin, 180° 13p  
D.I.N. 5 pin, 240° 15p  
D.I.N. 6 pin 15p  
Jack, 2½mm unscreened 9p  
Jack, 2½mm screened 10p  
Jack, 3½mm unscreened 8p  
Jack, 3½mm screened 12p  
Jack, 4mm unscreened 12p  
Jack, 4mm screened 20p  
Jack, stereo, unscreened 20p  
Jack, stereo, screened 35p  
Phono, plastic top 5p  
Phono, plated metal 12p  
Wander, red or black 3p  
Banana 4mm, red or black 6p



### SOCKETS

Car aerial 8p  
Co-axial, surface 8p  
Co-axial, flush 10p  
D.I.N. 2 pin (speaker) 10p  
D.I.N. 3 pin 9p  
D.I.N. 5 pin, 180° 9p  
D.I.N. 5 pin, 240° 9p  
Jack, 2½mm 10p  
Jack, 3½mm 10p  
Jack, 4mm unscreened 17p  
Jack, 4mm screened 15p  
D.I.N. 2 pin (speaker) 24p  
D.I.N. 3 pin 5p  
D.I.N. 5 pin, 180° 7p  
D.I.N. 5 pin, 240° 7p  
Phono, 3 on a strip 10p  
Phono, 4 on a strip 10p  
Phono, single, red or black 5p  
Wander, single, red or black 3p  
Banana 4mm red, or black 6p

### LINE SOCKETS

Car aerial 14p  
Co-axial 17p  
D.I.N. 2 pin (speaker) 15p  
D.I.N. 3 pin 16p  
D.I.N. 5 pin, 180° 16p  
D.I.N. 5 pin, 240° 16p  
Jack, 2½mm 15p  
Jack, 4mm 16p  
Jack, stereo, switched 24p  
Phono, single 5p  
Phono, 2 on a strip 7p  
Phono, 3 on a strip 9p  
Phono, 4 on a strip 10p  
Wander, single, red or black 5p

### CAPACITORS

2.2pF	500V S/M	7½p	0.0027µF	500V S/M	15p
3.3pF	500V S/M	7½p	0.0033µF	500V Cer.	5p
5pF	500V S/M	7½p	0.0033µF	1,000V MDC	6p
10pF	125V P.S.	5p	0.0036µF	500V S/M	15p
10pF	500V S/M	7½p	0.0047µF	125V P.S.	9p
15pF	500V Cer.	5p	0.0047µF	500V Poly.	6p
15pF	500V Cer.	4p	0.0047µF	500V S/M	20p
18pF	500V S/M	7½p	0.0047µF	1,000V MDC	6p
22pF	125V P.S.	5p	0.005µF	100V Molar	3p
22pF	500V S/M	7½p	0.005µF	500V Cer.	5p
25pF	500V S/M	7½p	0.0068µF	125V P.S.	10½p
27pF	500V Cer.	4p	0.0068µF	500V S/M	30p
33pF	125V P.S.	5p	0.0068µF	500V Poly.	6p
33pF	500V S/M	7½p	0.0082µF	125V P.S.	10½p
39pF	500V S/M	7½p	0.0082µF	500V S/M	30p
47pF	125V P.S.	5p	0.01µF	18V Disc	4p
47pF	500V Cer.	4p	0.01µF	125V P.S.	10½p
50pF	500V S/M	7½p	0.01µF	160V Poly.	4p
56pF	500V S/M	7½p	0.01µF	250V M.F.	3p
68pF	125V P.S.	5p	0.01µF	400V Poly.	5p
68pF	500V S/M	7½p	0.01µF	500V S/M	30p
75pF	500V S/M	7½p	0.01µF	500V MDC	7p
82pF	500V S/M	7½p	0.01µF	600V MDC	7p
100pF	125V P.S.	5p	0.015µF	1,000V MDC	9p
100pF	500V S/M	7½p	0.015µF	160V Poly.	3p
100pF	500V Cer.	5p	0.015µF	400V Poly.	3p
120pF	500V S/M	7½p	0.022µF	100V Mylar	3p
150pF	125V P.S.	5p	0.022µF	18V Disc	5p
150pF	500V S/M	7½p	0.022µF	250V M.F.	3p
150pF	500V Cer.	5p	0.022µF	400V Poly.	3p
180pF	500V S/M	7½p	0.022µF	600V MDC	7½p
200pF	500V S/M	7½p	0.022µF	1,000V MDC	10p
220pF	125V P.S.	5p	0.033µF	250V M.F.	4p
220pF	500V Cer.	5p	0.033µF	400V Poly.	4p
250pF	500V S/M	7½p	0.047µF	125V Disc	6p
270pF	500V Cer.	5p	0.047µF	160V Poly.	3p
300pF	500V S/M	7½p	0.047µF	250V M.F.	3p
330pF	125V P.S.	5p	0.047µF	400V Poly.	4p
330pF	500V S/M	7½p	0.047µF	600V MDC	8p
390pF	500V S/M	7½p	0.047µF	1,000V MDC	10p
470pF	125V P.S.	5p	0.1µF	30V Disc	6p
470pF	750V Disc	5p	0.1µF	250V M.F.	4p
500pF	500V S/M	7½p	0.1µF	400V Poly.	5p
560pF	500V S/M	7½p	0.1µF	600V MDC	10p
680pF	125V P.S.	6p	0.1µF	1,000V MDC	14p
680pF	500V S/M	7½p	0.15µF	250V M.F.	5p
820pF	500V S/M	7½p	0.22µF	160V Poly.	6p
0.001µF	100V Mylar	8p	0.22µF	250V M.F.	5p
0.001µF	125V P.S.	6p	0.22µF	400V Poly.	10p
0.001µF	400V Poly.	3p	0.22µF	1,000V MDC	15p
0.001µF	500V S/M	10p	0.33µF	250V M.F.	8p
0.001µF	500V Cer.	5p	0.47µF	250V M.F.	8p
0.001µF	1,000V MDC	6p	0.47µF	400V Foil	15p
0.001µF	400V Poly.	3p	0.47µF	1,000V MDC	25p
0.0015µF	500V S/M	10p	1.0µF	250V M.F.	15p
0.0015µF	500V S/M	10p			
0.0018µF	500V S/M	10p			
0.002µF	100V Mylar	10p			
0.002µF	500V Cer.	5p			
0.002µF	125V P.S.	6p			
0.0022µF	500V S/M	10p			
0.0022µF	1,000V MDC	6p			

### Note:

S/M=silver mica 1% tol.  
P.S.=polystyrene 2½% tol.  
MDC—a.c. rating=300V  
M.F.=Mullard min. foil.  
Cer.=Ceramic.

MAIL ORDERS: Some items have a post and packing charge shown against them. Where p. & p. is not shown the charge is 12p for any selection. When both classes of goods are ordered the charge is 12p plus any p. & p. charges shown. (Overseas extra.) Telephone 01-692 4412



# I.L.P. (Electronics) Ltd

## THE HY41

The HY41 supersedes the popular HY40 introduced by ILP last year. This highly improved module achieves true High Fidelity with a dramatic reduction in distortion (typically 0.05% at 1KHz into 8 ohms!) and is electronically and mechanically compatible with the HY40.

With this important improvement the HY41 retains all of the quality characteristics found in the earlier version and P.C. board, Resistor, Capacitors, Hardware Mountings and comprehensive manual are included in the basic kit. No further components are required to construct a complete power amplifier of extremely high performance sufficiently versatile to provide power not merely for Hi-Fi but also for public address systems and industry.

The free manual gives a full circuit diagram of the HY41 and its various applications including a complete stereo amplifier.

Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

**OUTPUT POWER:** British Rating 40 WATTS PEAK, 20 watts R.M.S. continuous.

**LOAD IMPEDANCE:** 4-16 ohms.

**INPUT IMPEDANCE:** 30K ohms at 1KHz.

**VOLTAGE GAIN:** 30db at 1KHz

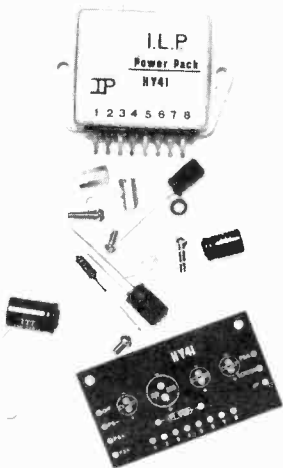
**TOTAL HARMONIC DISTORTION:** less than 0.15% (typical 0.05%) at 1KHz.

**FREQUENCY RESPONSE:** 5Hz-50KHz  $\pm$  1db.

**SUPPLY VOLTAGE:** + 22.5volts D.C.

**SUPPLY CURRENT:** 0.8 amps maximum.

**PRICE:** inc. comprehensive manual, P.C. board, five extra components and P. & P.:-  
**MONO:** £4.90 **STEREO:** £9.80



## UNIQUE HYBRID PRE-AMPLIFIER

The HY5 has rapidly established a position in the WORLD as the sole hybrid pre-amplifier to contain all feedback and equalization networks within an integrated pre-amplifier circuit.

Supplied with the HY5 are two stabilizing capacitors and by the addition of volume, treble and bass potentiometers it is ready for use.

Internally the HY5 provides equalization for almost every conceivable input, the desired function is achieved by use of a multi-way switch or by direct interconnection.

Two distinctive features of the HY5 are its inbuilt stabilization circuit, allowing it to be run off any unregulated power supply from 16-25 Volts and a balance circuit which, when linked by a balance control to a second HY5, forms a complete stereo pre-amplifier.

Specifically and critically designed to meet exacting Hi-Fi standards, the HY5 combines extremely low noise with a high overload capability. When used in conjunction with the HY41 and PSU45 forms a completely integrated system.

### INPUTS

Magnetic Pick-up (within  $\pm$ 1db RIAA curve) 2mV. 47K  $\Omega$

Tape Replay (external components to suit head). 4mV. 47K  $\Omega$

Microphone (flat) 10mV. 47K  $\Omega$

Ceramic Pick-up (equalized and compensatable) 20-2000mV. variable.

Tuner (flat) 250mV. 100K  $\Omega$

Auxiliary 1 250mV. 47K  $\Omega$

Auxiliary 2 2-20mV. 100K  $\Omega$

### OUTPUTS

Main Pre-amp output 500mV.

Direct tape output 120mV.

### ACTIVE TONE CONTROLS (Baxendall)

Treble + 12db.

Bass + 12db.

### INTERNAL STABILIZATION

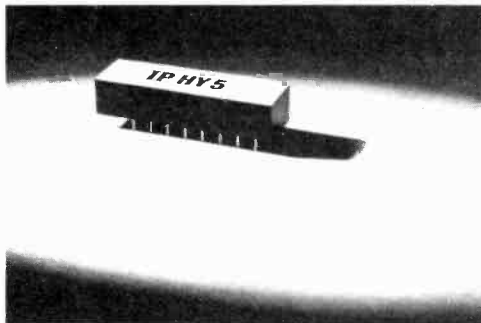
Enables the HY5 to share an unregulated supply with the Power Amplifier.

### SUPPLY VOLTAGE

16-25 volts

**PRICE:** MONO: £3.60

STEREO: £7.20



### SUPPLY CURRENT

6mA approx.

### OVERLOAD CAPABILITY

better than 26db on most sensitive input infinite on tuner and auxl.

**OUTPUT NOISE VOLTAGE:** 0.5mV.

## POWER SUPPLY PSU45

The versatile P.S.U.45 is designed to supply your HY41's +HY5's in stereo or mono format.

### Specification

Input: 200-240 Volts.

Output:  $\pm$  22.5 Volts at 2 amps.

Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

**PRICE:** £4.50 inc. P. & P.



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## MULLARD C296 POLYESTER FILM CAPACITORS

400V: 0.001, 0.0015, 0.0022, 0.0033, 0.0047, 21p, 0.0068, 0.01, 0.015, 0.022, 0.033, 3p, 0.047, 0.068, 0.1, 4p, 0.15, 51p, 0.22, 7p, 0.33, 101p, 0.47, 12p, 160V: 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 3p, 0.1, 31p, 0.15, 4p, 0.22, 41p, 0.33, 51p, 0.47, 7p, 0.68, 10p, 1.0, 12p.

## MULLARD C280 METALISED FILM CAPACITORS 250V

0.01, 0.015, 0.022, 3p, 0.033, 0.047, 0.068, 31p, 0.1, 4p, 0.15, 0.22, 41p, 0.33, 6p, 0.47, 7p, 0.68, 10p, 1.0, 12p, 1.5, 18p, 2.2, 21p.

## CERAMIC CAPACITORS 50V (Square plaque type body)

E12 Series 22pF-1,000pF, 11p, E6 series 0.0015-0.01, 2p, E6 series 0.015-0.047, 21p.

## HIGH VOLTAGE CAPACITORS 1000V d.c. (300V a.c.)

0.001, 0.0022, 0.0033, 0.0047, 7p, 0.0068, 0.01, 0.022, 10p, 0.047, 0.1, 12p, 0.22, 20p, 0.47, 22p.

## POLYSTYRENE CAPACITORS 125V, 21p

Values in pF: 5, 10, 15, 22, 33, 47, 56, 68, 100, 150, 220, 330, 470, 560, 680, 820, 1000, 31p.

## SOLID TANTALUM RESIN DIPPED BEAD CAPACITORS

µF/V: 0.1/35, 0.22/35, 0.47/35, 1.0/35, 2.2/35, 4.7/35, 10/6.3, 10/16, 10/25, 22/16, 47/6.3, 100/3, 15p.

## MULLARD 015/016/017 ELECTROLYTICS (Replaces C426/C437)

µF/V: 1/63, 1.5/63, 2.2/63, 3.3/63, 4.7/63, 6.8/63, 10/25, 10/63, 15/10, 15/16, 22/25, 22/63, 33/16, 33/40, 47/10, 68/16, 100/4, 100/10, 100/25, 150/16, 220/16, 5p, 47/63, 470/6.3, 51p, 68/63, 330/16, 9p, 100/63, 150/63, 680/16, 1500/6.3, 11p, 220/63, 470/40, 1000/16, 15p, 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6.3, 18p.

## RESISTORS

Type	Tolerance	Range	Values	Price each
ISKRA 1/2W	5%	4R7-2M2	E24	1p
ISKRA 1/2W	10%	3M3-10M	E12	1p
MULLARD 1/3W	10%	1R-3R9	E12	1p
MULLARD 1/5W	5%	4R7-1M	E12	1p
METAL FILM 1W	5%	27R-1M	E12	1p
WIREWOUND 2.5W	10%	R22-R33, R47	E12	9p
WIREWOUND 2.5W	5%	1R-270R	E12	7p
PRESETS 100R, 250R, 500R and Decades to 5M, 0.1W, 5p, 0.25W, 6p.				

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## PRACTICAL ELECTRONICS "SCORPIO" ELECTRONIC IGNITION SYSTEM



This Capacitor-Discharge Electronic Ignition system was described in the November and December issues of Practical Electronics. It is suitable for incorporating in any 12V ignition system in cars, boats, go-karts, etc., of either pos. or neg. earth and up to six cylinders. The original coil, plugs, points and contact-breaker capacitor fitted in the vehicle are used. No extra or special components are required.

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Construction of the unit can easily be completed in an evening and installation should take no longer than half an hour. A complete complement of components is supplied with each kit together with ready-drilled roller-tinned professional quality fibre-glass printed-circuit board, custom-wound transformer and fully-machined die-cast case. All components are available separately. Case size 7 1/2in x 4 1/2in x 2in. approx.

Complete assembly and wiring manual 25p, refundable on purchase of kit. Price: £10.50 plus 50p P. & P.

## PSYCHEDELIC LIGHTING UNIT Mk. 3



This unit represents a natural progression from our previously successful Mk. 1 and 2 Units. As before the drive voltage is derived directly from the amplifier output or across the speakers. The unit converts the audio frequency signals into a three-coloured light display; the colour depending on the frequency of the signal and the intensity on the loudness of the audio source.

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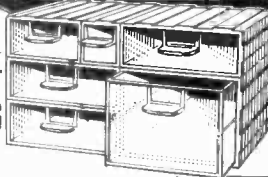
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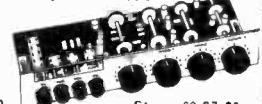
PZ5 £3.97

Z30 £3.50

Project 60

tuner £16.80

AU £4.50



Stereo 60 £7.80  
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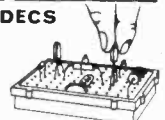
S-DECS £1.40

T-DECS £2.80

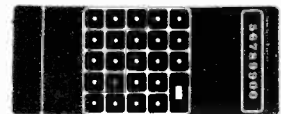
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40W	PNP	21p	19p	17p
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90W	PNP	25p	23p	21p
PAKS complementary pairs:				
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Hex. Inverter,	BMC935	12p	11p	10p
Hex. Inverter,	BMC936	12p	11p	10p
Hex. Inverter,	BMC937	12p	11p	10p
Decade Counter,	BMC938	25p	23p	21p
Div. by 16 Counter,	BMC939	25p	23p	21p
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Hex. Inverter,	BMC941	12p	11p	10p
Type D Flip Flop,	BMC942	20p	18p	16p
Ex. 2/4-input Power,	BMC944	12p	11p	10p
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4/2 Input NAND Gate	BMC946	11p	10p	9p
Clocked Flip Flop,	BMC948	20p	18p	16p
4/2 Input NAND Gate	BMC949	12p	11p	10p
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Dual J/K Flip Flop,	BMC955	20p	18p	16p
Dual J/K Flip Flop,	BMC956	20p	18p	16p
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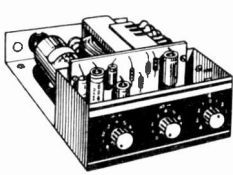
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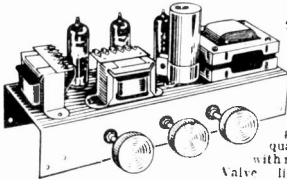
## SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand name components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohms. Frequency response 12Hz-30kHz  $\pm$  3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high x 6in wide x 7 1/2in deep. A.C. 200/250V. P. & P. 25p.

**PRICE £10.50**

## DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 volts. Using heavy duty fully insulated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2.

1 E280 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 8 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w. x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8.92.** P. & P. 40p.

## NEW! POWER SUPPLY UNIT

200, 240V. A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7.5V and 9V and 12V at 1 amp continuous (1 1/2 amp intermittent). Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 7" 3/4" x 4 1/2". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

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**SPECIAL OFFER! MAINS TRANSFORMER.** 200/240V A.C. input. 35V at 1 1/2 amp A.C. output. Overall size 2 1/2" x 2 1/2" x 3" approx. Suitable for drop through or vertical mounting. 80p. P. & P. 30p.

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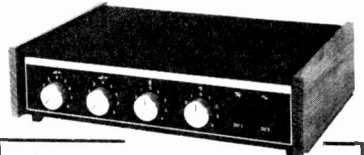
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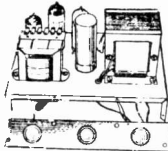
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**PRICES AMPLIFIER KIT, £10.50 P. & P. 15p.** (Magnetic input components 30p extra)

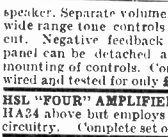
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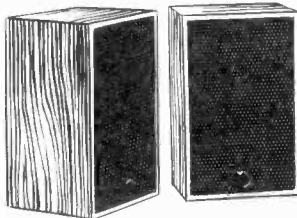
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**REALISTIC 30 WATT STEREO AMPLIFIER MODEL SA-500**

A superb hi-fi amplifier with all the features you've ever wanted—for under £46.00. Saving over £10.00 on the normal retail value. Up-to-the-minute slider controls for bass and treble. Separate volume and balance controls. Headphone socket on front panel. Push-button input controls—magnetic phono (high/low) tuner, aux. mono, monitor. Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz. ± 1 db at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trim. Inputs: phono 2.5mV and 5mV RIAA, tuner/aux 250mV. Hum and noise: phono—50db, tuner/aux—65db. How's that for a specification!  
Size 14 1/2" wide, 3 1/2" high, 10 1/2" deep.



As reviewed in "POPULAR HI-FI" February 1972

**ROC PRICE £35.20**  
Normal Price £55.50



**OLSON RA-310 AM/FM/MPX STEREO TUNER** This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as its good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10.00 less than the normal retail value...and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz, AM: 525-1605 kHz. FM Sensitivity: FM, 3µV, AM, 250µV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11 1/2" wide, 4" high, 7 1/2" deep.

**ROC PRICE £31.20**  
Normal Price £50.00



**REALISTIC SA-100B 6-WATT STEREO AMPLIFIER** Here's a fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide, 3" high, 5 1/2" deep. And yet it has separate gated volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/tuner and power on/off slide switches. The ends are oiled walnut, with matching enamel and metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 10,000 Hz. ± 3db. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.

**ROC PRICE £12.45**  
Normal Price £21.00

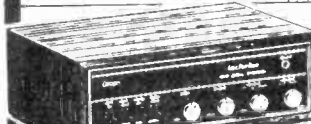
**SPECIAL OFFER!**



**TEC HR-007 HEAD-PHONE RADIO** When you want to listen to the radio all by yourself! Then this will solve the problem. Separate volume and tuning controls with easy-to-use knobs. Frequency range is 535 to 1605 kHz medium wave band. Maximum output is 300 mW.  
Normal Price £7.65 **ROC PRICE £5.00**

**EAGLE LC.07 STEREO MOVING-MAGNET CARTRIDGE**

Here's your opportunity to own a transcription cartridge for the price of a ceramic! Is specially designed to match top quality tone arms, and to get the very best from your hi-fi amplifier. 0.7 mil diamond stylus. Output: 7mV per channel. Frequency range: 20-21,000 Hz. Channel balance: -1db. Channel separation: 28db. Compliance: 12-10.6 cm/dyne.  
**ROC PRICE £6.37**



**OLSON AM-395 40-WATT STEREO AMPLIFIER** An ideal unit for your new stereo separate system. It is more than £10.00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for taping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz ± 3db. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3.0mV RIAA, crystal phono 100mV, tape 160mV, tuner 160mV. Size: 11 1/2" wide, 4" high, 7 1/2" deep. The specification reads well—sounds even better!

**ROC PRICE £24.10**  
Normal Price £39.50



**R.446 3-WAY MATCHED SPEAKERS** These will do justice to your amplifier—and to your pocket. At only £20.00 a pair, they are real value-for-money. Each cabinet is heavily lagged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a 6 1/2" base unit plus tweeter. Frequency range: 40 to 19,000 Hz. Size: 14" high, 9" wide, 6 1/2" deep.

**ROC PRICE £20.00**  
Normal Price £27.00 per pair.



**OLSON AM406 4-WATT STEREO AMPLIFIER** Here's marvellous value for someone just starting to set themselves up in audio! At only £10.50, you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 70-20,000 Hz. ± 3db. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV, tuner/aux 80mV. Size: 8" wide, 2 1/2" high, 4 1/2" wide.

**ROC PRICE £10.50**  
Normal Price £15.70



**25-WATT 3-WAY CRYLLER 'LIVING AUDIO' SPEAKER CE-5b** This high quality speaker has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units on 8" woofer, and a 5" mid range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s. into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10 1/2" x 7 1/2" x 8 1/2". Exactly right for matching the most modern dcor.

**ROC PRICE £27.25**  
Normal Price £39.95 each.

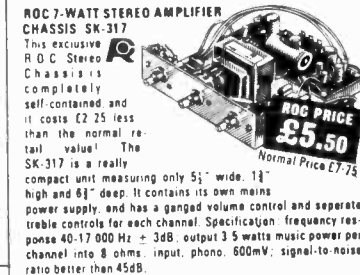


**PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-18** This is one of the lowest priced stereo tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received—that's the time to switch to 'Stereo'! The SSA-18 has all the facilities you'd expect to find on tuners costing twice as much—separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM: 88-108 MHz, AM: 535-1605 kHz. Frequency response: 50-10,000 Hz. ± 3db. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4 1/2" high, 8" deep.

**ROC PRICE £27.55**  
Normal Price £42.00

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Complete with solar cell  
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Make your own music. Complete with speaker  
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**ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317** This exclusive R O C Stereo Chassis is completely self-contained and it costs £2.25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5 1/2" wide, 1 1/2" high and 6 1/2" deep. It contains its own mains power supply, and has a gated volume control and separate treble controls for each channel. Specification: frequency response 40-17,000 Hz. ± 3db. output 3.5 watts music power per channel into 8 ohms. input, phono: 600mV; signal-to-noise ratio better than 45dB.

**ROC PRICE £5.50**  
Normal Price £7.75



**OLSON AM-372 18-WATT STEREO AMPLIFIER** Here's a really good amplifier at a really down-to-earth price—nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you—reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz. ± 3db. Output: 1 watt r.m.s. per channel music power into 8 ohm speakers. P. ino input 200mV. Tuner input 200mV. Size: 12 1/2" wide, 3 1/2" high, 7 1/2" deep.

**ROC PRICE £15.10**  
Normal Price £25.20

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NOW for the first time ever—a direct advisory and supply service to ANYONE wishing to install their own professional quality burglar or fire alarm system.

**BURGLAR ALARM CONTROL UNIT** (Type F) incorporating a test button fault indicator lamp, security keyswitch and solid state circuitry in a tamperproof metal case measuring 7in x 5in x 2in with provision for control battery. The unit will remove or apply a voltage in an alarm condition. £15.50 plus 30p P. & P.

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	Recommended Retail Price	Our Price
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Antex CN240	£1.70	£1.36
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MD806. Frequency 20-20,000 c.p.s. 8 ohm	£8.00	£4.95
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Amplifier module AE1000 3 watt,  
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D.I.L. HOLDERS—14 pin, 15p,  
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### LEAK TRUSPEED

2-speed 45 and 33 1/2 rpm belt drive turntable complete with plinth, cover and Shure cartridge

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Leak Truspeed on Walnut base with cover—Less arm and cartridge. A snip for the Hi-Fi enthusiast.

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The clock measures 5 7/8 in. (W) x 2 1/2 in. (H) x 3 in. (D) (overall from front of drum to back of switch). SPEC. 210/240V a.c. 50Hz operation, switch rating 250V, 3A. Complete with instructions. NOW WITH ILLUMINATED DIAL COMPLETE WITH KNOBS FEATURES: ● MAINS OPERATION ● 12-HOUR ALARM ● AUTO "SLEEP" SWITCH ● HOURS, MINUTES AND SECONDS READ-OFF ● FORWARD AND BACKWARD TIME ADJUSTMENT ● SILENT OPERATION ● SHOCK AND VIBRATION PROOF ● BUILT IN ALARM BUZZER

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### TM-1 TEST METER

1,000 ohms/volt

Lasky's new look top value TM-1 is a really tiny pocket multimeter providing 'big' meter accuracy and performance. Precision movement calibrated to +3% of full scale. Click stop range selection switch. Beautifully designed and made impact resistant black case with white and metallic red/green figuring. Ohms zero adjustment, 1,000's IN USE. SIZE ONLY 2 1/16 x 3 1/16 x 1 7/16 in. ● DC/V 0-10-50-250-1000 at 1K/ohms/V ● AC/V 0-10-50-250-1000 at 1K/ohms/V ● DC Current 0-1mA, 100mA ● Resistance 0-150K/ohms ● Decibels -10 +22dB ● Complete with test leads



LASKY'S PRICE **£1.99** C & P 15p

### TM-5 TEST METER

5,000 ohms/volt

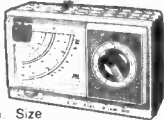
Another pocket multimeter from Lasky's. The slimline impact resistant case—size 4 1/4 in. x 2 1/4 in. x 1 1/2 in. fitted with extra large 2 1/2 in. square meter. Readability is superior on all low ranges, making this an excellent instrument for servicing transistorised equipment. Zero ohms adjustment. Buff finish with crystal clear meter cover. ● DC/V 3-15-150-300-1200 at 5K/ohms/V ● AC/V 6-30-300-600 at 2.5K/ohms/V ● DC Current 0-300µA 0-300mA ● Resistance 0-10K/ohms 0-1M/ohms ● Decibels -10dB to 16dB ● Complete with test leads, battery and instructions



LASKY'S PRICE **£2.45** C & P 35p

### TTC C.1051 TEST METER

Miniaturised version of Model C-1052 employing similar ultra compact slimline impact resistant cabinet. Buff/green finish. Size 1 21mm x 79mm x 29mm. Features large easy to read meter with mirror scale. D'Arsonval movement. Overload protection circuit. Fine calibration gives extremely high standard of accuracy on all ranges. Ohms zero adjustment. Colour coded scales ● DC/V 0-3-15-150-300-1.2KV at 20 K/ohms/V ● AC/V 0-6-30-300-1.2KV at 10 K/ohms/V ● DC Current 0-60µA-300mA ● Resistance 0-60K-5M/ohms ● Decibels -20dB to -17dB ● Complete with battery and test leads.



LASKY'S PRICE **£3.75** C & P 35p



### TTC. C.1052 TEST METER

A multimeter offering high accuracy standards for the low voltage current and resistance measurements required in servicing solid state devices. Expanded 86mm colour coded scale. Precision 1% resistors, jewelled meter movement, overload protection circuit. Dark green and buff impact resistant cabinet. Size 162mm x 95mm x 32mm.

● DC/V 0-6-3-15-60-300-1200-3000V at 30K/ohms/V ● AC/V 0-6-30-300-1200V at 15K/ohms/V ● DC current 0-0.03-3-30-300mA ● Resistance 0-6K-60K-600K-6M/ohms ● Decibels -20dB to +63dB ● Complete with battery, test leads and instructions.

LASKY'S PRICE **£6.45** C & P 35p

### TMK 200 KIT

BUILD YOUR OWN TOP QUALITY METER

This meter kit by TMK offers the professional electronics hobbyist and student the unique opportunity of building a first-class multimeter at a worthwhile saving in cost. The cabinet is supplied with the meter scale and movement and rotary range selector mounted in position. The highest quality components and 1% tolerance resistors are used throughout. Complete with full construction, circuit and operating instructions.



20,000 ohms/volt

Features 24 measurement ranges with mirror scale, large 76mm x 51mm meter scale. Accuracy DCV and current -2%, resistance ±3%. Special 0.6V DC range for transistor circuit measurements. ● DC/V 0-0.6-3-6-30-120-600-1200 at 20K/ohms/V ● AC/V 0-30-120-600-1200V at 10K/ohms/V ● DC current 0-0.06-6-60-600mA ● Resistance 0-10K-100K-1M-10M/ohms (58-580.5-8K at mid scale) ● Capacitance 0-002-0-2µF ● Decibels -20 +63 ● Output 0-05 blocking capacitor. Uses two 1.5V (UT type) batteries Black bakelite case. Size 127mm x 76mm x 25mm. COMPLETE WITH FULL INSTRUCTIONS

KIT PRICE **£5.15** C & P 35p

### TTC. C.1084 TEST METER

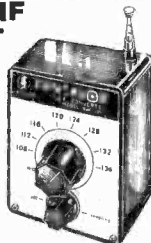
A 43 range precision multimeter for bench or field applications. Specially sensitive ranges for measurement in transistor circuits (0.3V DC range and 30µA). Range halving switch for DC voltage and current and AC voltage Ohms zero adjustment. Specification: DC/V 0-3-6-15-3-6-12-30-60-150-300-600-1200V at 50K/ohms/V (25K/ohms/V in VA/2 Position). ● AC/V 0-3-6-15-30-60-120-300-600-1200V at 5K/ohms/V (2.5K/ohms/V in VA/2 position) ● DC current 0-30-60µA, 1.5-3-15-30, 150, 300mA, 6, 12A ● Resistance 0-3K-300K-3 meg (centre scale 15) ● Decibels -10 to +17dB. Output: 0-3, 6, 15, 30, 60, 120, 300V ● DC circuit sensitivity: 30µA, 120mV. Complete with test leads, batteries.



LASKY'S PRICE **£11.50** C & P 40p

### FANTAVOX VHF 105 AIRCRAFT BAND CONVERTER

An item for the radio enthusiast bringing instant reception of the ground-to-air, air-to-ground waveband. For use with any standard AM or FM radio covering 535-1600KHz, 88-108MHz respectively—with no electrical connection required. The model VHF-105 self powered by one 9V (PP3 type) battery. Is merely placed close to the receiving set and then tuned over 110 to 135MHz which covers the aircraft communications band. Volume and reception effectiveness is adjusted by moving both sets to the most favourable position. Brushed metal front panel and 18 in. chrome telescopic antenna. Size only 102 x 73 x 60mm (including knobs). Complete with battery and full instructions.



LASKY'S PRICE **£2.60** C & P 15p

### AUDIOTRONIC 6 POLE QUAD-RPHONIC DECODER



This new Audiotronic Decoder is a fully transistorised system to reproduce 4-channel sound from SQ records and 4-channel discrete sources. It performs the CBS SQ matrix decoding function on SQ encoded programme material (adopted by the majority of the world's manufacturers), from disc, tape or FM radio. The four signals, when reproduced through four amplifiers and four speakers, will be presented as left, right and front, left and right back information. Switching is provided for: SQ recording and FM Broadcasts; 'Ambient' for enhanced 2 channel sound by synthesizing four channels; normal stereo, 2 and 4 channel record and playback. The master volume control allows overall level to be set plus a rear control for front to back balancing. BRIEF SPEC. Input Imp 40K ohms Output Imp 300 ohms. Freq Resp. 4Hz-100KHz. Freq Sep 60dB. Rear Sep 20dB. Power Req. AC240V 50/60Hz. Size 180 (W) x 55(H) x 220 (D)mm.

LASKY'S PRICE **£22.50** C & P 35p

### LASKY'S DOLBY 'B' NOISE REDUCTION UNIT



Lasky's NOISE REDUCTION UNIT uses the famous DOLBY 'B' system to provide users of semi professional and cassette recorders with a way to increase performance at low tape speeds by reducing tape hiss by 3dB at 600Hz rising to 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. The unit is ideal for replay of pre-recorded tapes and cassettes now being issued in the DOLBY B FORMAT. Controls are provided for input levels and NOISE reduction on record and replay. 2 meters are provided for instant checking of DOLBY level. Off tape monitoring is provided by the replay input button when used with 3 head machines. Brief spec: Frequency Response 20Hz to 15KHz ±1dB 19KHz-35dB Channel sep 50dB at 1KHz. Sig. to noise, better than 70dB (ref 580mV). Power: 200-250V AC 40/60Hz. Size 403 x 229 x 83mm. Matt black front panel, with white figuring and silver controls. COMPLETE WITH A TEST TAPE (PLEASE SPECIFY WHETHER CASSETTE OR REEL REQUIRED).

LASKY'S SPECIAL INTRODUCTORY PRICE **£32.50** C & P 75p

### FANTAVOX FM-TI STEREO MULTIPLEX TUNER



A really compact self powered FM tuner with built-in stereo multiplex decoder. Variable output (volume) control makes it suitable for use with most stereo amplifiers. Switchable AFC and directional telescopic aerial ensure spot reception over 88-108MHz. Power: 9V DC battery or rechargeable power pack. Impact resistant black plastic cabinet size only 6 (W) x 4 1/2 (D) x 2 1/2 (H) in. Complete with battery.

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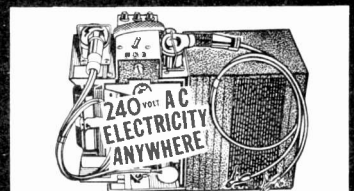
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Designs by GERRY BROWN and JOHN SALMON and presented on TV.

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range of light dimmers

standard wall mounting models

**Rotary:** 400W £3.10 1KW £3.95  
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**Slider:** 400W £4.35 1KW £4.95  
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(Tomorrows World) 2nd Nov., 1972  
AM 10 trans TRF circuit in TO18 package, plus six components equals one radio, price £1.25 including P. & P.

DIL size switches:  
1p8w, 2p4w, 4p2w 4 @ 1p2w  
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NEW LED PRICES:  
TIL302 Large 7 seg display £3.50  
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**MOTOROLA MC1310P**

**EX STOCK DELIVERY**

Specn. Separation: 40dB 50Hz—15kHz. Distortion: 0.3%. I/P level: 560mV rms. O/P level: 485mV rms per channel. Input impedance: 50k. Power requirements: 8-12V @ 16mA. Will drive up to 75mA stereo 'on' lamp or LED.

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### 1 R.P.M. MOTOR

Smiths. 240V 50 cycle mains working. Ideal motor to drive clock mechanisms. Price £1 each or 10 for £9.

### 3 PIN PLUG AND SOCKET

Our Ref. No. P801. Flat pins American style rated at 10A 250V. Socket panel mounting. Plug is white and intended for flex. Useful where standard power outlet is required. Also suitable for speaker leads, etc. Price 25p per pair.

### THERMOSTAT WITH PROBE

Our Ref. No. TH01. Made by Ranco. Range 0-107°C 18A 250V switch. Joined to a 10in probe by approx. 40in of capillary tubing. 1 hole fixing. Normal control spindle 85p each.

### THERMOSTAT WITH PROBE

Our Ref. No. TH02—As TH01 but the range is 0-120°C and the capillary tube is approx. 46in long. Price 95p each.

### PROCESS SWITCH

Our Ref. No. P301. 6 switches some of which are changeover types. All rated at 10A. Operated by motor which makes 1 rev every 3 mins. Price £1.25 each.

### PUSH PUSH SWITCH

Our Ref. No. 804. This is fitted to table lamps, etc. Superior quality and reliable (Leviton). Conservatively rated 1A 250V. Has 2 flex leads attached measuring 40in and 12in each respectively. Price 10p each.

### RE : TIMAC CLOCKS

Advertised last month we now have obtained some continental plugs which will fit these clocks where only two lead outlets for electric blankets are required. Price 30p each with 6ft flex attached.

### INDUCTION MOTOR

Made by G.E.C. Normal type with approx. 1in of 3/8 spindle. Standard fixing 1/4in stack. Brand new 65p each less usual quantity discounts. Good stocks available.

### CLOCK WITH 25 AMP SWITCH

A Smiths Mains driven clock will cost over £6 in normal shops—but for less than £2 you can have a Smiths clock and a

### MINIATURE ROCKER SWITCH

Our Ref. R801. 10A 240V. Self-fixing into hole size approx. 1in x 1/4in by famous French maker Rusembergh. Price 10p each.

### ROCKER SWITCH

Our Ref. R802. 13A self-fixing into hole approx. 1in x 1/4in. Made by the Carr Fastener Co. Very reliable. Price 8p each.

### PHOTO TRANSISTOR

OCPT70—ideal for burglar alarms and similar applications. Price 65p each.

### EXIT SIGNS

One of our customers has pointed out how easily our box signs can be converted to exit signs. These are illuminated having a 20W fluorescent lamp with associated control gear. The front is very thick, clear plastic. Directly onto this you can stick down the letters available at most stationers. There is room inside the box for a battery and low volt lamp in the case of power failure. Size of sign is 2ft high x 14in wide x 5in deep. Solidly made from sheet steel and hammer finished in enamel. Price £3.50 plus 50p carriage per 200 miles.

### 6 PIN PLUG AND SOCKET

And metal case with flex grip for one end, this can be fitted either to a plug or socket and the other part fitting the equipment. Price 40p per pair—10 pairs £2.60.

### LIGHT DIMMERS

We regret that through increased costs our 1kW model has now to be increased to £2.95.

### LIGHT DIMMER BOX

Another feature we can supply is box and 13A socket, this makes dimmer suitable for control of portable lights and equipment. This price is 45p extra.

### TAPE HEADS

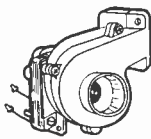
We are gradually obtaining more information about the Truvox tape heads we have, we are told that these have been wound in a very ingenious way so that winding may be coupled either in parallel or in series depending whether high or low impedance is required. We also have matching erase heads and now offer these in pairs, 1 record and 1 erase head. Price of the 2 track 45p per pair, 4 track 75p per pair. Pair mounted on plate 45p extra.

### REED SWITCH COILS

These are solenoids wound on moulded formers of the correct shape and dimensions to take standard reed switches. They have printed circuit board mounting. 8ix types available—

RC1	1 reed	Operates 10-15V	600ohm	30p	
RC2	2 "	"	150ohm	25p	
RC3	1 "	"	15-30V	1kohm	35p
RC4	2 "	"	15-30V	300ohm	45p
RC5	1 "	"	45-70V	6500ohm	35p
RC6	2 "	"	45-70V	3500ohm	40p

Standard reed switches available 10p each or 10 for 90p, 100 for £2.50.



### 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 of blower is approx. 4 1/2in x 4 1/2in x 4in. When mounted by its flange air is blown into the equipment but to suck air out mount it from the centre using a clamp, ideal for cooling electrical equipment, or fitting into a cooker hood, film drying cabinet, or for removing fume smoke when soldering etc., etc. A real bargain at £1.85.

### MULLARD I.F. MODULE

This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10.7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. 85p each. 10 for £7.85. 100 for £62.60. With connection diagram.



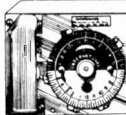
### TANGENTIAL HEATER UNITS

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW element and 1kW element allowing switching 1, 2 and 3kW and with thermal safety cut-out. Can be fitted into any metal lined case or cabinet.

Only need control switch, £3.50. 2kW Model as above except 2 kilowatts, £2.50. Don't miss this. Control Switch, 35p. P. & F. 40p.

### ELECTRIC TIME SWITCH

Made by Smiths these are A.C. mains operated. NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. 2 completely adjustable time periods per 24 hours, 5A change-over contacts will switch circuit on or off during these periods £2.80 post and ins. 23p. Additional time contacts 50p pair.



### COMPUTER TAPE

2,400ft of the Best Magnetic Tape may be used—users claim good results with Video and sound. 1in wide £1.00 plus 33p post and insurance with cassette. 1/2in wide £1 plus 30p post and insurance with cassette. 1/4in wide 85p plus 25p post and insurance with cassette. Spools and cassettes—1in 75p, 1/2in 75p each plus 20p post and insurance.



### THIS MONTH'S SNIP

#### MULLARD 4 WATT AMPLIFIER EP 9000

Suitable for mono or stereo systems. Its output approx. 4W speech or music into a 12-15ohm speaker. Power requirements 240V. Harmonic distortion at typical listening level is less than 2%. Frequency response at typical listening level 50Hz to 16kHz. Totally enclosed in moulded case size 3 1/2in x 2 1/2in x 1 1/4in with screw terminal connections. A fantastic bargain at only £1.25 while stocks last. Don't miss this—it's one of our best bargains ever.

#### HORSTMANN "TIME AND SET" SWITCH

(To a 30A Switch.) Just the thing if you want to connect a to a warm house without it costing you a fortune. You can delay the switch on time of your electric fire, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price £1.50, p. & ins. 23p.



#### HONEYWELL THERMOSTAT

Made by Honeywell for normal air temperatures 40°-80°F (5-25°C). This is a precision instrument with a differential which can be adjusted to better than 1.5°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bi-metal element and adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows thermometer above and switch setting scale below—size approx. 3.8in x 3.2in x 1.4in deep—can be mounted on conduit box or directly on wall. Price £1.25 each or ten for £11.85.



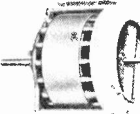
#### LIGHT CELL

Almost zero resistant in sunlight increases to 10kohms in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by 1/2in thick. Rated at 500MV, wire ended. 43p with circuit. Also ORP 12 light cell 45p.



#### PAPST MOTORS

Est. 1/40th h.p. Made for 110-120V working, but two of these work ideally together off our standard 240V mains. A really beautiful motor, extremely quiet running and reversible. £1.60 each. Postage one 25p, two 33p. 230V model £2.

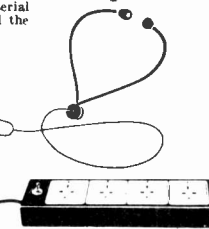


#### RADIO STETHOSCOPE

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—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece £2—win stetho-set instead of earpiece 75p extra post and ins. 20p.

#### DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 x 13A sockets in metal box to take standard 13A fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work, £2.25 plus 23p P. & I.



#### MULLARD AUDIO AMPLIFIERS

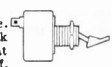
All in module form, each ready built complete with heat sinks and connection tags, data supplied. Model 1153 500m watt power output 65p. Model 1172 750m watt power output 85p. Model EP9000 4 watt power output £1.45. EP9001 Twin channel pre amp for stereo £1.80. 10% discount 10 or more ordered.



Where postage is not stated then orders over £5 are post free. Below £5 add 20p. Semi-conductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

### CAR PANEL SWITCH

Our Ref. No. 802. Arco made. Has long flat ended toggle, black and chrome finish. Rated 2A at 250V and is double pole on/off. Listed at 45p. Our price 22p each.



### CAR PANEL AUTO SWITCH

Ref. No. 803. Again a flat ended toggle. Made by Arrow. A 3 position double pole changeover switch centre off for auto aerials, reversing motors, etc. 30p each.

### 3 PIN REVERSE PLUG & SOCKET

Our Ref. P802. For bringing live leads to equipment. All brown bakelite construction, rated 10A 250V. Price 35p per pair.

### 13 AMP JUNCTION BOXES

Made to take 7029 cables so ideal for ring mains. Price 8p each or 10 for 72p.

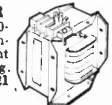
### PORCELAIN FUSE AND CARRIER

20A 250V MEM Ref. No. 15LBB/15LRHW. Make your own fuse board. Price 20p per pair.



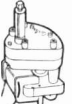
### AUTO TRANSFORMER

Primary 220-240V. Secondary 110-120V. Well built and varnish impregnated. 250W intermittent rating. 150W continuous rating. Size approx. 3 1/2in x 3in x 3in. £1 plus 20p post and insurance.



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200-250V Induction Motor, driving a Carter gear box with 1 1/2in of shaft. Drive shaft running at 5 revs per minute. Intended for roasting chickens also suitable for driving models—windmills, coloured disc lighting effect, etc., etc. £1.85 plus 20p post and insurance.



### PANEL NEON INDICATOR

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Designed to operate transistor sets and amplifiers. Adjustable output 0V, 3V, 12V for up to 300mA (class B working). Takes the place of any of the following batteries: PPI, PPS, PPA, PPG, PPT, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1, plus 20p postage.

### INSTANT START UNITS

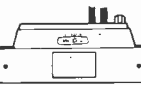
For 2ft tubes. Philips or Smart & Brown in a tra complete with clips and tube ends. Price £1.60 each or 10 for £13.60.

### FLUORESCENT TUBES

Standard types—B1pin ends, ideal pelmet lighting as well as for standard replacement—18in 15W, 24in 40W, 36in 40W, 39in 40W. 11 first grade tubes offered at one price—£2.50 per box of 24—i.e. less than 15p each. If not collecting then please add 50p per box per 200 miles.

### DIGITAL DISPLAY

Panel mounting unit measuring approx. 3 1/2in x 1 1/2in x 1 1/4in deep. Size of the display aperture is approx. 1 1/2in x 1 1/2in. Light up to 0-9. Ex equipment but unused and in perfect order. Price £1 each.



### DIGITAL SWITCHES

Simple 8 T.C. number 8W21/630CAA. These are a snap in fit hole approx. 1 1/2in x 1/2in. Knob engraved 0-9. Gold plated contacts 1 pole 10 way. Thumb wheel operation. These are designed so that they may be stacked in rows. Price 75p each.

### 6 DIGIT COUNTER

Operated by 240V a.c. mains through resistor or direct from 115V a.c. or from 80V d.c. Made by Veeder-Root of America. Metal encased for flame mounting. Size approx. 3 1/2in x 1 1/2in x 2 1/2in. Price £1 each. 10 for £9.

### COLOURED 13 AMP SOCKETS

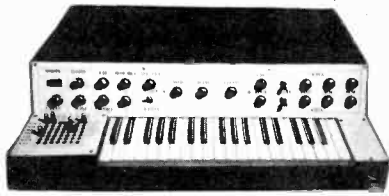
Standard Flush mounting available in the following colours: Yellow, Green, Grey and Red. These are a good quality socket with porcelain interior made by Ward and Goldstone. Useful on control panels. Price 20p each, 10 for £1.90.

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BFS97	21p	ZTX331	14p	ZS123	14p	KS039A	17p
BFS98	18p	ZTX382	11p	ZS124	16p	KS043A	17p
ZTX107	8p	ZTX383	13p	ZS141	22p	KS047A	17p
ZTX108	7p	ZTX384	16p	ZS142	39p	KS051A	17p
ZTX109	10p	ZTX450	15p	ZS170	9p	KS056A	17p
ZTX114	20p	ZTX451	15p	ZS171	11p	KS062A	17p
ZTX212	12p	ZTX500	10p	ZS172	14p	KS068A	17p
ZTX213	12p	ZTX501	11p	ZS174	15p	KS075A	17p
ZTX214	13p	ZTX502	15p	ZS176	21p	KS082A	17p
ZTX300	10p	ZTX503	12p	ZS178	34p	KS091A	17p
ZTX301	11p	ZTX504	39p	ZS270	10p	KS100A	17p
ZTX302	15p	ZTX510	15p	ZS271	14p	KS110A	17p
ZTX303	12p	ZTX520	19p	ZS272	16p	KS120A	17p
ZTX304	19p	ZTX531	20p	ZS274	17p	KS130A	17p
ZTX310	8p	ZTX550	15p	ZS276	23p	KS150A	17p
ZTX311	9p	ZTX551	15p	ZS278	33p	KS180A	17p
ZTX312	9p	2N3055	65p				

MOTOROLA: MJE2955, £1-06; MJE3055, 65p; 2N4444, £2-25. R.C.A.: CA3075, £1-35; CA3090Q, £4-30.

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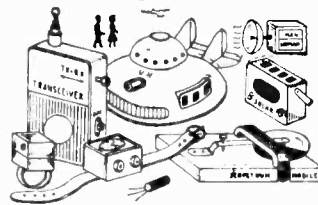
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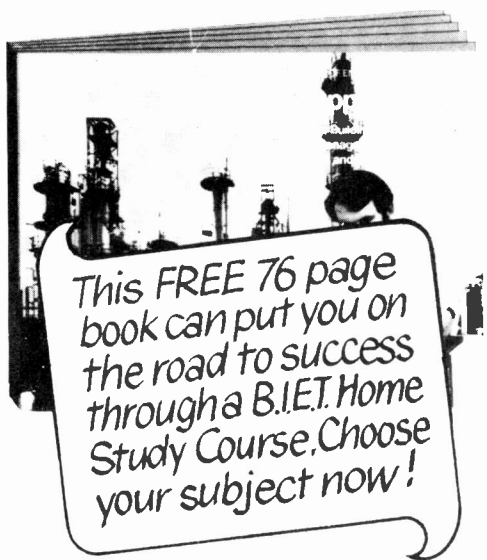
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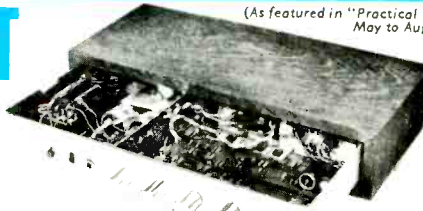
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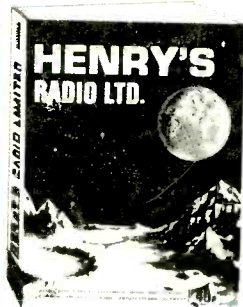
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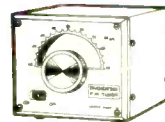
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