PRACTICAL
ELECTRONICS
FEBRUARY 1973
20p

P.E. SOUND SYNTHESISER

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

FREE INSIDE
CAPACITOR IDENTICHART

PRACTICAL
ELECTRONICS
VOLUME 9 No. 2 FEBRUARY 1973

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

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

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

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

SUPERTESTER 680R SPECIFICATION:

13 d.c ranges from 0·1 to 2000V. 12 ranges from 50µA to 5A. 20,000Ω/V. Accuracy 1%. 11 a.c. ranges from 2 to 2500V. 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.

ELECTRONIC BROKERS LTD 49-53 Pancras Rd., London NW1 2QB. Tel. 01-837 7781

EXCLUSIVE stereosystem

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 × 10¾ × 9¼in. Player size: 13¾ × 8 × 5¼in. 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

Cut these 3 pages out and keep for reference

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	0·46	2N4059	0·10
AC113	0·20	AD161 &		BC149	0·12	BD138	0·50	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	0·55	BF195	0·12	OC22	0·38	2G373	0·17	2N2221	0·20	2N3391	0·14	2N4061	0·12
AC117K	0·20		0·55	BC151	0·20	BD140	0·60	BF196	0·14	OC23	0·42	2G374	0·17	2N2222	0·20	2N3391A	0·16	2N4062	0·12
AC122	0·12	ADT140	0·50	BC152	0·17	BD155	0·80	BF197	0·14	OC24	0·56	2G377	0·30	2N2368	0·17	2N3392	0·14	2N4284	0·17
AC125	0·17	AF114	0·24	BC153	0·28	BD175	0·60	BF200	0·45	OC25	0·38	2G378	0·16	2N2369	0·14	2N3393	0·14	2N4285	0·17
AC126	0·17	AF115	0·24	BC154	0·30	BD176	0·60	BF222	0·95	OC26	0·25	2G381	0·16	2N2369A	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	0·60	OC29	0·50	2G401	0·30	2N2412	0·24	2N3402	0·21	2N4288	0·17
AC132	0·14	AF118	0·35	BC159	0·12	BD179	0·70	BF259	0·85	OC35	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	0·65	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	0·65	BF270	0·35	OC42	0·24	2N388A	0·55	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	AF139	0·30	BC169	0·12	BD188	0·70	BF272	0·80	OC45	0·12	2N404A	0·28	2N2904A	0·21	2N3416	0·28	2N5172	0·12
AC142K	0·17	AF178	0·50	BC170	0·12	BD189	0·75	BF273	0·35	OC70	0·10	2N524	0·42	2N2905	0·21	2N3417	0·28	2N5457	0·32
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	2N5458	0·32
AC154	0·20	AF180	0·50	BC172	0·14	BD195	0·85	BFW10	0·60	OC72	0·14	2N598	0·42	2N2906	0·15	2N3646	0·09	2N5459	0·40
AC155	0·20	AF181	0·45	BC173	0·14	BD196	0·85	BFX29	0·27	OC74	0·14	2N599	0·45	2N2906A	0·18	2N3702	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
AC165	0·20	AL102	0·65	BC177	0·19	BD199	0·95	BFX86	0·22	OC77	0·25	2N698	0·24	2N2923	0·14	2N3705	0·10	2S303	0·55
AC166	0·20	AL103	0·65	BC178	0·19	BD200	0·95	BFX87	0·24	OC81	0·15	2N699	0·35	2N2924	0·14	2N3706	0·09	2S304	0·70
AC167	0·20	ASY26	0·25	BC179	0·19	BD205	0·80	BFX88	0·22	OC81D	0·15	2N706	0·08	2N2925	0·14	2N3707	0·11	2S305	0·84
AC168	0·24	ASY27	0·30	BC180	0·24	BD206	0·80	BFY50	0·20	OC82	0·15	2N706A	0·09	2N2926 (G)		2N3708	0·07	2S306	0·84
AC169	0·14	ASY28	0·25	BC181	0·24	BD207	0·95	BFY51	0·20	OC82D	0·15	2N708	0·12		0·12	2N3709	0·09	2S307	0·84
AC176	0·20	ASY29	0·25	BC182	0·10	BD208	0·95	BFY52	0·20	OC83	0·20	2N711	0·30	2N2926 (Y)		2N3710	0·09	2S321	0·56
AC177	0·24	ASY50	0·25	BC182L	0·10	BDY20	1·00	BFY53	0·17	OC84	0·20	2N717	0·35		0·11	2N3711	0·09	2S322	0·42
AC178	0·28	ASY51	0·25	BC183	0·10	BF115	0·24	BPX25	0·85	OC139	0·20	2N718	0·24	2N2926 (O)		2N3819	0·28	2S322A	0·42
AC179	0·28	ASY52	0·25	BC183L	0·10	BF117	0·45	BSX19	0·15	OC140	0·20	2N718A	0·50		0·10	2N3820	0·50	2S323	0·56
AC180	0·17	ASY54	0·25	BC184	0·12	BF118	0·70	BSX20	0·15	OC169	0·25	2N726	0·28	2N2926 (R)		2N3821	0·35	2S324	0·70
AC180K	0·20	ASY55	0·25	BC184L	0·12	BF119	0·70	BSY25	0·15	OC170	0·25	2N727	0·28		0·10	2N3823	0·28	2S325	0·70
AC181	0·17	ASY56	0·25	BC186	0·28	BF121	0·45	BSY26	0·15	OC171	0·25	2N743	0·20	2N2926 (B)		2N3903	0·28	2S326	0·70
AC181K	0·20	ASY57	0·25	BC187	0·28	BF123	0·50	BSY27	0·15	OC200	0·25	2N744	0·20		0·10	2N3904	0·30	2S327	0·70
AC187	0·22	ASY58	0·25	BC207	0·11	BF125	0·45	BSY28	0·15	OC201	0·28	2N914	0·14	2N3010	0·70	2N3905	0·28	2S701	0·42
AC187K	0·20	ASZ21	0·40	BC208	0·11	BF127	0·50	BSY29	0·15	OC202	0·28	2N918	0·30	2N3011	0·14	2N3906	0·27	40361	0·40
AC188	0·22	BC107	0·09	BC209	0·12	BF152	0·55	BSY38	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	BSY39	0·18	OC204	0·25	2N930	0·21						
ACY17	0·25	BC109	0·10	BC213L	0·11	BF154	0·45	BSY40	0·28	OC205	0·35	2N1131	0·20						
ACY18	0·20	BC113	0·10	BC214L	0·14	BF155	0·70	BSY41	0·28	OC309	0·40	2N1132	0·22						
ACY19	0·20	BC114	0·15	BC225	0·25	BF156	0·48	BSY95	0·12	P346A	0·20	2N1302	0·14						
ACY20	0·20	BC115	0·15	BC226	0·35	BF157	0·55	BSY95A	0·12	P397	0·42	2N1303	0·14						
ACY21	0·20	BC116	0·15	BCY30	0·24	BF158	0·55	Bu105	2·00	OCP71	0·43	2N1304	0·17						
ACY22	0·16	BC117	0·15	BCY31	0·26	BF159	0·60	C111E	0·50	ORP12	0·43	2N1305	0·17						
ACY27	0·18	BC118	0·10	BCY32	0·30	BF160	0·40	C400	0·30	ORP60	0·40	2N1306	0·21						
ACY28	0·19	BC119	0·30	BCY33	0·22	BF162	0·40	C407	0·25	ORP61	0·40	2N1307	0·21						
ACY29	0·35	BC120	0·80	BCY34	0·25	BF163	0·40	C424	0·20	ST140	0·12	2N1308	0·23						
ACY30	0·28	BC125	0·12	BCY70	0·14	BF164	0·40	C425	0·50	ST141	0·17	2N1309	0·23						
ACY31	0·28	BC126	0·18	BCY71	0·18	BF165	0·40	C426	0·35	TI843	0·30	2N1613	0·20						
ACY34	0·21	BC132	0·12	BCY72	0·14	BF167	0·22	C428	0·20	UT46	0·27	2N1711	0·20						
ACY35	0·21	BC134	0·18	BCZ10	0·20	BF173	0·22	C441	0·30	2G301	0·09	2N1889	0·32						
ACY36	0·28	BC135	0·12	BCZ11	0·25	BF176	0·35	C442	0·30	2G302	0·19	2N1890	0·45						
ACY40	0·17	BC136	0·15	BCZ12	0·25	BF177	0·35	C444	0·35	2G303	0·19	2N1893	0·37						
ACY41	0·18	BC137	0·15	BD121	0·60	BF178	0·80	C450	0·22	2G304	0·24	2N2147	0·72						
ACY44	0·35	BC139	0·40	BD123	0·65	BF179	0·30	MAT100	0·19	2G306	0·40	2N2148	0·57						
AD130	0·38	BC140	0·80	BD124	0·60	BF180	0·30	MAT101	0·20	2G308	0·35	2N2160	0·60						
AD140	0·48	BC141	0·30	BD131	0·50	BF181	0·30	MAT120	0·19	2G309	0·35	2N2192	0·35						
AD142	0·48	BC142	0·30	BD132	0·60	BF182	0·40	MAT121	0·20	2G339	0·20	2N2193	0·35						
AD143	0·38	BC143	0·30	BD133	0·65	BF183	0·40	MPF102	0·42	2G339A	0·16	2N2194	0·35						
AD149	0·50	BC145	0·45	BD135	0·40	BF184	0·25	MPF104	0·37	2G344	0·18	2N2217	0·22						
AD161	0·33	BC147	0·10	BD136	0·40	BF185	0·30	MPF105	0·37	2G345	0·16	2N2218	0·20						

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		OA70	0·07
AAY30	0·09		0·42	OA79	0·07
AAZ13	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	0·07
BA154	0·12	BYZ17	0·35	OA200	0·06
BA155	0·14	BYZ18	0·35	OA202	0·07
BA156	0·13	BYZ19	0·23	SD10	0·05
BY100	0·15	CG62		SD19	0·05
BY101	0·12	(Eg) OA91		IN34	0·07
BY105	0·17		0·05	IN34A	0·07
BY114	0·12	CG651		1N914	0·06
BY126	0·14	(Eq) OA70·		1N916	0·06
BY127	0·15	OA79	0·06	IN414B	0·06
BY128	0·15	OA5	0·35	IS021	0·10
BY130	0·16	OA58L	0·21	IS951	0·06

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0·50
C 2	200	Capacitors mixed values approx. count by weight	0·50
C 3	50	Precision Resistors ·1%, ·01% mixed values	0·50
C 4	75	⅛th W Resistors mixed preferred values	0·50
C 5	5	Pieces assorted Ferrite Rods	0·50
C 6	2	Tuning Gangs, MW/LW VHF	0·50
C 7	1	Pack Wire 50 metres assorted colours	0·50
C 8	10	Reed Switches	0·50
C 9	3	Micro Switches	0·50
C10	15	Assorted Pots & Pre-Sets	0·50
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Types	0·50
C12	40	Paper Condensers preferred types mixed values	0·50
C13	20	Electrolytics Trans. types	0·50
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·50
C15	4	Mains Toggle Switches, 2 Amp D/P	0·50
C16	20	Assorted Tag Strips & Panels	0·50
C17	10	Assorted Control Knobs	0·50
C18	4	Rotary Wave Change Switches	0·50
C19	3	Relays 6—24V Operating	0·50
C20	4	Sheets Copper Laminate approx. 10″ × 7″	0·50

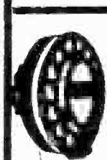
Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.

PLUS-MUCH MORE-
SEND NOW FOR THE
BI-PAK *"Component Catalogue"*

5p to cover postage etc.

JUMBO COMPONENT PAKS
MIXED ELECTRONIC COMPONENTS
Exceptionally good value

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. £1·50 only.



BRAND NEW POST OFFICE TYPE TELE-PHONE DIALS
ONLY 75p each

THE NEW S.G.S. EA 1000 AUDIO AMP MODULE **Guarantee*

3 Watts
R.M.S.
ONLY
£2·63 each

Modual Tested and Guaranteed. Actual Size
Qty. 1—9 £2·63; 10—25 £2·28 Price each. Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each modual or available separately at 10p each.

SYSTEM 12 STEREO

Each Kit contains two Amplifier Modules, 3 watts RMS, two loudspeakers, 15 ohms, the pre-amplifier, transformer, power supply module, front panel and other accessories, as well as an illustrated stage-by-stage instruction booklet designed for the beginner.
Further details available on request.

ONLY £16·95 FREE P. & P.

NOW-TURN OVER FOR MORE FANTASTIC OFFERS

The largest selection

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

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0·23	0·25	0·35	0·35	0·47	0·50	0·53	1·15
100	0·25	0·33	0·47	0·47	0·50	0·58	0·63	1·40
200	0·35	0·37	0·49	0·49	0·57	0·61	0·75	1·60
400	0·43	0·47	0·56	0·56	0·67	0·75	0·93	1·75
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	4·00

SIL. RECTS. TESTED

PIV	300mA	750mA	1A	1·5A	3A	10A	30A
50	0·04	0·05	0·05	0·07	0·14	0·21	0·60
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·25	0·34	0·45	1·86
800	0·10	0·17	0·11	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·14	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·38	0·57	0·75	—

TRIACS

VBOM	2A TO-1	6A TO-66	10A TO-88
	£p	£p	£p
100	30	50	76
200	50	60	90
400	70	75	1-10

DIACS

FOR USE WITH TRIACS
BR100 (D32) 37p each

FREE

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	OC44
T7	8 2G345B	OC45
T8	8 2G378	OC78
T9	8 2G399A	2N1302
T10	8 2G417	AF117

All 50p each pak

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

120 VCB MIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 17p each. TO.5 N.P.N. 25 up 15p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5p each. Any Qty.

FULL RANGE OF ZENER DIODES VOLTAGE RANGE

2-33V. 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

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

NEW LINE

Plastic Encapsulated 2 Amp. BRIDGE RECTS.

50 v RMS 32p each
100 v RMS 37p „
400 v RMS 46p „
Size 15 mm × 6 mm.

UNIJUNCTION

UT46. Eqvt. 2N2646, Eqvt. TI843. BEN3000 27p each, 25-99 25p 100 UP 20p.

CADMIUM CELLS

ORP12 43p
ORP60, ORP61 40p each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N700/8. BSY-27/28/95A.

All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		£p
20	For	0·50
50	For	1·00
100	For	1·75
500	For	7·50
1000	For	13·00

SIL. G.P. DIODES £p

300mW	30	0·50
40PIV(Min.)	100	1·50
Sub-Min.	500	5·00
Full Tested	1,000	9·00

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U 2	60 Mixed Germanium Transistors AF/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 BSY95A. 2N706	0·50
U 7	16 Sil. Rectifiers TOP-HAT 750mA VLTG. RANGE up to 1000	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 2N1132, 2N2904	0·50
U12	12 Silicon Rectifiers Epoxy 500mA 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 6 Amp Silicon Rectifiers BYZ13 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 2G300 Series & OC71	0·50
U23	30 MADT's like MHz Series PNP Transistors	0·50
U24	20 Germanium 1 Amp Rectifiers GJM Series up to 300 PIV	0·50
U25	25 300 MHz NPN Silicon Transistors 2N708, BSY27	0·50
U26	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	0·50
U27	12 NPN Germanium AF Transistors TO-1 like AC127	0·50
U29	10 1 Amp SCR's TO-5 can, up to 600 PIV CRS1/25-600	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 SO-2 PNP OC200, 28322	0·50
U38	20 Fast Switching Silicon Trans. NPN 400 MHz 2N3011	0·50
U39	30 RF. Germ. PNP Transistors 2N1303/5 TO-5	0·50
U40	10 Dual Transistors 6 lead TO-5 2N2060	0·50
U41	25 RF Germanium Transistors TO-5, OC45, NKT72	0·50
U42	10 VHF Germanium PNP Transistors TO-1 NKT667, 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.

QUALITY TESTED SEMICONDUCTORS

Pak No.		Price £p
Q1	20 Red spot transistors PNP	0·50
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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	0·50
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0·50
Q16	2 GET880 low noise Germanium transistors	0·50
Q17	5 NPN 2 × ST.141 & 3 × ST.140	0·50
Q18	4 MADT'S 2 × MAT 100 & 2 × MAT 120	0·50
Q19	3 MADT'S 2 × MAT 101 & 1 × 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 IN69	0·50
Q27	2 10A PIV Silicon rectifiers IS425R	0·50
Q28	2 Silicon power rectifiers BYZ 13	0·50
Q29	4 Silicon transistors 2 × 2N696, 1 × 2N697, 1 × 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 × 2N1131, 1 × 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 × 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 × 2N3703, 3 × 2N3702	0·50

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2N3819	35p	2N5458	50p
2N3820	50p	2N5459	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 I.C's and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	12 × 7400	0·50	UIC46	5 × 7446	0·50	UIC86	5 × 7486	0·50
UIC01	12 × 7401	0·50	UIC47	5 × 7447	0·50	UIC90	5 × 7490	0·50
UIC02	12 × 7402	0·50	UIC48	5 × 7448	0·50	UIC91	5 × 7491	0·50
UIC03	12 × 7403	0·50	UIC50	12 × 7450	0·50	UIC92	5 × 7492	0·50
UIC04	12 × 7404	0·50	UIC51	12 × 7451	0·50	UIC93	5 × 7493	0·50
UIC05	12 × 7405	0·50	UIC53	12 × 7453	0·50	UIC94	5 × 7494	0·50
UIC06	8 × 7406	0·50	UIC54	12 × 7454	0·50	UIC95	5 × 7495	0·50
UIC07	8 × 7407	0·50	UIC60	12 × 7460	0·50	UIC96	5 × 7496	0·50
UIC10	12 × 7410	0·50	UIC70	8 × 7470	0·50	UIC100	5 × 74100	0·50
UIC13	8 × 7413	0·50	UIC72	8 × 7472	0·50	UIC121	5 × 74121	0·50
UIC20	12 × 7420	0·50	UIC73	8 × 7473	0·50	UIC141	5 × 74141	0·50
UIC30	12 × 7430	0·50	UIC74	8 × 7474	0·50	UIC151	5 × 74151	0·50
UIC40	12 × 7440	0·50	UIC75	8 × 7475	0·50	UIC154	5 × 74154	0·50
UIC41	5 × 7441	0·50	UIC76	8 × 7476	0·50	UIC193	5 × 74193	0·50
UIC42	5 × 7442	0·50	UIC80	5 × 7480	0·50	UIC199	5 × 74199	0·50
UIC43	5 × 7443	0·50	UIC81	5 × 7481	0·50			
UIC44	5 × 7444	0·50	UIC82	5 × 7482	0·50	UICXI	25 Assorted 74's	1·50
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GENERAL PURPOSE GERM. PNP

Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. T13027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1-24	25-99	100 up
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TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.
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2N3055

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SN7403	0·15	0·14	0·12
SN7404	0·15	0·14	0·12
SN7405	0·15	0·14	0·12
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SN7408	0·18	0·17	0·16
SN7409	0·18	0·17	0·16
SN7410	0·15	0·14	0·12
SN7411	0·25	0·24	0·23
SN7412	0·35	0·31	0·28
SN7413	0·29	0·26	0·24
SN7416	0·43	0·40	0·38
SN7417	0·43	0·40	0·38
SN7420	0·15	0·14	0·12
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SN7423	0·50	0·48	0·45
SN7425	0·50	0·48	0·45
SN7427	0·45	0·42	0·40
SN7428	0·70	0·65	0·60
SN7430	0·15	0·14	0·12
SN7432	0·45	0·42	0·40
SN7433	0·80	0·75	0·70
SN7437	0·64	0·62	0·60
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SN7447	£1·00	0·97	0·95
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SN7453	0·15	0·14	0·12
SN7454	0·15	0·14	0·12
SN7460	0·15	0·14	0·12
SN7470	0·29	0·26	0·24
SN7472	0·29	0·26	0·24
SN7473	0·37	0·35	0·32
SN7474	0·37	0·35	0·32
SN7475	0·45	0·43	0·42
SN7476	0·40	0·39	0·38
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SN74177	£2·50	£2·40	£2·30
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SN74194	£2·70	£2·60	£2·50
SN74195	£2·00	£1·90	£1·80
SN74196	£1·80	£1·70	£1·60
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BP709—72709	36p	34p	30p
BP709P—μA709C	36p	34p	30p
BP710—72710	44p	42p	40p
BP711—μA711	45p	43p	40p
BP741—72741	75p	60p	50p
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BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
BP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

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

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

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

RTL MICROLOGIC CIRCUITS

Epoxy TO-5 case	Price each 1–24	25–99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2i/p gate	35p	33p	27p
uL923 J-K flip-flop	50p	47p	45p

Date and Circuits Booklet for IC's Price 7p.

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TSO 16 ,, ,,	35p	32p	30p
LOW COST No.			
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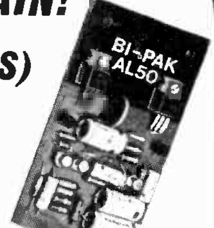

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HI-FI AUDIO AMPLIFIER

THE AL50

★ Frequency Response 15Hz to 100,000—1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than ·1% at 1KHz.

★ Signal to noise ratio 80dB.

ONLY £3.25p each

★ Supply voltage 10–35 Volts.

★ Overall size 63mm × 105mm × 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
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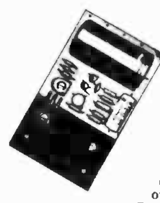
STABILISED POWER MODULE SPM80



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63mm × 105mm × 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p **PRICE £2·95**

TRANSFORMER BMT80 £1·95 p. & p. 25p.

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION

Frequency Response	20Hz – 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs : 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters : Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than – 65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

ONLY £11·95

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £23·00 FREE p. & p.

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BI-PAK

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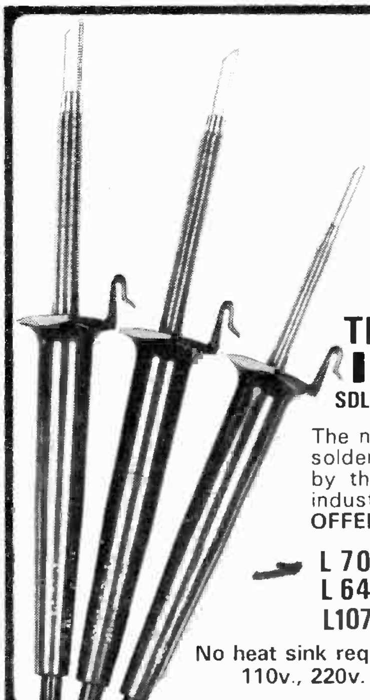

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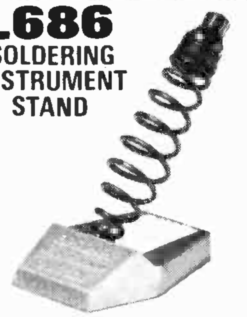
L 646 23 watts £2·12
L1076 27 watts £2·18

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



L686

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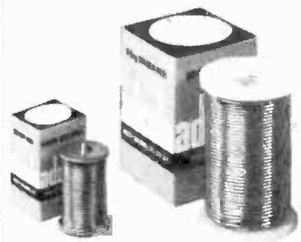

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Sinclair Project 60

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.

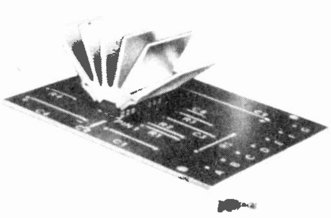
Gain at 1kHz: Filters flat 0.98 (—0.2 dB)

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

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

Distortion: at 1kHz (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 transistor 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:** 22×45×28mm including pins and heat sink.

Manual available separately 15p post free.

With FREE printed circuit board and 40 page manual.

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Project 605

The easy way to buy and build Project 60

Project 605 is one pack containing one PZ5, 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.

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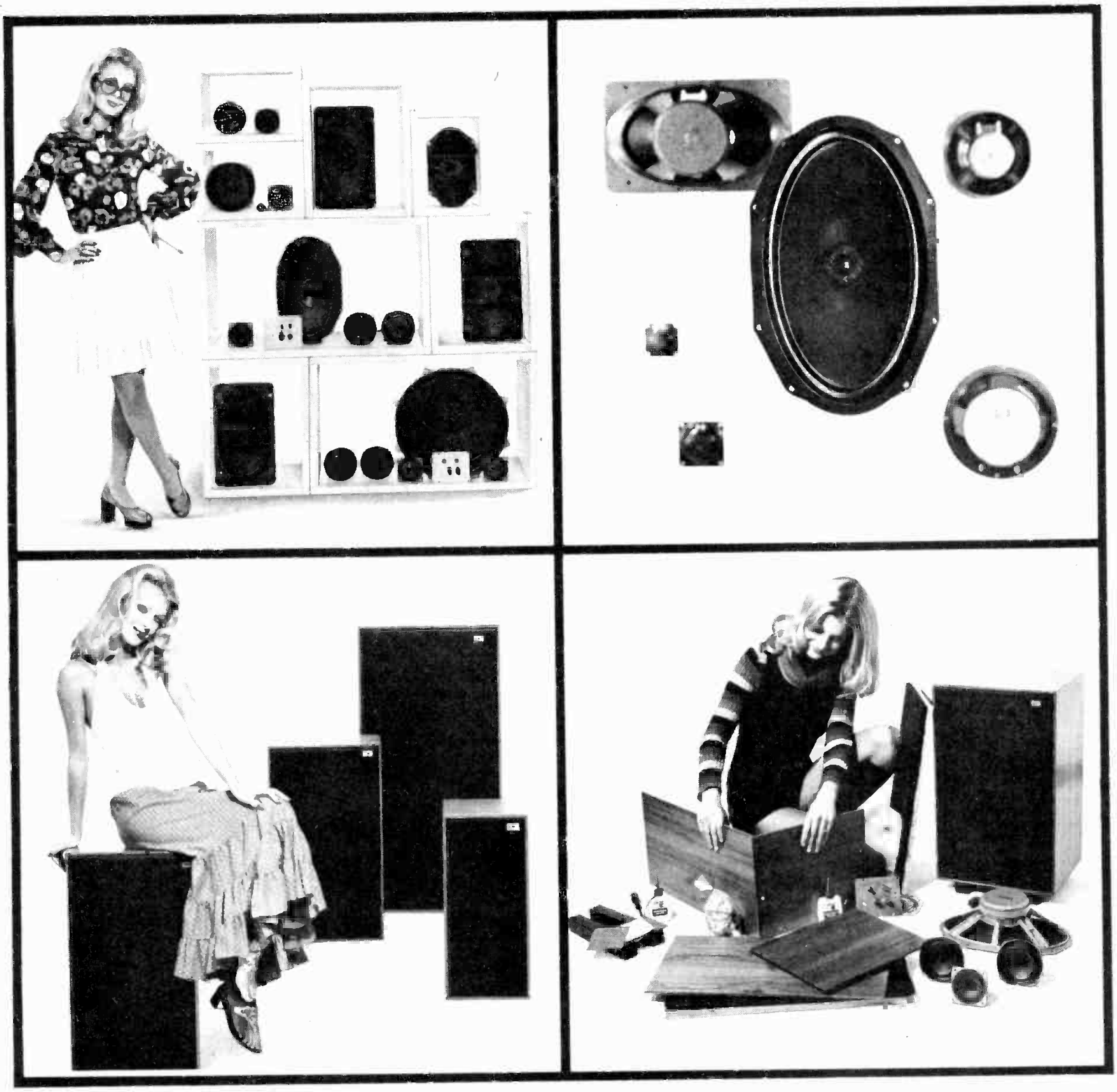

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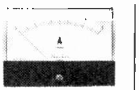
100μA	£3·80		
100-0-100μA	£3·70		
500μA	£3·50		
1mA	£3·40		
20V d.c.	£3·40		
50V d.c.	£3·40	5 amp. d.c.	£3·40
300V d.c.	£3·40	300V a.c.	£3·40
1 amp. d.c.	£3·40	VU Meter	£4·15

Type SD.830 82·5mm × 110mm Fronts



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		50mA	£2·50
		100mA	£2·50
		500mA	£2·50
		1 amp.	£2·50
		5 amp.	£2·50
		10 amp.	£2·50
50μA	£2·75	5V d.c.	£2·50
50-0-50μA	£2·70	10V d.c.	£2·50
100μA	£2·70	20V d.c.	£2·50
100-0-100μA	£2·70	50V d.c.	£2·50
200μA	£2·70	300V d.c.	£2·50
500μA	£2·55	15V a.c.	£2·75
1mA	£2·50	300V a.c.	£2·75
5mA	£2·50	VU Meter	£3·00

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50-0-50μA	£2·55	1 amp.	£2·35
100μA	£2·55	5 amp.	£2·35
100-0-100μA	£2·55	10 amp.	£2·35
200μA	£2·55	5V d.c.	£2·35
500μA	£2·35	20V d.c.	£2·35
1mA	£2·35	50V d.c.	£2·35
5mA	£2·35	300V d.c.	£2·35
10mA	£2·35	15V a.c.	£2·40
50mA	£2·35	300V a.c.	£2·40
100mA	£2·35	VU Meter	£2·70

Type SD.460 46mm × 59·5mm Fronts

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50-0-50μA	£2·35	5 amp.	£2·15
100μA	£2·35	10 amp.	£2·15
100-0-100μA	£2·35	5V d.c.	£2·15
200μA	£2·35	10V d.c.	£2·15
500μA	£2·20	20V d.c.	£2·15
1mA	£2·15	50V d.c.	£2·15
5mA	£2·15	300V d.c.	£2·15
10mA	£2·15	15V a.c.	£2·30
50mA	£2·15	300V a.c.	£2·30
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500mA	£2·15		

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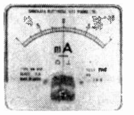

		50mA	£3·10
		100mA	£3·10
		500mA	£3·10
		1 amp.	£3·10
		5 amp.	£3·10
		15 amp.	£3·10
		30 amp.	£3·20
		20V d.c.	£3·10
		50V d.c.	£3·10
50μA	£3·95	150V d.c.	£3·10
50-0-50μA	£3·40	300V d.c.	£3·10
100μA	£3·40	15V a.c.	£3·10
100-0-100μA	£3·30	300V a.c.	£3·10
200μA	£3·30	S Meter 1mA	£3·15
500μA	£3·20	VU Meter	£3·95
500-0-500μA	£3·10	1 amp. a.c.	*£3·10
1mA	£3·10	5 amp. a.c.	*£3·10
1-0-1mA	£3·10	10 amp. a.c.	*£3·10
5mA	£3·10	20 amp. a.c.	*£3·10
10mA	£3·10	30 amp. a.c.	*£3·10

Type MR.52P. 2¼in. square Fronts.

50μA	£3·40	10V d.c.	£2·20
50-0-50μA	£2·85	20V d.c.	£2·20
100μA	£2·85	50V d.c.	£2·20
100-0-100μA	£2·75	300V d.c.	£2·20
500μA	£2·55	15V a.c.	£2·30
1mA	£2·20	300V a.c.	£2·30
5mA	£2·20	S Meter 1mA	£2·30
10mA	£2·20	VU Meter	£3·50
50mA	£2·20	1 amp. a.c.	*£2·20
100mA	£2·20	5 amp. a.c.	*£2·20
500mA	£2·20	10 amp. a.c.	*£2·20
1 amp.	£2·20	20 amp. a.c.	*£2·20
5 amp.	£2·20	30 amp. a.c.	*£2·20

Type MR.65P. 3½in. × 3¼in. Fronts

50μA	£3·70	10V d.c.	£2·40
50-0-50μA	£3·00	20V d.c.	£2·40
100μA	£3·00	50V d.c.	£2·40
100-0-100μA	£2·95	150V d.c.	£2·40
200μA	£2·90	300V d.c.	£2·40
500μA	£2·65	15V a.c.	£2·55
500-0-500μA	£2·40	50V a.c.	£2·55
1mA	£2·40	150V a.c.	£2·55
5mA	£2·40	300V a.c.	£2·55
10mA	£2·40	500V a.c.	£2·55
50mA	£2·40	S Meter 1mA	£2·55
100mA	£2·40	VU Meter	£3·79
500mA	£2·40	50mA a.c.	*£2·40
1 amp	£2·40	100mA a.c.	*£2·40
5 amp	£2·40	200mA a.c.	*£2·40
10 amp.	£2·40	500mA a.c.	*£2·40
15 amp.	£2·40	1 amp. a.c.	*£2·40
20 amp.	£2·40	5 amp. a.c.	*£2·40
30 amp.	£2·55	10 amp. a.c.	*£2·40
50 amp.	£2·75	20 amp. a.c.	*£2·40
5V d.c.	£2·40	30 amp. a.c.	*£2·40

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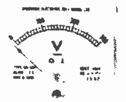
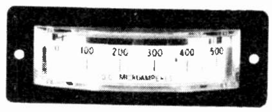
Type MR.38P. 1 21/32in. square Fronts.



		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
50μA	£2·30	10V d.c.	£1·75
50-0-50μA	£2·10	15V d.c.	£1·75
100μA	£2·10	20V d.c.	£1·75
100-0-100μA	£1·95	50V d.c.	£1·75
200μA	£1·95	100V d.c.	£1·75
500μA	£1·80	150V d.c.	£1·75
500-0-500μA	£1·75	300V d.c.	£1·75
1mA	£1·75	500V d.c.	£1·75
1-0-1mA	£1·75	750V d.c.	£1·75
2mA	£1·75	15V a.c.	£1·85
5mA	£1·75	50V a.c.	£1·85
10mA	£1·75	150V a.c.	£1·85
20mA	£1·75	300V a.c.	£1·85
50mA	£1·75	500V a.c.	£1·85
100mA	£1·75	S Meter 1mA	£1·85
150mA	£1·75	VU Meter	£2·30

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

50μA	£2·50	5 amp.	£1·85
50-0-50μA	£2·30	10V d.c.	£1·85
100μA	£2·30	20V d.c.	£1·85
100-0-100μA	£2·05	50V d.c.	£1·85
200μA	£2·05	300V d.c.	£1·85
500μA	£1·95	15V a.c.	£2·00
500-0-500μA	£1·85	300V a.c.	£2·00
1mA	£1·85	S Meter 1mA	£2·05
5mA	£1·85	VU Meter	£2·50
10mA	£1·85	1 amp. a.c.	*£1·85
50mA	£1·85	5 amp. a.c.	*£1·85
100mA	£1·85	10 amp. a.c.	*£1·85
500mA	£1·85	20 amp. a.c.	*£1·85
1 amp.	£1·85	30 amp. a.c.	*£1·85



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100μA	£3·30	300V a.c.	£2·70
100-0-100μA	£3·20	VU Meter	£3·75
200μA	£3·20		

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Type MR.65. 3½in. square Fronts.

		1 amp.	£2·15
		5 amp.	£2·15
		15 amp.	£2·15
		30 amp.	£2·15
		50 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
25μA	£3·85	50mV d.c.	£2·40
50μA	£3·00	100mV d.c.	£2·40
50-0-50μA	£2·60	30V a.c.*	£2·20
100μA	£2·60	50V a.c.*	£2·20
100-0-100μA	£2·50	150V a.c.*	£2·20
500μA	£2·45	300V a.c.*	£2·20
500-0-500μA	£2·15	500mA a.c.*	£2·15
1mA	£2·15	1 amp. a.c.*	£2·15
1-0-1mA	£2·15	5 amp. a.c.*	£2·15
5mA	£2·15	10 amp. a.c.*	£2·15
10mA	£2·15	20 amp. a.c.*	£2·15
50mA	£2·15	30 amp. a.c.*	£2·15
100mA	£2·15	50 amp. a.c.*	£2·15
500mA	£2·15	VU Meter	£3·40

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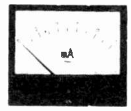

50μA	£3·50		
50-0-50μA	£3·40		
100μA	£3·40		
100-0-100μA	£3·30		
500μA	£3·05		
1mA	£2·85		
20V d.c.	£2·85		
50V d.c.	£2·85		
300V d.c.	£2·85		
1 amp. d.c.	£2·85	300V a.c.	£2·85
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1-0-1mA	£4·85	Dual range	
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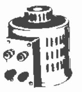

1 amp.	£7·00
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5 amp.	£11·75
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10 amp.	£22·50
12 amp.	£23·60
20 amp.	£49·00
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S-260 Panel Mounting

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1000W	£7·50	P. & P. 38p
1500W	£10·20	P. & P. 43p
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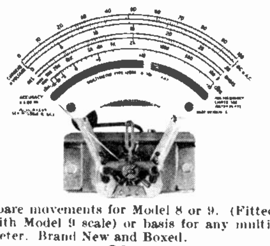

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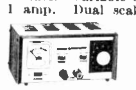

Solid state. Variable output 0–24V d.c. up to 1 amp. Dual scale meter to monitor voltage and current. Input 220/240V a.c. Size 185 × 85 × 105mm. **£8·97** Post 25p.

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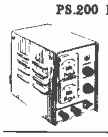

Solid state. Variable output 5–20V d.c. up to 2 amp. Independent meters to monitor voltage and current. Output 220/240V. a.c. Size 7¼in. × 5¼in. × 3¼in. **£14·97.** Post 25p.

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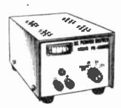

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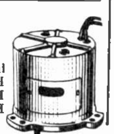

Built in gearbox. All brand new and boxed. 30 RPH CW; 2 RPH CW; 20 RPH CW; 2 RPH ACW; 30 RRH CW. **50p** each, Post 12p.

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Tests PNP or NPN transistors. Audio indication. Operates on two 1·5V batteries. Complete with all instructions, etc.
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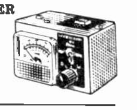
LB3 TRANSISTOR TESTER



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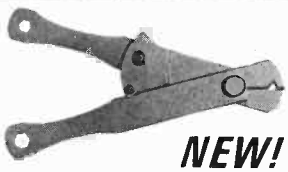

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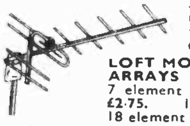

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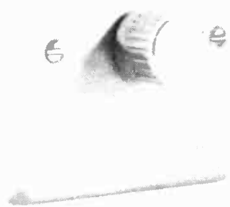

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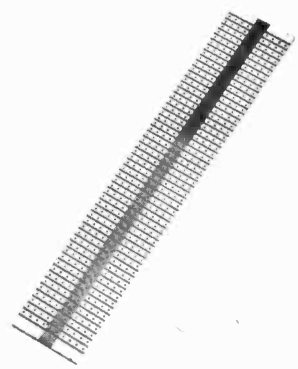

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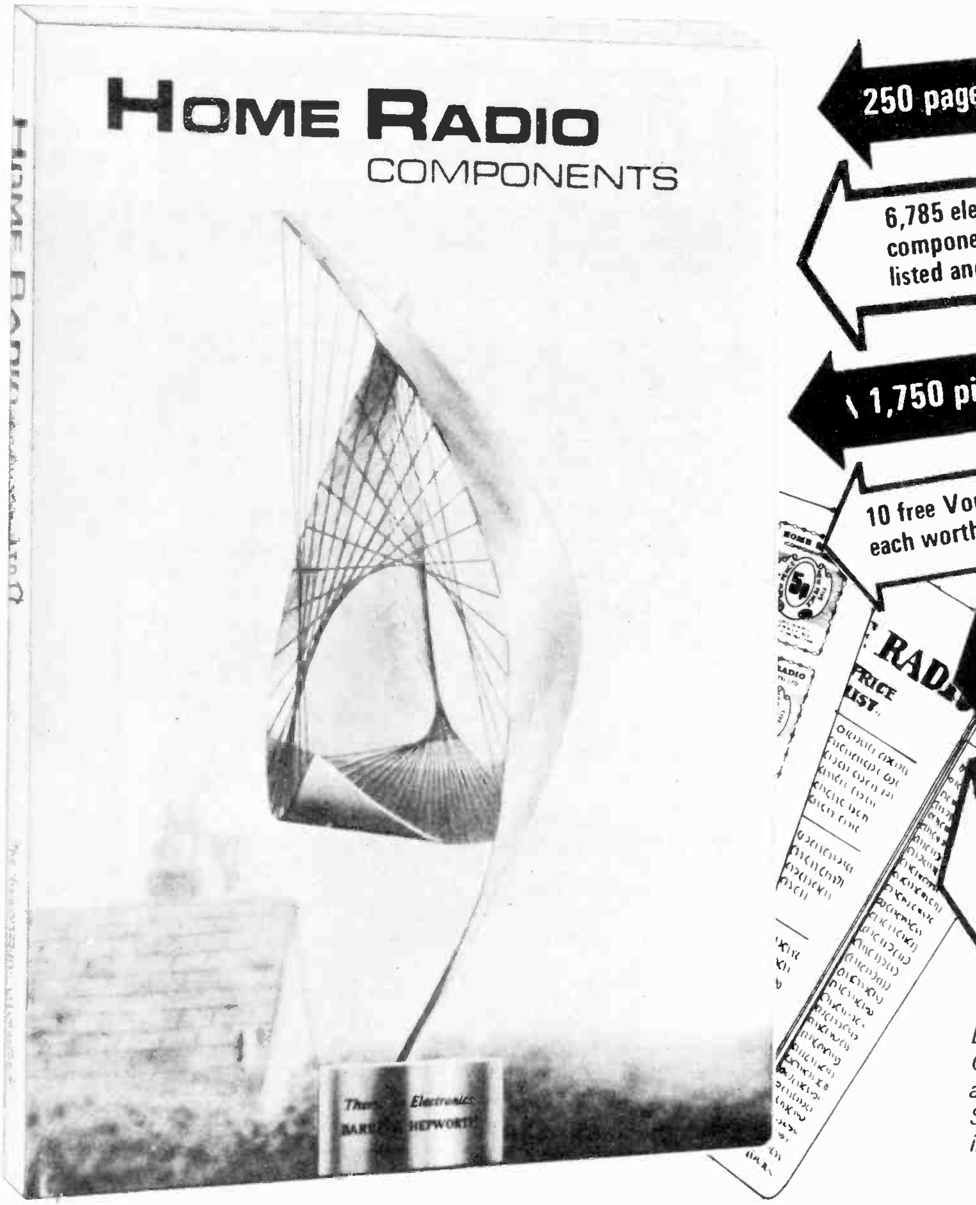

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THE WHOLE AND THE PARTS

SCOPE 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 unwieldly 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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The latest in circuit integration.....

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 desgined 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.

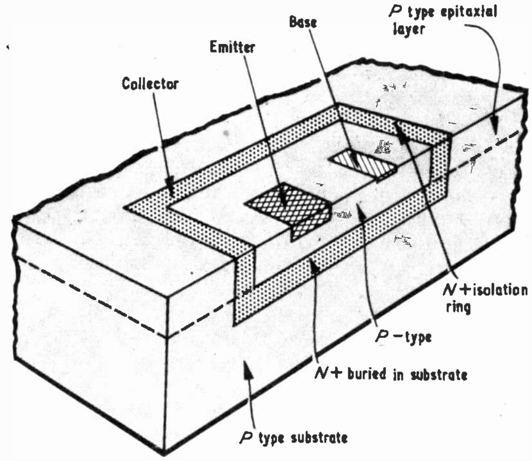


Fig. 1. Cross section view through a CDI transistor

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 compatability 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_{fe}	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.

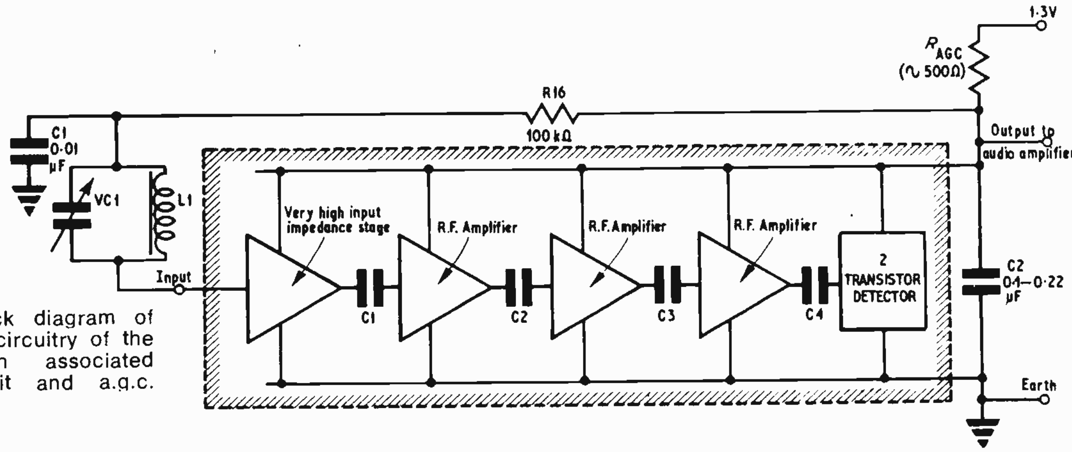
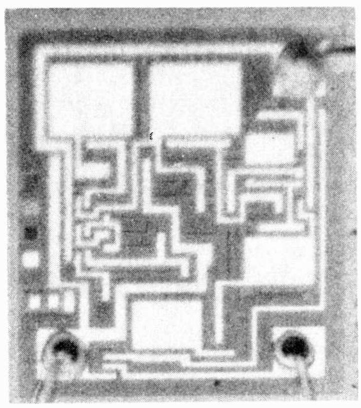


Fig. 2. Block diagram of the interior circuitry of the ZN414 with associated tuned circuit and a.g.c. components

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 2kΩ to 50kΩ).

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

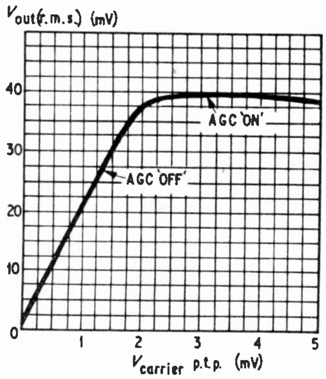


Fig. 3. Graph of voltage gain showing the effective a.g.c. region

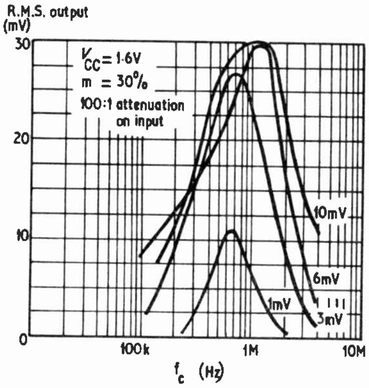


Fig. 4. Bandwidth of the ZN414 on the medium wave band

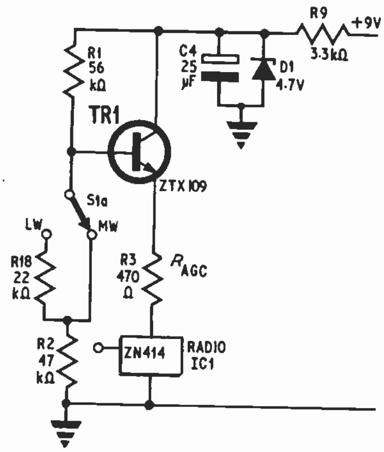


Fig. 5. The integrated circuit is driven from a constant voltage source of 1·3 volts derived from a 9 volt supply

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, 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.

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

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.

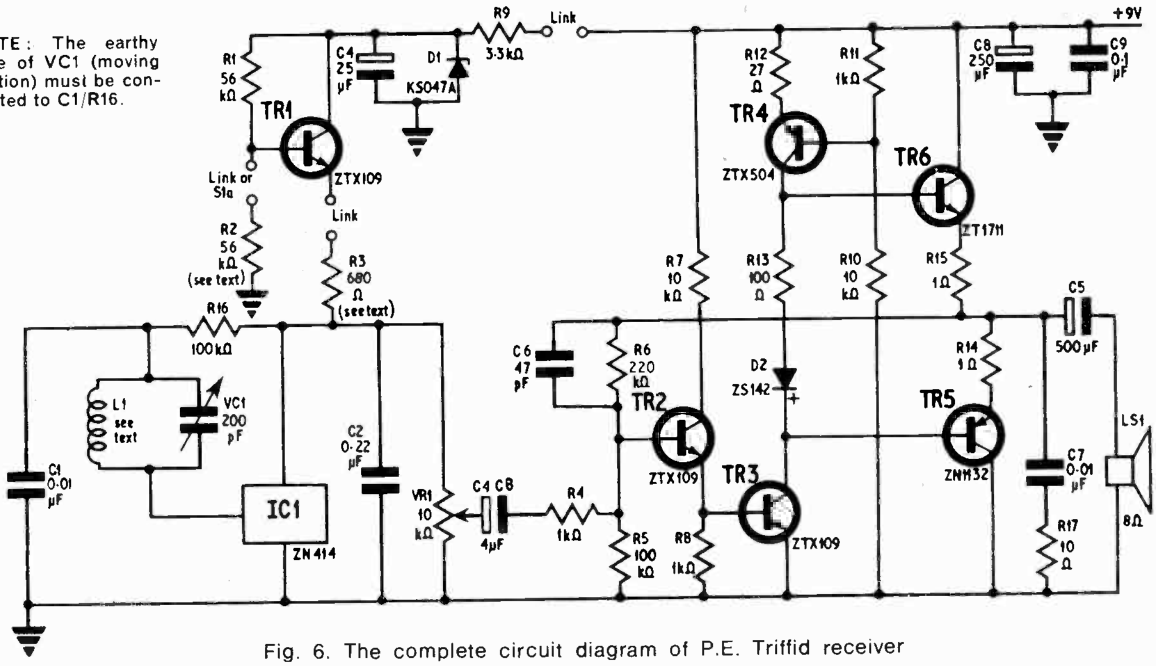


Fig. 6. The complete circuit diagram of P.E. Triffid receiver

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 *pnp* 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 ouput 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".

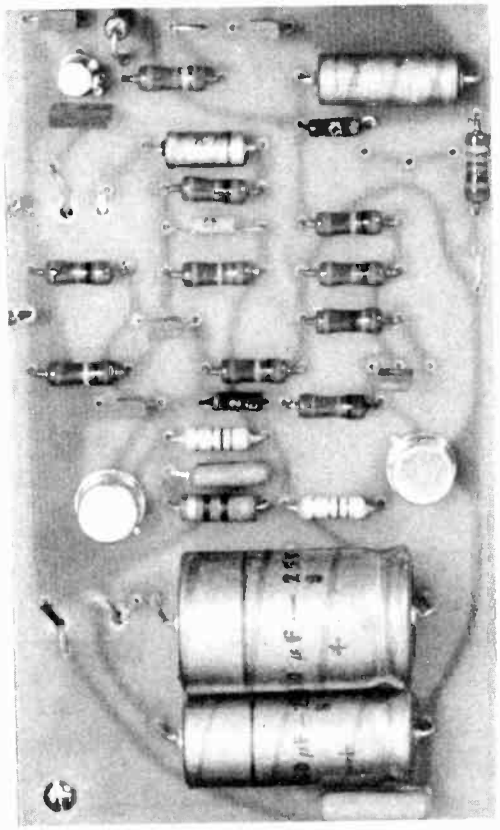
No heatsinks are necessary with the recommended output pair. Three layouts of the circuit were tried, all were stable and gave similar results.

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 Ω
*R2 56k Ω
*R3 680 Ω
*R4 1k Ω
R5 100k Ω
R6 220k Ω
R7 10k Ω
R8 1k Ω
R9 3·3k Ω
R10 10k Ω 2%
R11 1k Ω 2%
R12 27 Ω
R13 100 Ω
R14 1 Ω 1W
R15 1 Ω 1W
R16 100k Ω
R17 10k Ω
R18 22k Ω
R19 220k Ω

All ± 5% ¼W carbon except where stated

Potentiometer

VR1 10kΩ volume control with switch (S3)

Capacitors

C1 0·01μF
C2 0·22μF
C3 4μF elect 10V
C4 25μF elect 10V
C5 500μF elect 10V
C6 47pF disc ceramic
C7 0·01μF polyester
C8 250μF elect 10V
C9 0·1μF 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 ⅜in dia. 6in ferrite rod (see text)

Miscellaneous

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

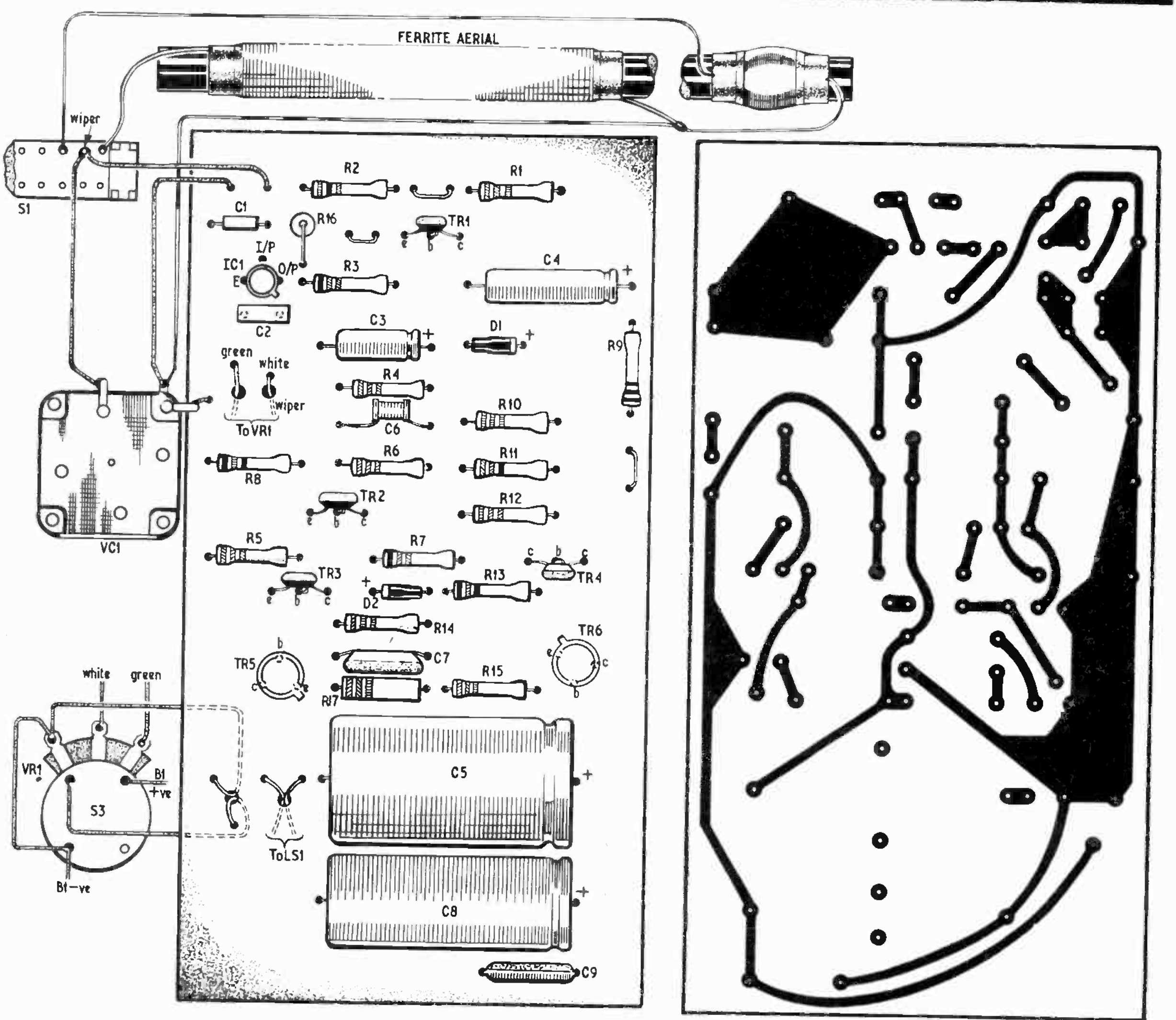


Fig. 7. Component layout and printed circuit board pattern (full size)

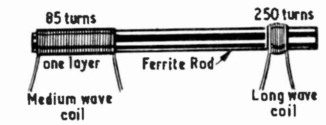
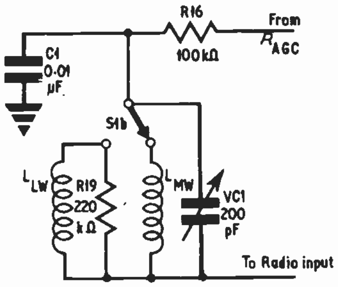


Fig. 8. Coil winding details and waveband selection



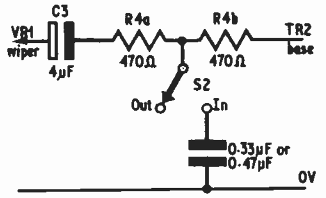


Fig. 9. A tone control circuit is inserted in the position of R4 as shown here with another capacitor

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.

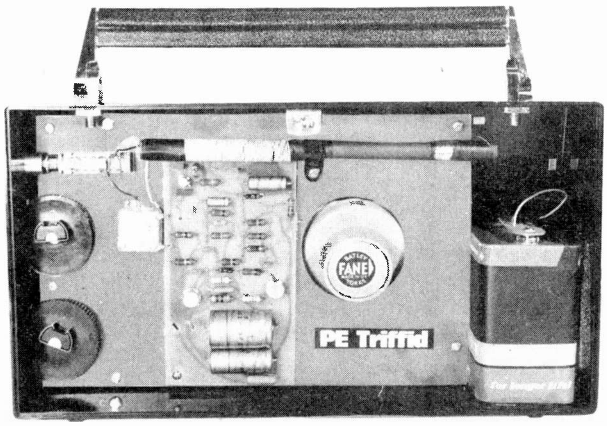
The type of ferrite rod affects the inductance, as does the type of wire, but it is easy to adjust the coil to suit the requirements of the rod obtained. Do not expect to adhere rigidly to the specified coil details for optimum results.

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 ±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 ±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.

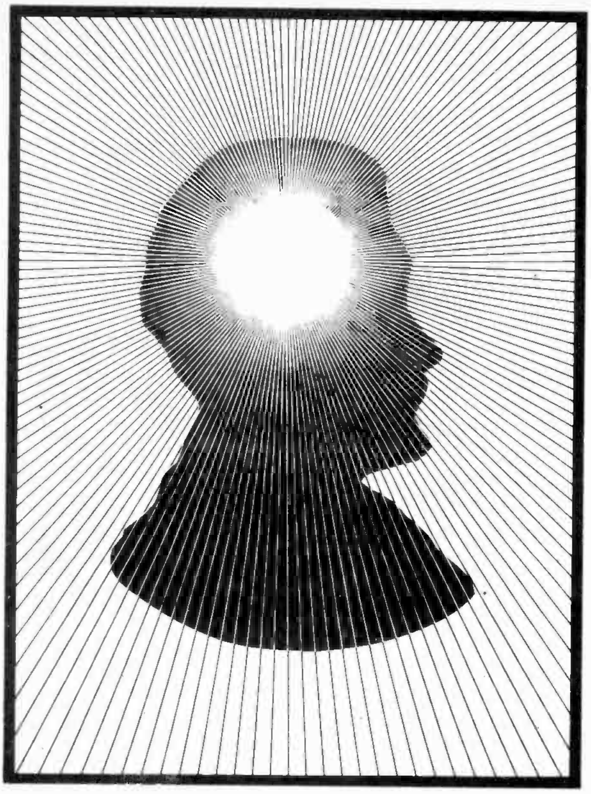
In normal circumstances this receiver should not drift and once set, the tuning should not need to be altered.

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. ★



Biological Amplifier

By D. BOLLEN

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.

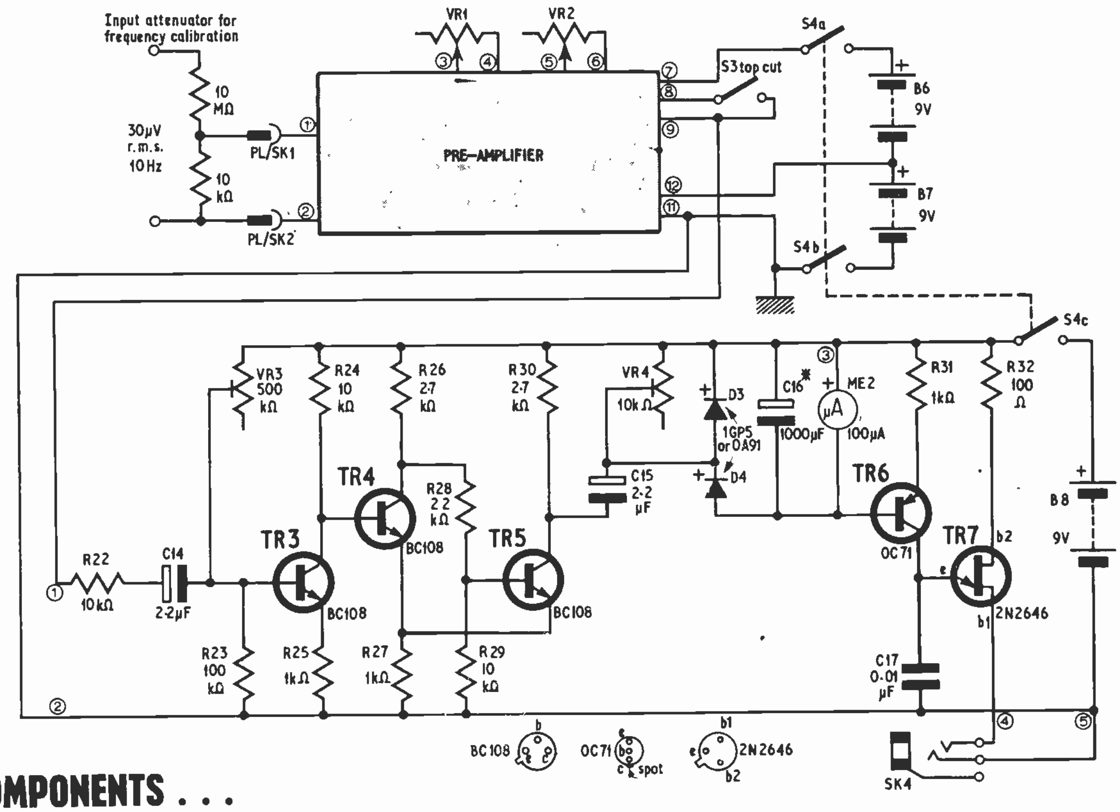
In addition to the frequency meter, a voltage controlled unijunction oscillator TR7, gives an audio output into 8 ohm headphones of frequency proportional to the subsonic brain rhythm frequency, so that the user can sense changes of rhythm with his eyes closed. TR6 controls the charge rate of the unijunction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



COMPONENTS . . .

ADDITIONAL COMPONENTS FOR FREQUENCY METER

Resistors

R22	10kΩ	R26	2·7kΩ	R30	2·7kΩ
R23	100kΩ	R27	1kΩ	R31	1kΩ
R24	10kΩ	R28	22kΩ	R32	100Ω
R25	1kΩ	R29	10kΩ		

All ±10% ½ watt carbon

Potentiometers

VR3 500kΩ sub-min horizontal pre-set
VR4 10kΩ sub-min horizontal pre-set

Semiconductors

TR3	BC108	TR6	OC71
TR4	BC108	TR7	2N2646
TR5	BC108	D3, D4	1GP5 or OA91

Capacitors

C14 2·2μF tantalum 35V
C15 2·2μF tantalum 35V
C16 1,000μF elect. 3V
C17 0·01μF polyester

Meter

M2 100μA 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

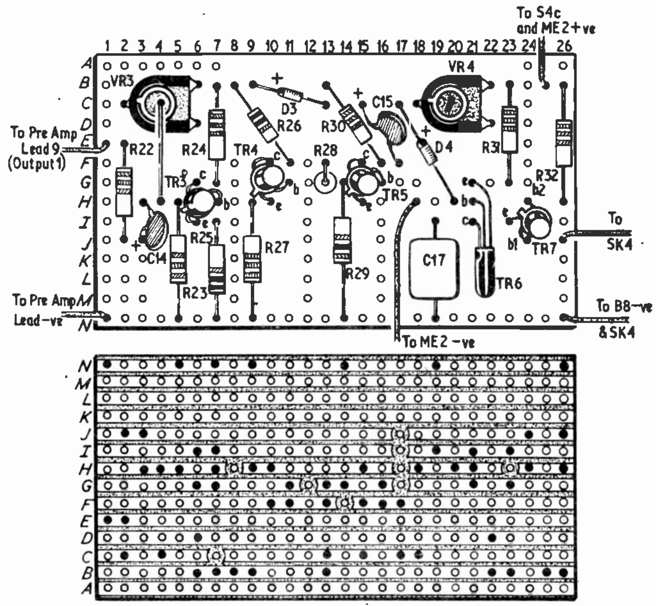


Fig. 9. Layout and wiring of the frequency meter board

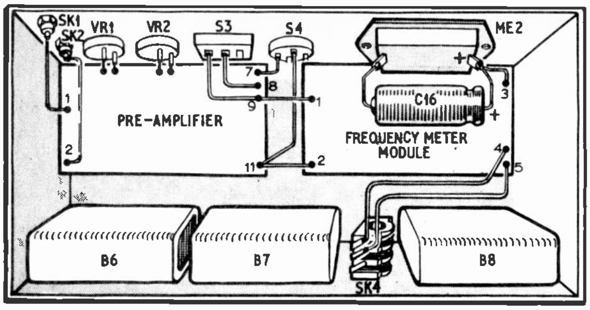


Fig. 10. Suggested layout of components for the brain rhythm frequency meter circuit shown in Fig. 8

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.

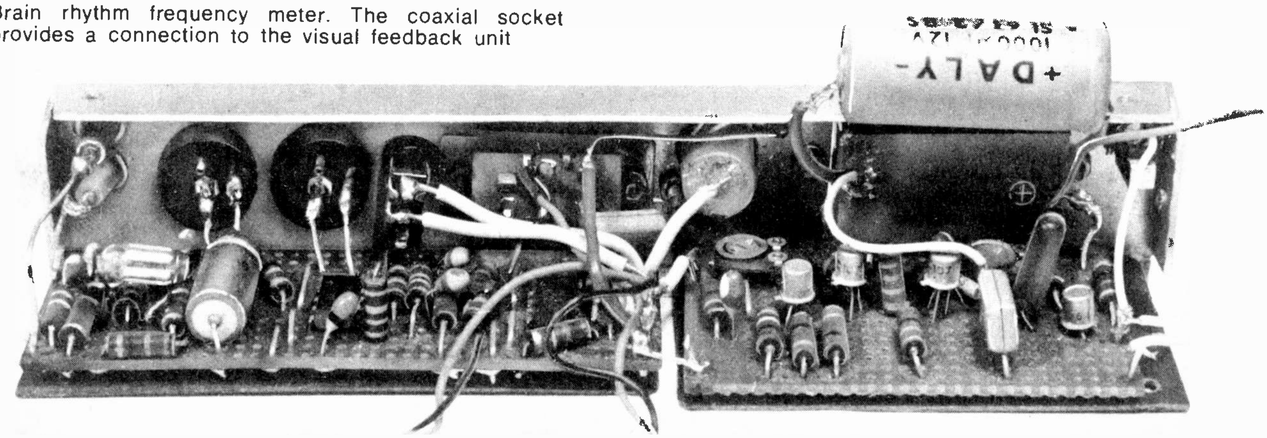
By making the heartbeat clearly audible, it is possible to detect these subtle changes, and perhaps learn to control them. This is really an example of bio-feedback. If the heart speeds up slightly in response to some unconscious stimulus, you become aware of it and seek to reduce it.

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 astable 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



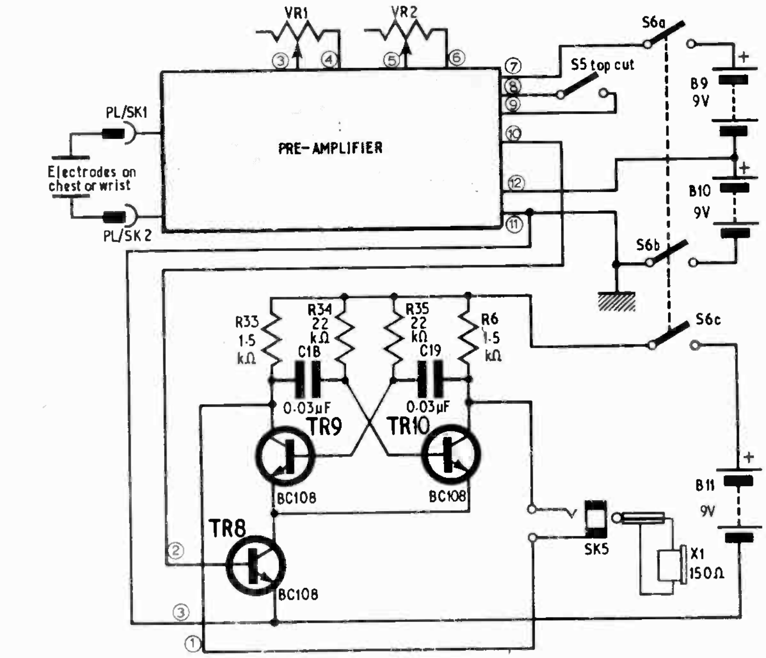


Fig. 11. The pre-amplifier used with a cardio-phone circuit

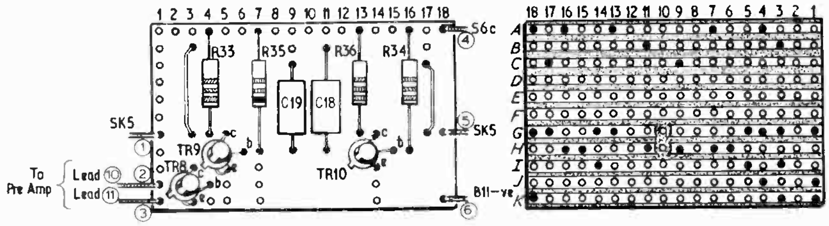


Fig: 12. Layout and wiring of the cardiophone output module

COMPONENTS . . .

ADDITIONAL COMPONENTS FOR CARDIOPHONE

Resistors
R33 1·5kΩ
R34 22kΩ
R35 22kΩ
R36 1·5kΩ
All ±10% ½ watt carbon

Capacitors
C18 0·03μF polyester
C19 0·03μF 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)

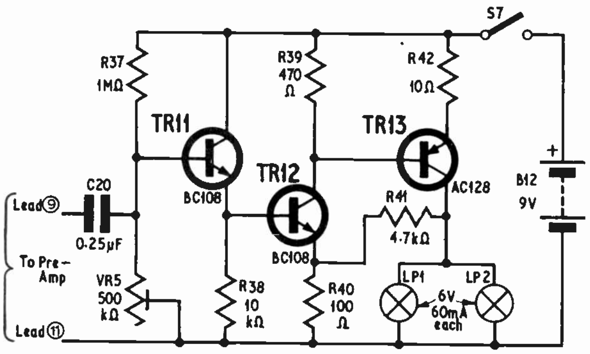


Fig. 13. Circuit of the visual feedback lamp driver

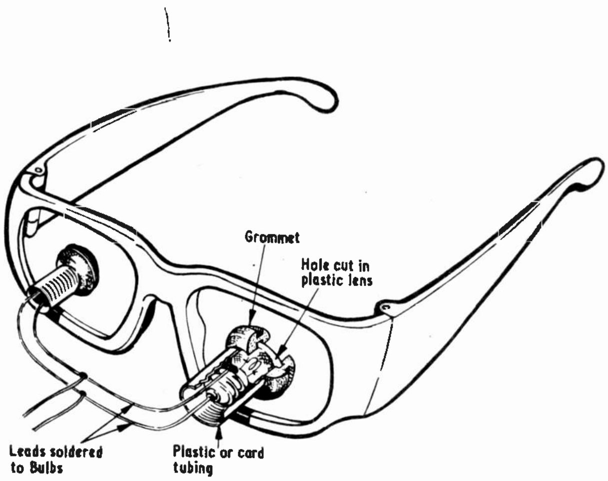


Fig. 14. The method of mounting the lamps in plastics lens sunglasses

COMPONENTS . . .

ADDITIONAL COMPONENTS FOR VISUAL FEEDBACK LAMP DRIVER

Resistors
R37 1MΩ
R38 10kΩ
R39 470Ω
R40 100Ω
R41 4·7kΩ
R42 10Ω
All ±10% ½watt 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

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.

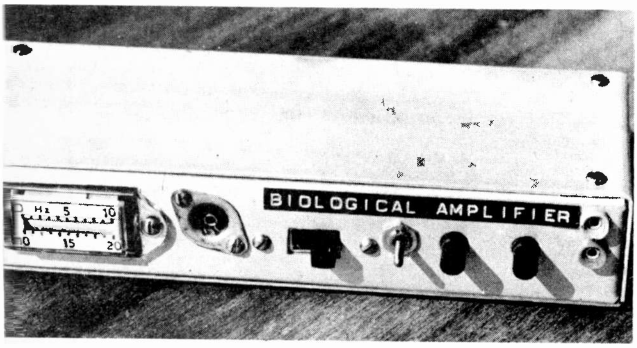
Try using the cardiophone with a friend who is driving a car. The "bleep" rate will increase when negotiating roundabouts, traffic lights, and congested streets, and will rise sharply when overtaking.

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 pre-amplifier (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 plastics lens sunglasses; see Fig. 14.

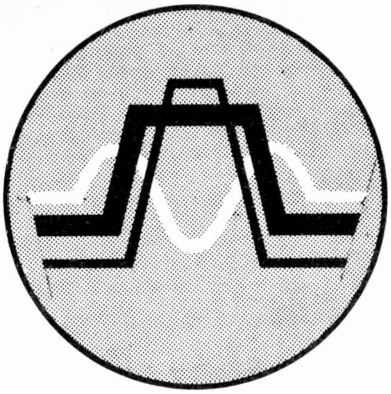
When driven by brain rhythms, visual feedback will produce an interesting variety of "strobe" effects while leaving the ears free to, say, listen to music or other sound sources.

If the lamp driver circuit is housed in a small plastics box, it can be coupled to the alphaphone, alphameter, 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. ★



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

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



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

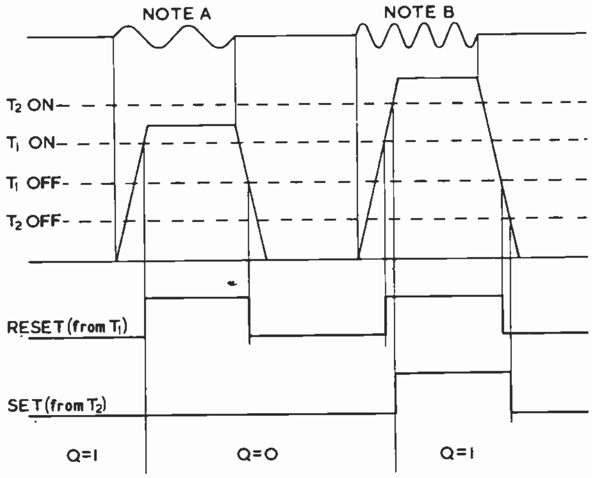


Fig. 2. Trip circuit switching levels and waveforms

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

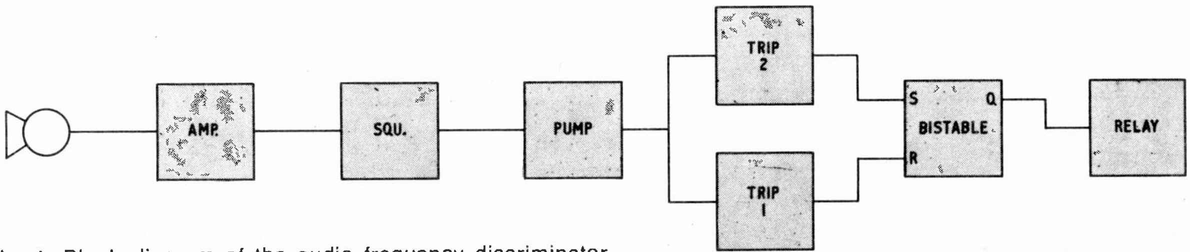
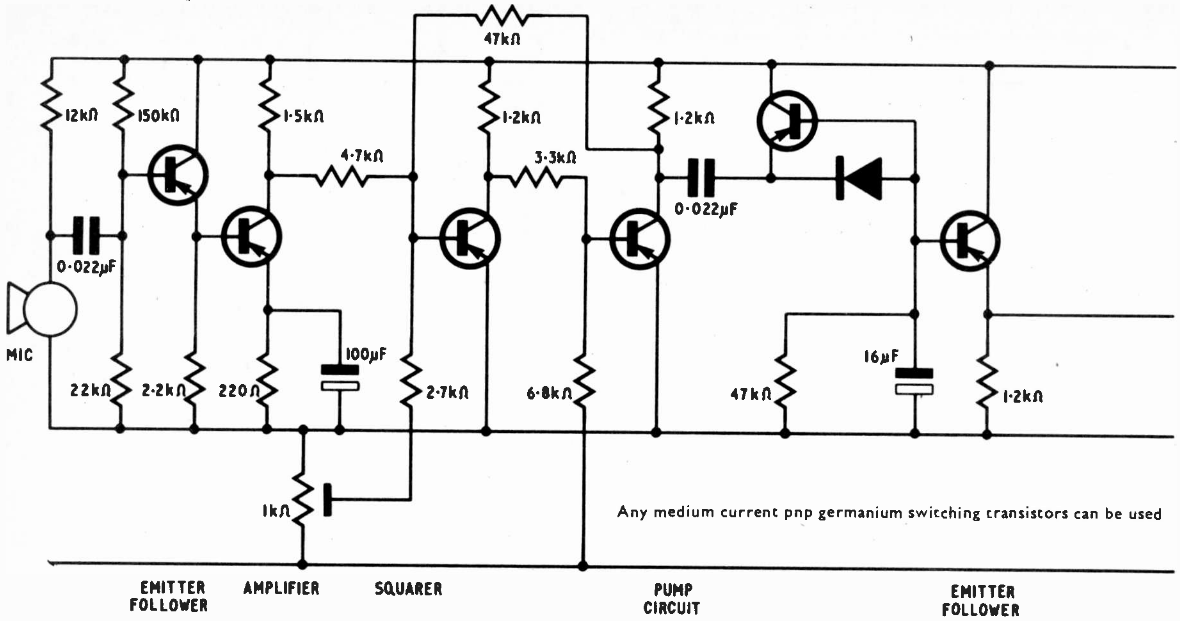


Fig. 1. Block diagram of the audio frequency discriminator

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.

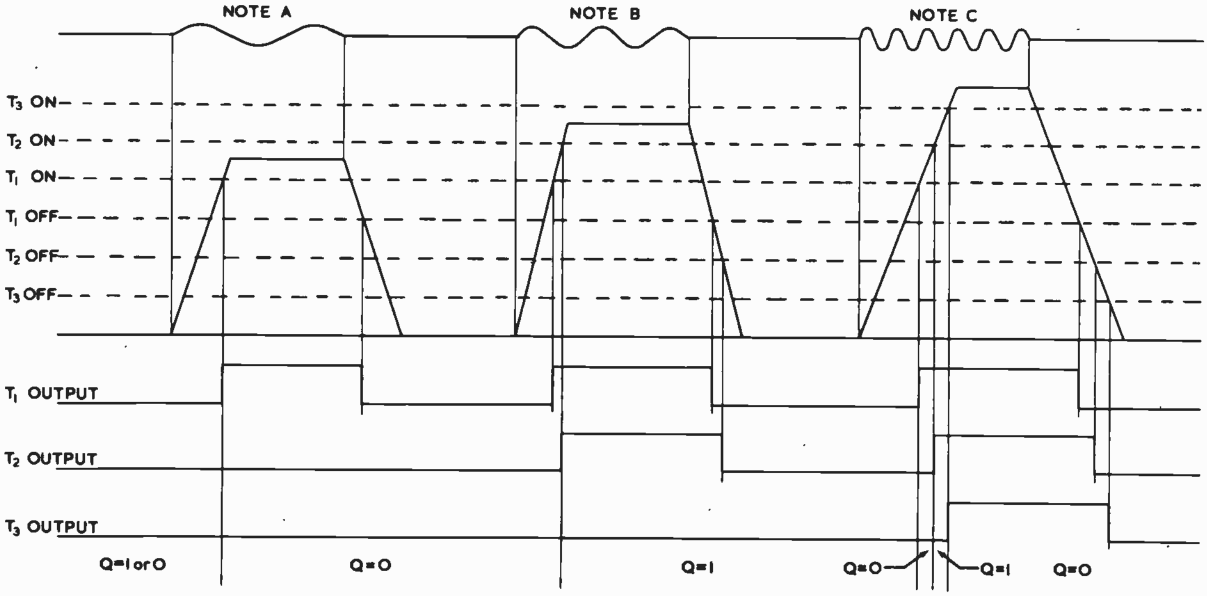
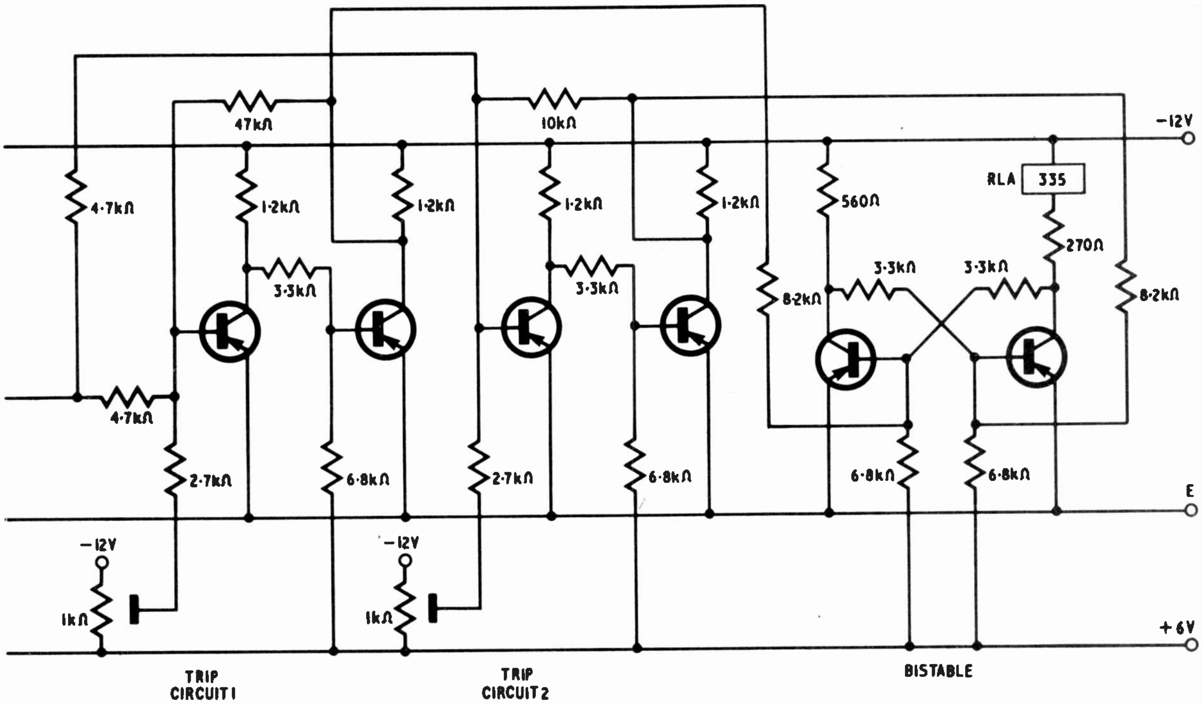


Fig. 4. Trip circuit and bistable outputs from selective discriminator



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 (0·022μF), and a transistor must be used in the place of the usual shunt diode. Adequate sensitivity then demands a fairly large shunting resistor (47 kΩ), which therefore necessitates the inclusion of an emitter follower between the pump circuit and the trip circuits.

A large value (16μF) 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	0 1 0	0 1 1 0 0	0 1 1 1 0 0 0
Trip 2	0 0 0	0 0 1 1 0	0 0 1 1 1 0 0
Trip 3	0 0 0	0 0 0 0 0	0 0 0 1 1 1 0
Bistable (Q)	Q′ 0 0	Q′ 0 1 1 1	Q′ 0 1 0 0 0 0

From this table it is easy to deduce that the reset signal for the bistable has to be $\overline{T_1}$ (the inverse of the Trip 1 output), while the set signal has to be $\overline{T_2} + T_3$ (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 deseases 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 180km². 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 habitable 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 Bamgalore. 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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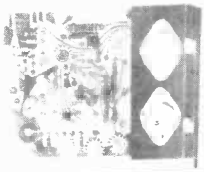

THESE THREE MODULES HAVE ENJOYED UNPARALLELED SUCCESS DURING THE FIRST FEW MONTHS' OF THEIR BEING MADE AVAILABLE TO THE GENERAL PUBLIC. WE ARE PLEASED TO ANNOUNCE THAT WE CAN NOW OFFER FAST DISPATCH ON MOST OF OUR ADVERTISED ITEMS, INCLUDING THESE THREE MODULES.

SA25 £2·95 carr. free
25 WATTS R.M.S. 7 transistors, 7 diodes

SA35 £4·45 carr. free
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SA100 £10·90 carr. free
100 WATTS R.M.S., 11 transistors, 6 diodes

ALL THREE MODULES HAVE OPEN AND SHORT CIRCUIT PROTECTION, AND THE SA100 IS PROOF AGAINST OVER-DISSIPATION AND FAULTY INDUCTIVE LOADS.

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BRIEF SPEC. FOR ALL THREE MODULES

Freq. response	15–40,000Hz ± 1dB
Distortion	0·2% at 1kHz
Loads	4 to 16 ohms
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Noise	Better than −75dB
Supply voltage	25–45V, SA25/35 40–70V, SA100
Size	4½in × 4in × 1in (SA100) 4in × 3in × 1in (SA25, SA35)

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

POWER SUPPLIES FOR THE SA25/35 and SA100 AUDIO MODULES

PS45	Stabilised module for 2 SA25's or two SA35's, £35·0, carr. free
MT45	Transformer for above, heavy duty, £2·85, carr. 20p
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PU70	Unstabilised supply for one or two SA100, £7·75, carr. 40p
PS70	Stabilised supply module for one or two SA100's, £4·90, carr. free
MT70	Transformer for PS70, £4·90, carr. 40p

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Featuring a rugged class A driver stage, this module will run from all our mixers etc., and most other makes of mixer. It delivers 120W into an eight ohm load and employs 4 TO3 can (115W) output transistors.

SPECIFICATION

Power output	120W into 8 ohms
Freq. response	20–20,000Hz ± 2dB
Input sensitivity	200mV into 10K
Construction	Fibreglass board
Size	8in × 4in × 4in (5in with supply)

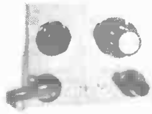
Low distortion parallel push-pull output stage.

NEW: 160 Watt version + supply **£27·90**

SINGLE CHANNEL SOUND/LIGHT CONVERTER

This compact and reliable unit operates from amplifiers with outputs from 5–100W. Does not impose a heavy load on the amplifier, or, if connected in the wrong polarity, cause any damage, as with some units.

Operation is simplicity itself and the unit is fully fused. The unit is supplied to function from bass notes but may easily be converted to respond only to treble or mid-range notes by the addition of components costing less than 5p.



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THREE CHANNEL SOUND TO LIGHT UNIT

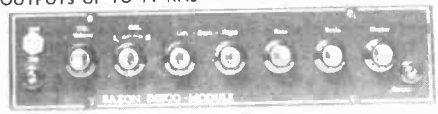
Handling the total of 3,000W (3kW) this unit is unique for its price in that not only bass middle and treble but also master controls are provided. Two amplifier sockets eliminate the need for split leads, etc. Supplied in tough white steel case with a blue stelevite hooded cover. Fully guaranteed.

£19·75 carr. 30p

SAXON STEREO CONTROL UNIT

£15·80 carr. 30p

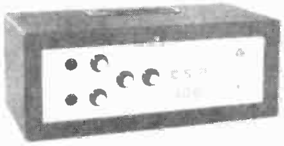
MONO VERSION **£6·50**, carr. 20p
(As illustrated below. S.A.E. details. 9V operation)
OUTPUTS UP TO 1V RMS



Two decks, and full headphone monitoring. The unit is mains operated and measures 17½in × 3in × 4in deep and is finished with a smart white on black facia. 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 DISCOTHEQUE AND IS COMPARABLE TO UNITS AT OVER TWICE THE PRICE.**

COMPLETE AMPLIFIERS

THE CS 100. £34·90 carr. free



This versatile unit is now available in a black vynide case and so represents even better value than ever, delivering speech and music powers of up to 100W R.M.S. and continuous signal outputs of 70W. Two individually controlled inputs with wide range bass and treble controls. Ideal for small groups, D.J's, etc

The SAXON 100. £48·50, carr. free.

With an R.M.S. output of 120W speech and music, 100W continuous power, four individually controlled F.E.T. input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

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12in 25W 8/15 ohms £5·95, carr. 30p; 15in 50W 8/15 ohm, £14·50, carr. 50p.
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D11DHL r.r.p. £11, our price £9·45 post free.
D190C High Z r.r.p. £21·50, our price £17·45 post free.
D1000C 24 ct. gold plate r.r.p. £37, our price £32 post free.

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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 × 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.

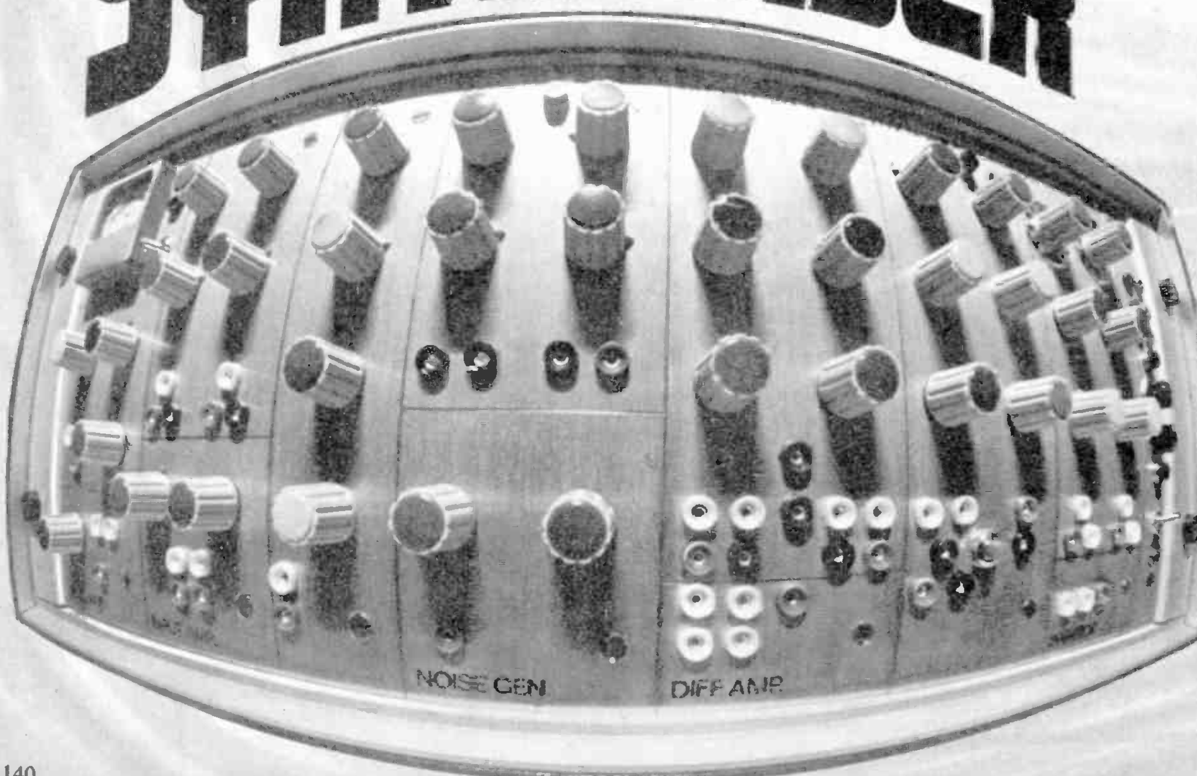
The system has been made available to the Australian Post Office for its research laboratories to evaluate the fibre's potential in the development of Australia's Telecommunications network.

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 SYNTHESISER



THE 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 indispensible 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.

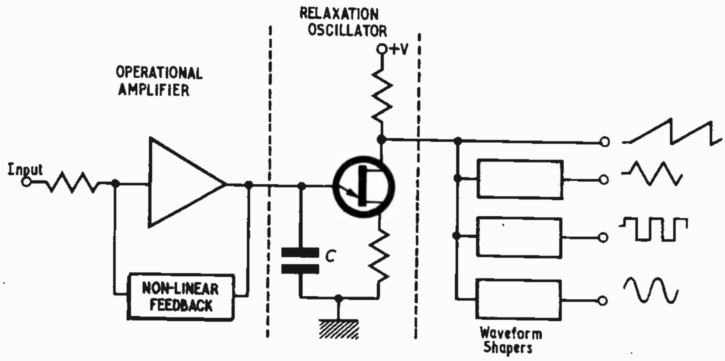


Fig. 1. Block diagram of a voltage controlled oscillator

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:

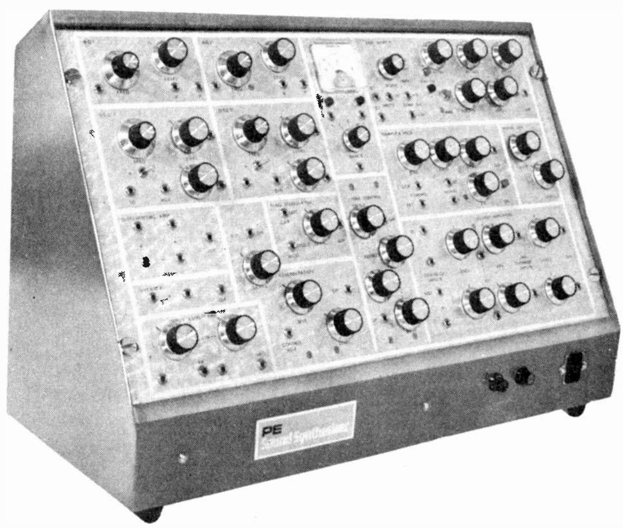
1. Signal and control paths are quite separate from one another. Thus a device may be remotely controlled without compromising the signal in any way.
2. Devices can control one another in a continuously variable manner without the necessity of complicated, expensive and limited-range switching circuits. 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.

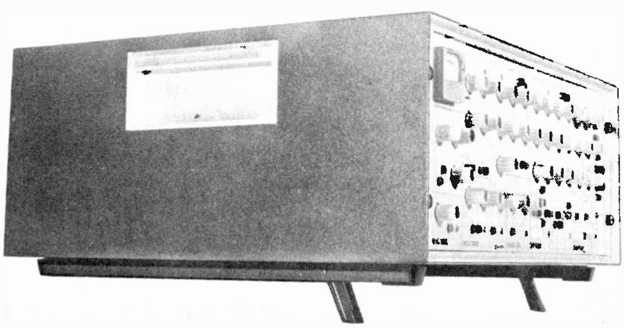
SYNTHESISER DESIGN

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 × 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 × 500mV 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.

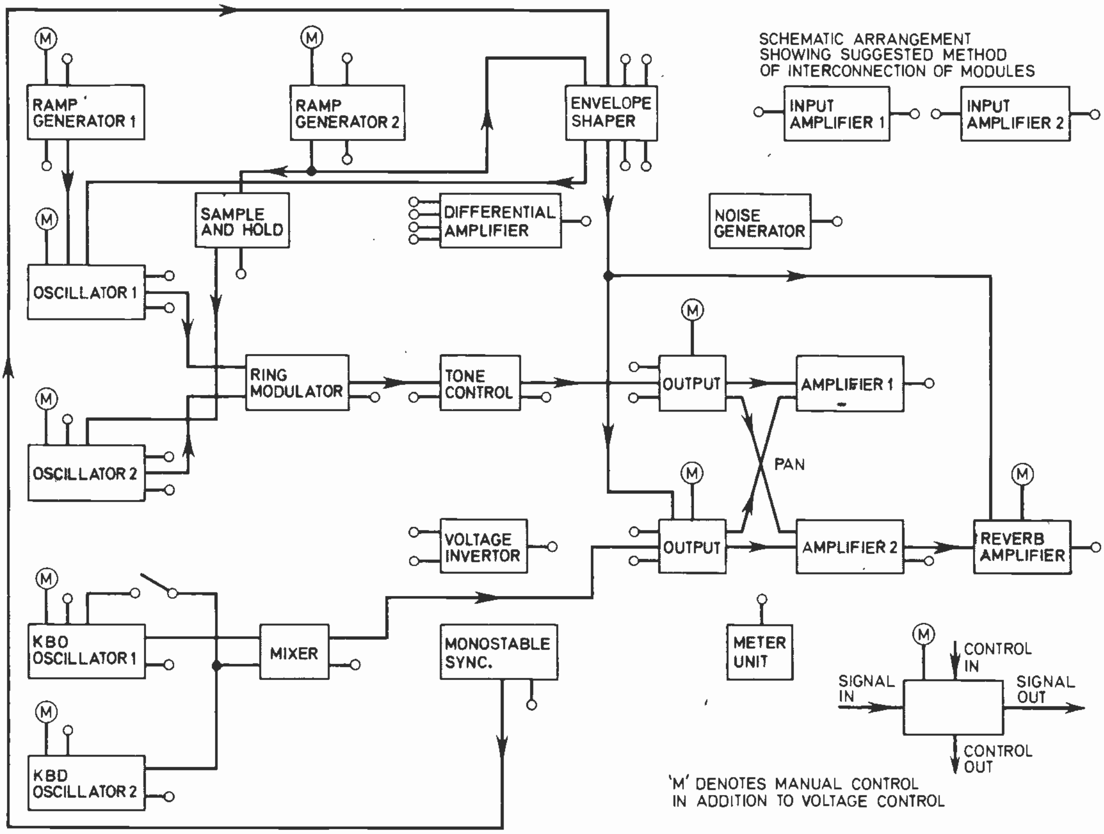


Fig. 2. Block diagram of the synthesiser

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.

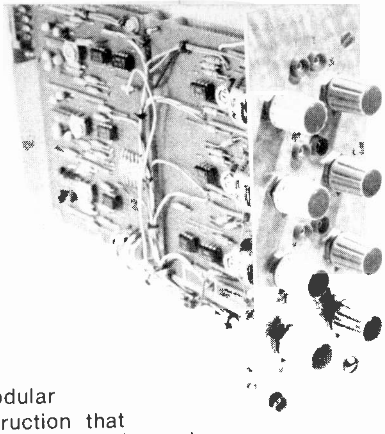
On the simpler side there is also a place for a form of tone control of sufficient range to enable extreme effects to be investigated.

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

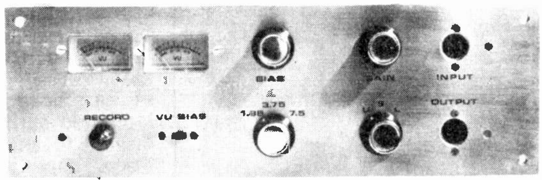
Full constructional details will be given on building the synthesiser shown and an outline specification of the instrument appears in this article.

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

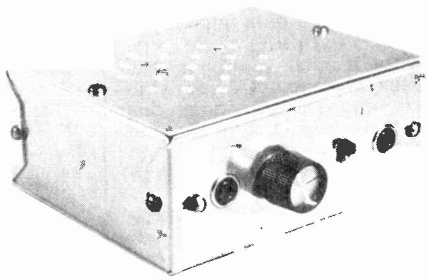


HI FI TAPE LINK....

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 $1\frac{7}{8}$, $3\frac{3}{4}$ 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 Nexus

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.

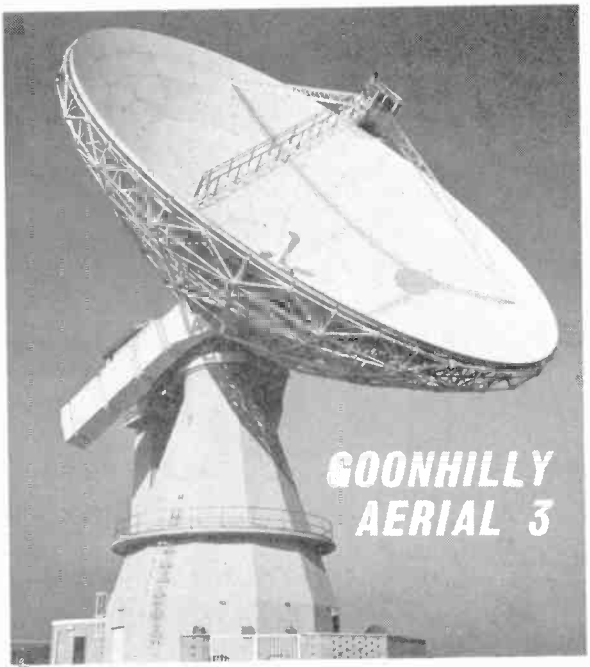
One reason for the link-up is said to be the reduction in size of Ministry R and D establishments and the farming out of work to the larger companies.

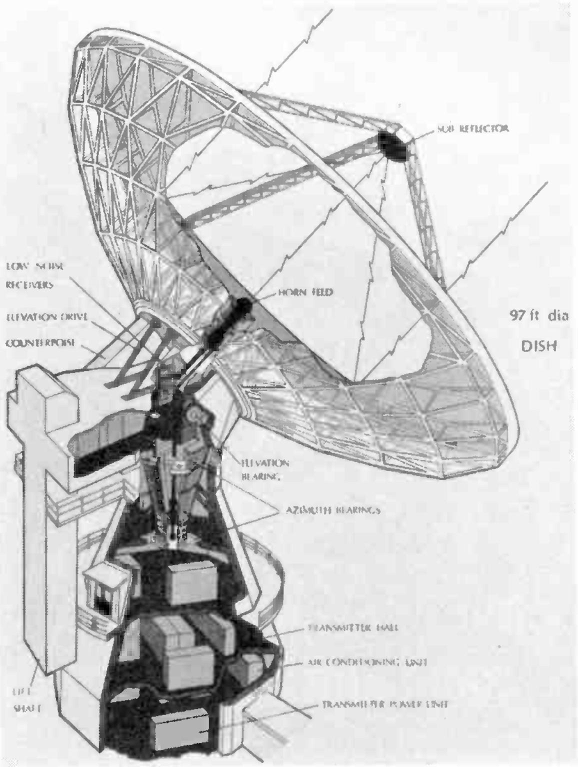
IN TRIPLICATE

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 on 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.

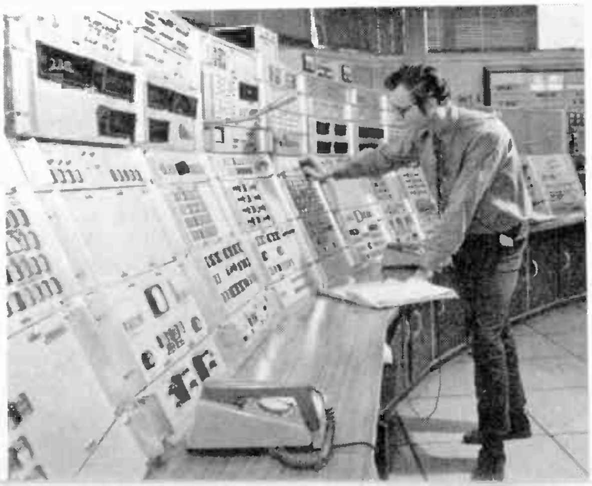
Goonhilly 3 is currently transmitting two and receiving 11 telephony carriers, although it is capable of being expanded ultimately to receive 33 carriers. The transmit carriers are radiated in the band 5·930 to 6·420GHz and received in the 3·705 to 4·195GHz band.

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*).



PE Digi-Cal

By R.W. COLES — PART 8

LOGIC AND CONSTRUCTION OF THE ADDER BOARD

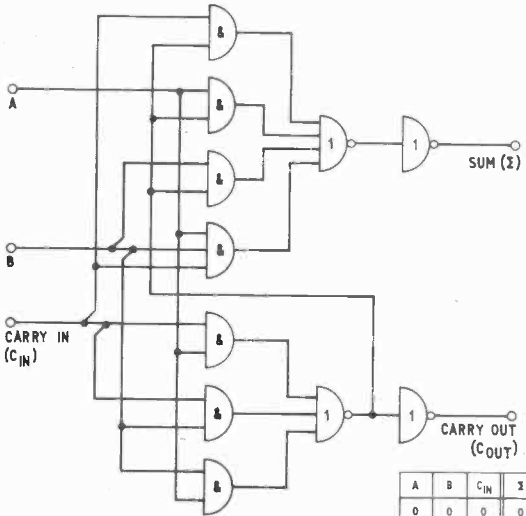
THE BOARD to be described this month is the all important ADDER board which forms the heart of the arithmetic section of the calculator. The name ADDER is a shortened name for what is really an adder/subtractor with carry store, but before going into the design of the board in detail it is necessary 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_{IN}	Σ	C_{OUT}
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

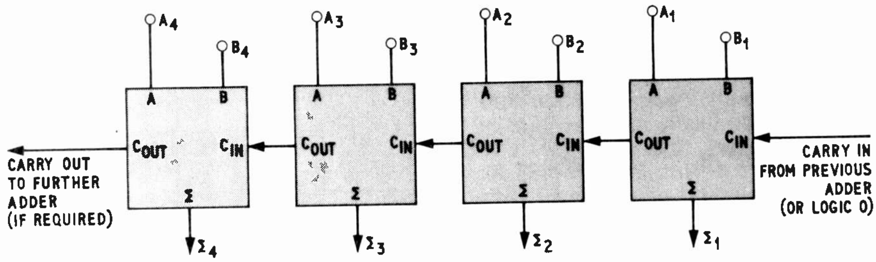


Fig. 8.2. A parallel binary adder to add two four-bit words. Each of the stages in this adder is identical to that shown in Fig. 8.1

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.

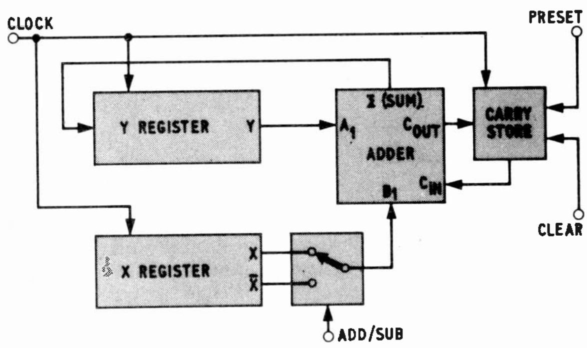


Fig. 8.3. Basic serial binary adder/subtractor. The ADD/SUBTRACT unit presents either the true or complemented output from the X REGISTER to the adder under the control of the FUNCTION CODE A signal

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 cricuit 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.

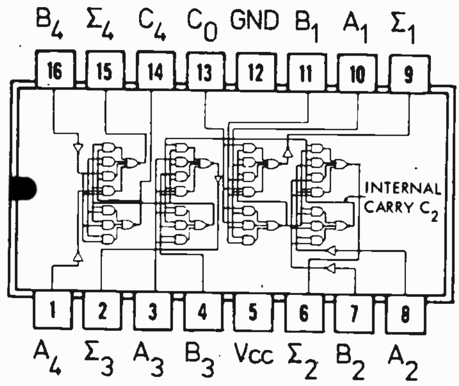


Fig. 8.4. The internal logic of the SN7483 four bit binary adder i.c.

The two four-bit words to be added to indicate the termed A and B with a suffix 1 to 4 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 }
1001 equals 9 } (In straight binary *or* B.C.D.)

01101001 in straight binary equals 105

0110,1001 in B.C.D. equals 69

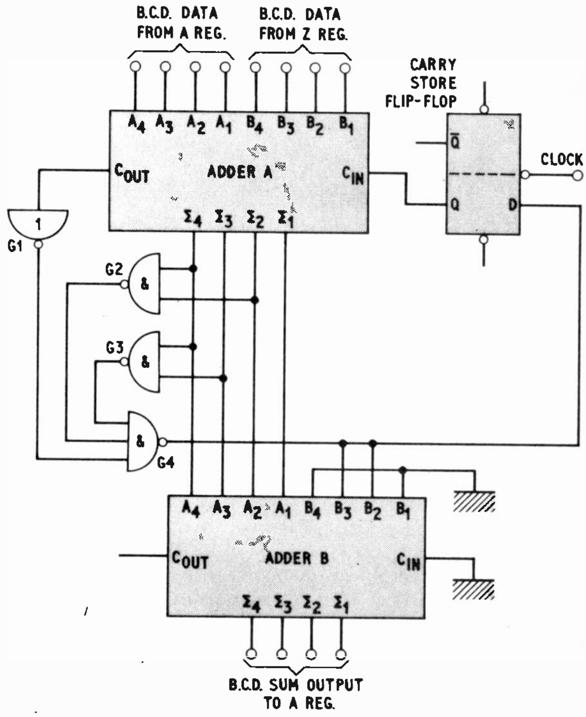


Fig. 8.5. Basic practical B.C.D. adder with a carry store flip-flop

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 Σ_1 and Σ_3 change, and can be eliminated. In the second group the terms Σ_1 and Σ_2 change, resulting in the required gating function of (Σ_2 AND Σ_4 OR Σ_3 AND Σ_4) 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 Σ_2 and Σ_4 and Σ_3 and Σ_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.

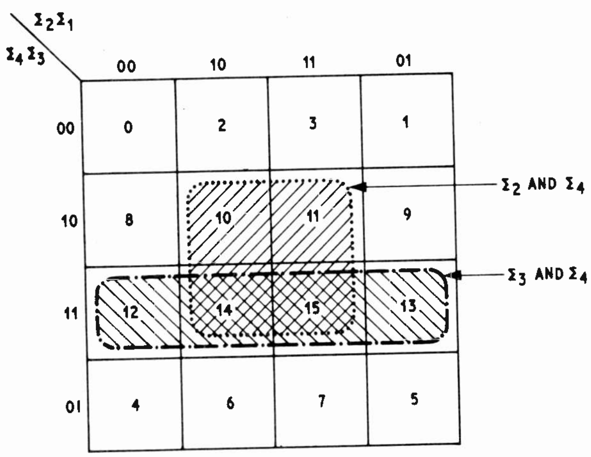


Fig. 8.6. The Karnaugh map used to determine the gating required to detect the sums from 10 to 15 inclusive

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.

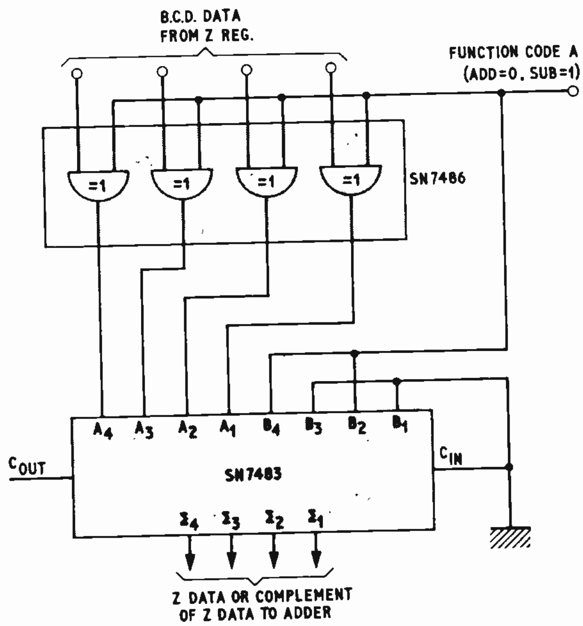


Fig. 8.7. B.C.D. nines complementer. This generates the output 9 minus Z when subtraction is required

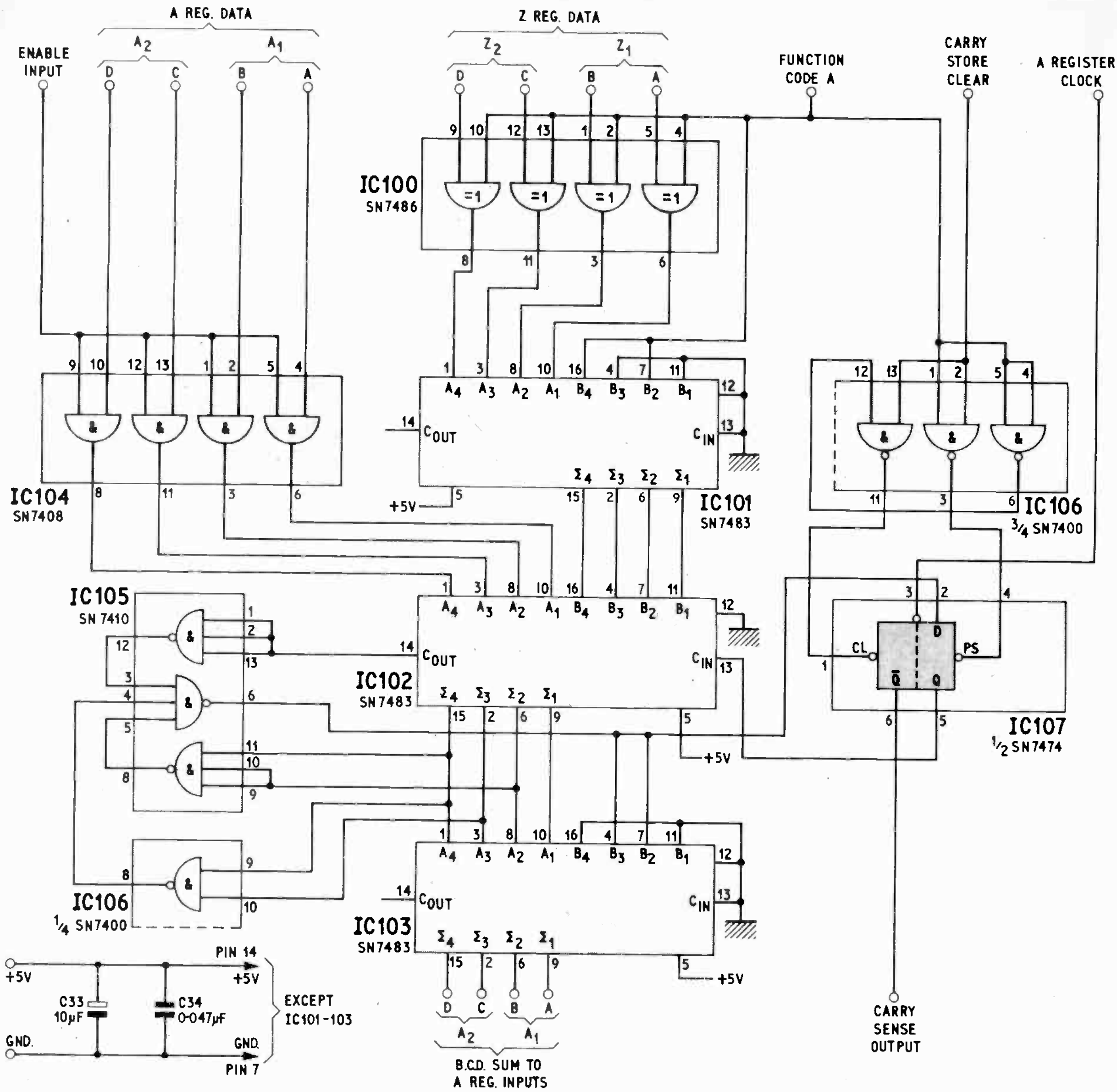


Fig. 8.8. Complete circuit diagram of the ADDER board

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 10μF 15V elect.
C34 0·047μF

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.

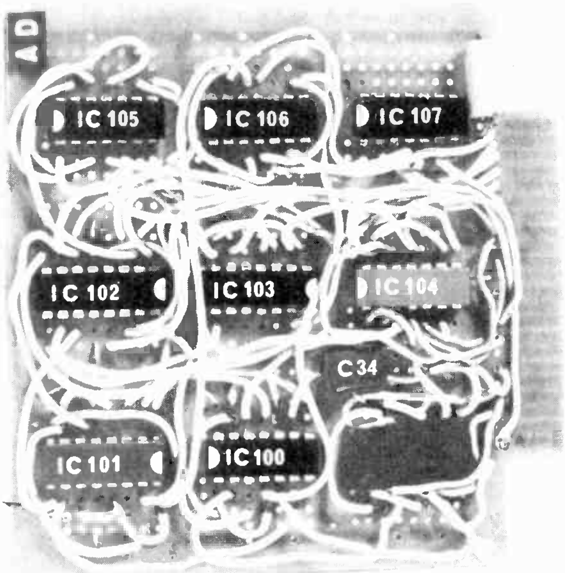
CONSTRUCTION

The construction and wiring of the ADDER board is quite straightforward since the circuit is housed on the usual Dualine 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



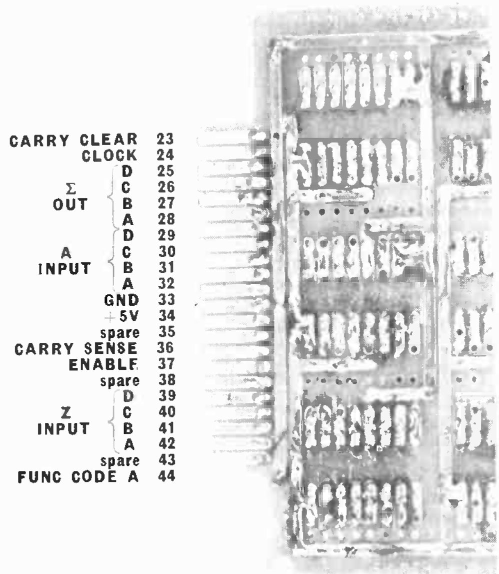


Fig. 8.9. Layout of the components on the DL109/22 printed circuit board

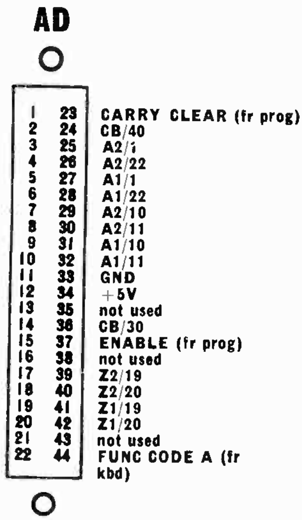


Fig. 8.10. Function of the edge contacts for the ADDER board

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 10μF not 22μF

Next month: Programme Board

NEWS BRIEFS

COMPUTER '72

Taking 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 nuumber 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

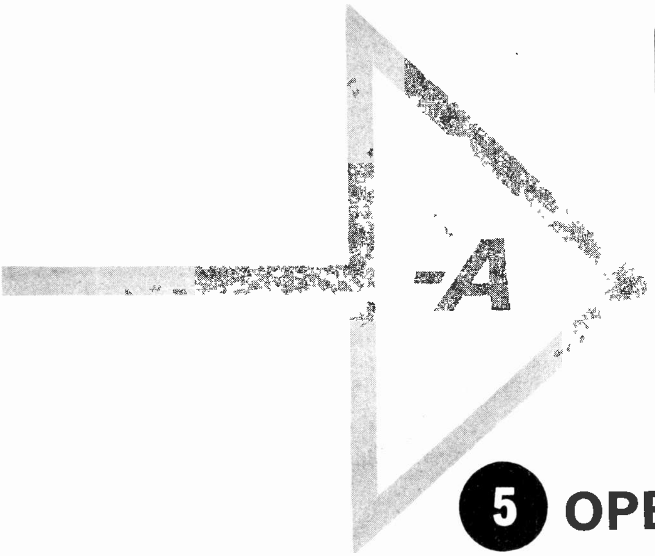
A NON-IPACT printer capable of writing 1,000 lines per minute is being developed by R.C.A. for the U.S. Army. The new printer uses a laser to transfer digital communications alphanumerics onto ordinary paper.

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.



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).

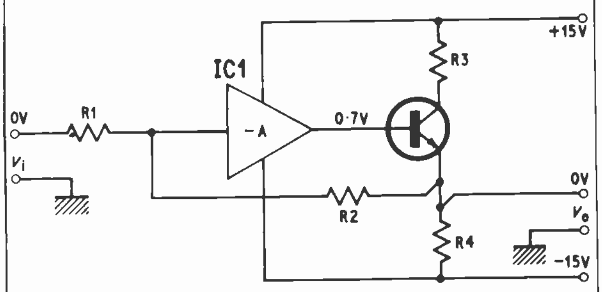


Fig. 5.1. An operational amplifier with a class-A emitter follower output

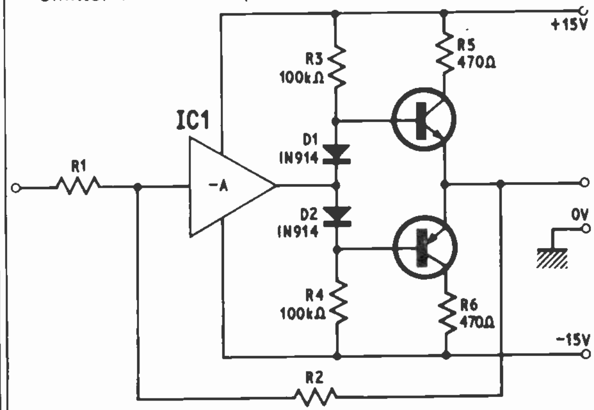


Fig. 5.2. An operational amplifier with a class-B output stage

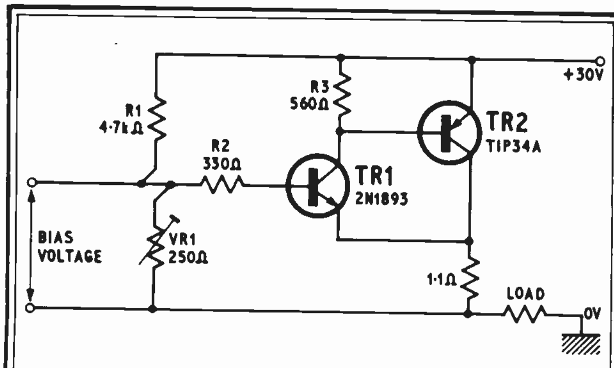


Fig. 5.3. One section of a class-B, unity gain, high current, output stage

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 ouput 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

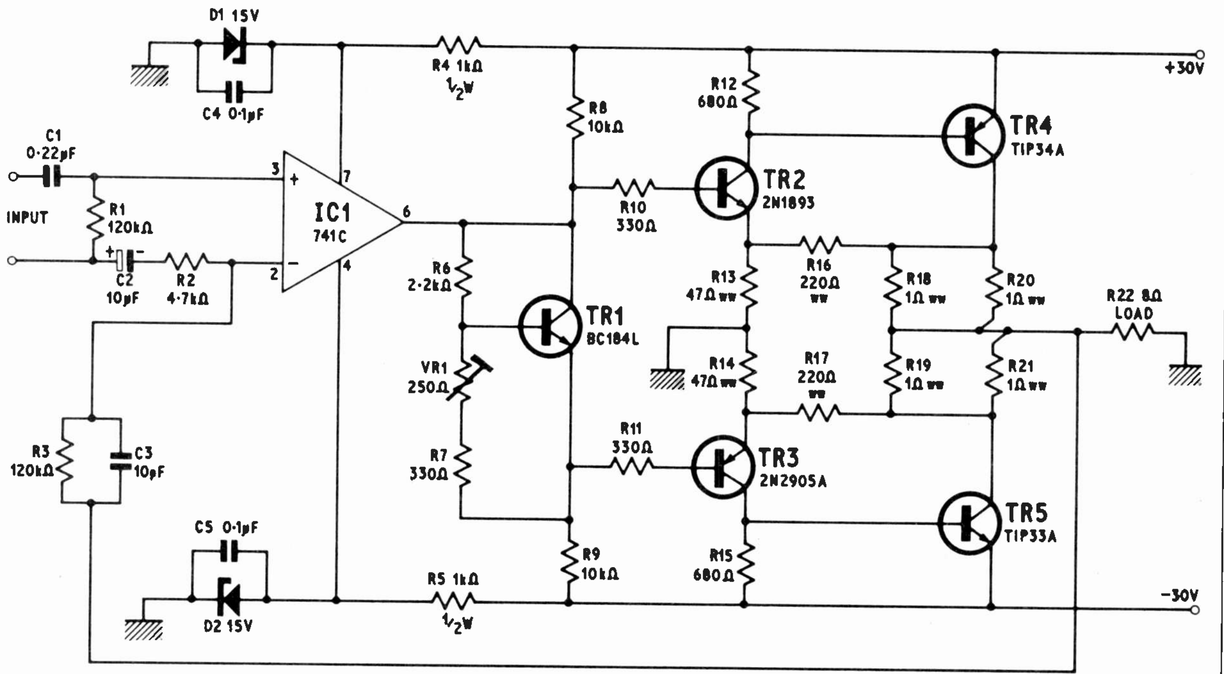


Fig. 5:4. Complete circuit for a 30 watt power amplifier using an instrumentation approach

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2G371	0·22
2G381	0·25
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2G417	0·22
2N404	0·20
2N697	0·15
2N698	0·40
2N706	0·10
2N706A	0·12
2N708	0·15
2N709	0·63
2N1091	0·33
2N1131	0·25
2N1132	0·25
2N1302	0·18
2N1303	0·18
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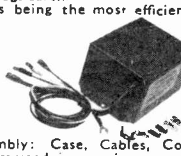

Kit includes absolutely everything for assembly: Case, Cables, Coil Connectors, Silicon Grease, etc. 8 page illustrated instructions cover fitting of all types of tachometers. Call in for a workshop demonstration. S.A.E. all enquiries please, or Phone 33652. (Many letters from satisfied customers.)
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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

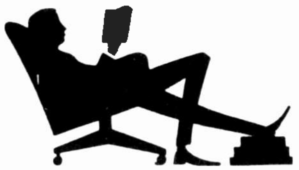
It is essential that the 10μF capacitor is a low leakage tantalum type because if a leakage current flows through this component there will be a d.c. offset at the output which could cause a quiescent current to flow in the load.

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 × 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. 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 × 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) × 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.

BP 1 280 117

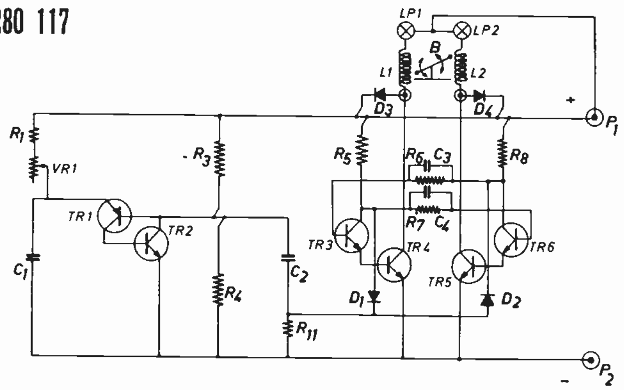


Fig. 1

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 Spartanics Limited, of Illinois, USA, in BP 1 280 311) the overall results have been poor.

In this new British patent Spartanics 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 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.

BP 1 280 311

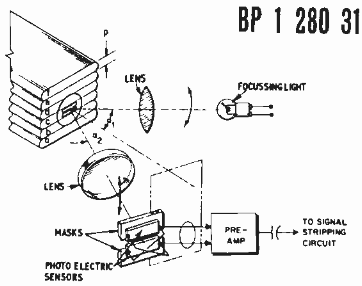


Fig. 1

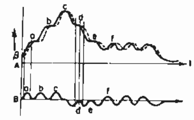


Fig. 2

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.

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

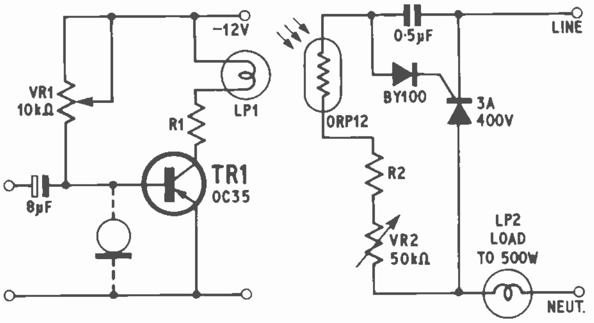


Fig. 1. Circuit diagram of the sound/light modulator. The value of R2 was found to vary between 15 to 27 kilohms according to the load

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.

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 ½in 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.

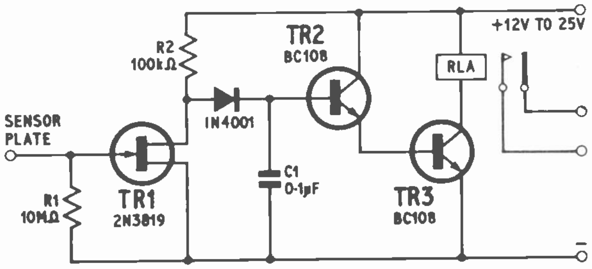


Fig. 1. Circuit diagram of a simple proximity switch

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 Ebberns 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.

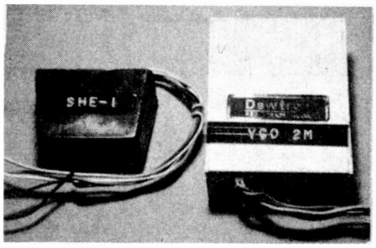
Included with the catalogue is a price supplement which will be updated from time to time and each page will have the date stamped on it. At the bottom of the price supplement is a note to the effect that "when the supplement is six months old 10 per cent should be added to any item purchased and a new 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 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.



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

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

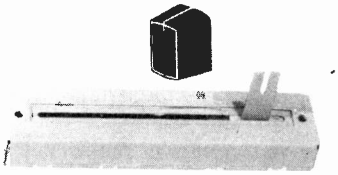
Whilst on the subject of effects units we often get requests for the slider type of controls which are used extensively in effects units. To, date, these type of controls have been difficult for the home constructor to obtain and a compromise has had to be made by using standard rotary potentiometers.

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.

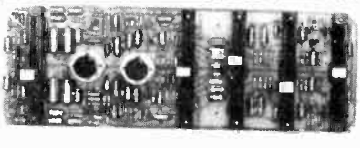
The cost of the sliders are expected to be 61p for single gang types; and 81p for double gang. The mounting plates will cost 25p for single-way, 36p for double-way and 45p for three-way.

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



Slider control from DJ Electronics

PCB'S FROM PHONOSONICS



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PCB's designed by Phonosonics except where stated otherwise

DESIGNS PUBLISHED IN P.E.

AURORA (Apr./Aug. 71) Multichannel Sound Controlled Light
S/c's (excl. SCRs), 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.), unstabilised, £2·85; stab., £3·65. PCB (4½in × 11in) for Pre-amp and 4 Chans. incl. all pots, £2·35. PCB (4¼in × 6½in) for PSU, Sync Gen, 8 cores, 8 SCRs, £1·35.

A.F. SIGNAL GENERATOR (Nov. 72)
S/c's, Rs, Cs, Pots, Sw's **£2·25**. PCB (2½in 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 × 7¾in) 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 × 3½in), **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 PCBs
Pre-Amp—S/c's, Cs, Pots, Maka-Sw's—with ½W 2% M.O. Rs, **£13·45**—with ½W 5% C.F. Rs, **£11·20**.—with ¼W 5% C.F. Rs, **£10·75**.—with Slider Pots and Knobs extra, **£1·65**. PCB (3½in × 10¾in) for kits with ½W M.O. or ¼W C.F. Rs. Holds pots and Maka-Sw's, **£2·10**. Main Amp—Rs, Cs, Pots, **£4·30**. PCB (3½in × 5in), **£1·40**. PSU—Rs, Cs, Pot, **£3·70**. PCB (2in × 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 requ.) 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 requ.) 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 (3¾in × 4½in)—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 (3½in × 5½in) also holds pots, relay, Keyswitch, **£1·20.**

SOUND SYNTHESISER—Details on request.

TAPE NOISE LIMITER (Feb. 72)—Mono Circuit
S/c's, Rs, Cs, Pot, PCB (1½in × 3in), **£2·20**. Regulated Power Supply (will feed 2 units) and PCB (1½in × 2½in), **£3·20.**

ULTRASONIC TRANSMITTER-RECEIVER (May 72)
Rs, Cs, Pot, S/c's, T/ducers, Relay, **£9·95**. Dual PCB (2in × 5½in), **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, Keyswitch, **£8·85**. PCB (5¾in × 5¾in) also holds Pots, Sw, T/former (T/T7), **£1·50**. Slider Pots and Knobs (excl. 2SR 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 × 11¼in) 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 (2½in × 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 (3½in × 7½in) (Stereo)—also holds all pots and Maka-Sw., **£1·50.**

I.C. 2·7W STEREO AMPLIFIER (Radio Constructor July 71)
Rs, Cs, Pots, I.C's complete with heatsinks, **£7·50**. PCB (4½in × 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 (3¾in × 5¾in) holds all generators plus pots, **£1·35.**

THYRISTORS (400V P.I.V.)
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8in × 5in 3, 8 & 15 ohms	1·30
7in × 4in 3 & 8 ohms	1·05
FANE 8in 8 ohm, dual cone	2·30
CELESTION 8in 15 ohm	1·50
GOODMANS 10in × 6in 3 ohm	1·60
BAKER GROUP 25 12in 25W 8 or 15 ohm	5·75
Postage 25p per speaker	
2¾in 8 or 64 ohm P.P. 10p	50

Kit-form cabinets, teak
(17in × 10in × 6in) 2·75
with a 13in × 8in or 8in cut out
(12in × 12in × 6in) with a 8in × 5in or 8in cut out. 2·25
(please specify cut out)
Add 35p per Cabinet for post & packing

Microphone Bargains	**£p**
MIC45 "ACOS" metal case, crystal hand	95
CM 20 Crystal Hand	45
DX143 Dynamic, cassette-type stick	1·00
MIC60 "ACOS" stick crystal	1·00
CM70 PLANET stick metal, switch crystal	1·45
DM160 Dynamic uni-dir, ball metal	3·75
UD130 50K/600 ohm uni-dir, ball metal	4·50
TW209 Lesson dual imp ball metal uni-dir	5·75
Guitar mike	45
Lapel type, crystal	40
Postage 17p each	

Stereo Headphones
De-Luxe finish 8-16 ohm matching imp. mono/stereo switch complete with lead and stereo jack plug only **£2·75** (P. & P. 25p).

Cartridges—with standard fittings & stylii	**£p**
ACOS GP91/28C or GP91/38C stereo compatible	1·05
ACOS GP94 stereo ceramic	1·90
ACOS GP95 stereo crystal	1·35
9THAC Sonotone stereo ceramic (diamond)	2·00
ACOS GP67/2C mono crystal	65
ACOS GP101 compatible crystal	75
19-TI Sonotone stereo crystal	90p
Postage 5p per cartridge	

Amplifier Modules
One valve chassis amplifier for record player, 2W output, volume control and tune control, on/off switch, **£3·50** (P. & P. 25p).
3W mono audio module (transistorised), **£2·50** (P. & P. 10p).
15W mono audio module (transistorised), **£3·95** (P. & P. 10p).
3W stereo module (1½in watt/channel), **£3·75** (P. & P. 10p).
5W stereo module (2½in. watt/channel), **£5·50** (P. & P. 15p)

NO STEREO PHONO SOCKET?
Headphone adaptor only **£1·35** (P. & P. 10p).

Tapes—"MYLAR" base finest quality British made.

5in	600ft	**36p**	5¾in	1800ft	**85p**
5in	900ft	**45p**	7in	1200ft	**55p**
5in	1200ft	**60p**	7in	1800ft	**80p**
5¾in	900ft	**49p**			
5¾in	1200ft	**55p**	7in	2400ft	**95p**

Postage 9p each

THIS MONTH'S SPECIAL OFFER
Converts your battery operated radio or cassette recorder to mains. "Binatone Battery Eliminator" 230V in 6V or 9V out., only **£1·99** (P. & P. 10p).

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SEND 25p FOR COMPLETE CATALOGUE

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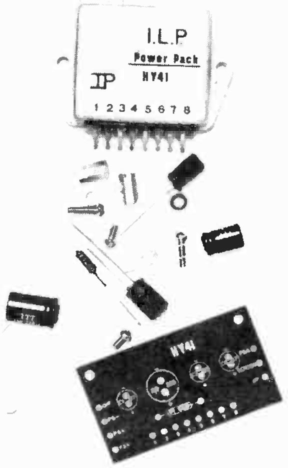


THE HY41

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.

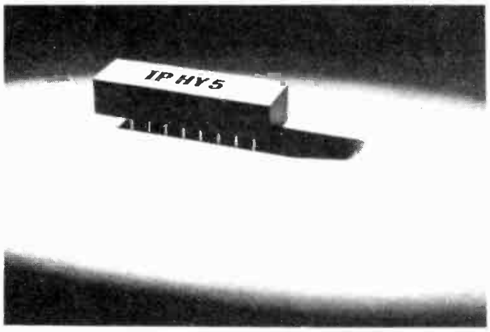
Like its predecessor the HY41 is based on conventional and proven circuit techniques developed over recent years.

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 ± 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 intergrated system.

INPUTS
Magnetic Pick-up (within ±1db RIAA curve) 2mV. 47K Ω
Tape Replay (external components to suit head). 4mV. 47KΩ
Microphone (flat) 10mV. 47KΩ
Ceramic Pick-up (equalized and compensatable) 20–2000mV. variable.
Tuner (flat) 250mV. 100K Ω
Auxiliary 1 250mV. 47K Ω
Auxiliary 2 2–20mV. 100K Ω

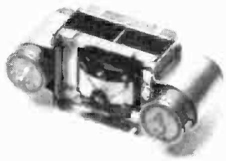
OUTPUTS
Main Pre-amp output 500mV.
Direct tape output 120mV.

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

SUPPLY CURRENT
6mA approx.
OVERLOAD CAPABILITY
better than 26db on most sensitive input infinite on tuner and auxl.
OUTPUT NOISE VOLTAGE: 0.5mV.

PRICE: **MONO: £3.60** **STEREO: £7.20**

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: ± 22.5 Volts at 2 amps.
Overall Dimensions: L. 7"; D. 3.8"; H. 3.1"

PRICE: **£4.50 inc. P. & P.**

CROSSLAND HOUSE · NACKINGTON · CANTERBURY · KENT

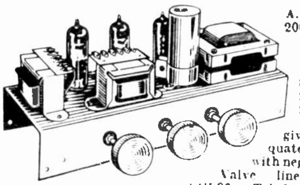
CANTERBURY 63218

SUPERSOUND 13 HI-FI MONO AMPLIFIER

A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz—30KHz ± 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 × 6in wide × 7½in deep. A.C. 200/250V.

PRICE £10·50 P. & P. 25p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200–240 volts. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:—2 · ECL86 Triode Pentodes. 1 EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w · 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £8·92.** P. & P. 45p.

NEW! POWER SUPPLY UNIT

200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7½V and 9V and 12V at 1 amp continuous (1½ amp intermittent).
Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" · 3½" · 2½". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

PRICE £4·50 P. & P. 35p.

BLACK ANODISED 16g. ALUMINIUM HEAT SINKS. For TO3, complete with mica's and bushes. Size 2¾in × 3in approx. 25p pair. P. & P. 5p.

LIMITED NUMBER! COILED SPRING BACK TELEPHONE CABLE. Closed approx. 10", extends to 36". 4 core or 6 core. 25p each. P. & P. 5p. 5 or more post free.

SPECIAL OFFER! MAINS TRANSFORMER. 200/240V A.C. input. 35V at 1½ amp A.C. output. Overall size 2½" × 2¼" · 3" approx. Suitable for drop through or vertical mounting. 90p. P. & P. 30p.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-0-10, 20-0-20, 30-0-30V, at 2 amps full wave. Size 3inL 3½inW × 3inD. Price £1 85. P. & P. 30p.

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V. Sec. 9-0-9 at 500mA. 85p. P. & P. 13p.
Pri. 200/240V. Sec. 12-0-12 at 1 amp. 95p. P. & P. 13p.
Pri. 200/240V. Sec. 10-0 10 at 2 amp. £1 45. P. & P. 30p.

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U. Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 1½ × 1¼ × ½in. Brand new — complete with instructions. Price 88p. P. & P. 13p.

HANDBOOK OF TRANSISTOR EQUIVALENTS and SUBSTITUTES

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

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.
LATEST B.S.R. C109/C129 4-SPEED AUTOCHANGER. With latest mono compatible cartridge £6·97. Carr. 50p. With stereo cartridge £7·97. Carr. 50p.

SPECIAL BARGAIN OFFER!
PRECISION ENGINEERED PLINTHS

Beautifully constructed in heavy gauge "Colorcoat" plastic coated steel. Resonance free. Designed to take Garrard 1025, 2000, 2025TC, 2500, 3000, 3500, 5100, SP25 II and III, SL65B, AT60, etc., or B.S.R. C109, C129, A21, etc. Black leatherette finish. Size 12¾in × 14¼in × 3¼in high (approx. 7¼in high, including rigid smoked acrylic cover). P. & P. 35p. **NOW ONLY £4·50**

LATEST ACOS GP91/1SC Mono Compatible Cartridge with t/o stylus for LP/EP/78. Universal mounting bracket. £1 50. P. & P. 8p.

SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. ONLY £2·50. P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. £3. P. & P. 10p.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. £1·63. P. & P. 10p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono or stereo records on mono equipment. £1·50. P. & P. 10p.

QUALITY RECORD PLAYER AMPLIFIER MK II
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. · 3 d. · 6 h. Ready built and tested. PRICE £3·95. P. & P. 40p. ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit cabinet below. PRICE £5·25. P. & P. 50p.

DE LUXE QUALITY PORTABLE R/P CABINET MK II
Uncut motor board size 14½ · 12in., clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD changer or Single Player (except AT60 and SP25). Size 18 × 15 × 8in. PRICE £4·75. P. & P. 50p.

SPECIAL OFFER!!
HI-FI LOUDSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16½in high × 10¼in wide · 5½" deep. Fitted with E.M.I. Ceramic Magnet 13in · 8in bass unit, two H.F. tweeter units and crossover. Power handling 10W. Available 3, 8 or 15 ohm impedance.

Our Price £8·40 Carr. 65p.

CABINET AVAILABLE SEPARATELY £4·50. Carr. 60p.
Also available in 8 ohm with EMI 13in × 8in. bass speaker with parasitic tweeter. £6·50. Carr. 65p.

LOUDSPEAKER BARGAINS
5in 3 ohm £1·05, P. & P. 15p. 7 × 4in 3 ohm £1·15, P. & P. 20p. 10 × 6in 3 or 15 ohm £1·90, P. & P. 30p. E.M.I. 8 × 5in 3 ohm with high flux magnet £1·62, P. & P. 20p. E.M.I. 13½ × 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm £3·20. P. & P. 30p. E.M.I. 13 × 8in, 3 or 8 or 15 ohm with two inbuilt tweeters and crossover network £4·20. P. & P. 30p.

BRAND NEW. 12in 15w H/D Speakers, 3 or 15 ohm. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £6·75. Guitar models: 25w £6 75. 35w £8·50. P. & P. 38p each.

SPECIAL OFFER!

LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUDSPEAKERS. With large ceramic magnet and plasticised cone surround. 8 ohm impedance. £2·75. P. & P. 25p.

12in "RA" TWIN CONE LOUDSPEAKER
10 watts peak handling. 3, 8 or 15 ohm, £2·20. P. & P. 30p.

35 ohm SPEAKERS 3". ONLY 63p. P. & P. 13p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾in × 14¼in × 1⅜in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20kHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. Only £5·95 each. P. & P. 25p.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54in. wide. Usually £1·75 yd., our price 75p yd. length. P. & P. 15p per yd. (min. 1 yd.). S.A.E. for samples.

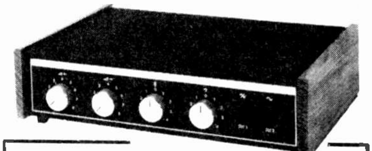
HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30–15,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. PRICE £2·95. P. & P. 15p.

HIGH IMPEDANCE CRYSTAL STICK MIKES. OUR PRICE £1·05. P. & P. 8p.

CENTRE ZERO MINIATURE MOVING COIL METER. 100μA for balance or tuning. Approx. size 1in · 1in · ⅞in. Limited number 75p. P. & P 10p.

HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED FIBRE GLASS PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled fibre glass printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12-30,000Hz. Sensitivity better than 80mV into 1MΩ. Full power bandwidth ± 3dB 12-15,000Hz. Bass boost approx. to + 12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1·0 amp. Overall size 12" wide 8" deep · 2½" high.
Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

PRICES AMPLIFIER KIT, £10·50 P. & P. 15p.
(Magnetic input components 30p extra)
POWER PACK KIT, £3 P. & P. 30p.
CABINET, £3 P. & P 30p.
(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, £20·50. Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMPLIFIER HA34 MK II

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in w. · 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £4·95. P. & P. 35p.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £4·10. P. & P. 40p.

HARVERSON'S SUPER MONO AMPLIFIER
A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide 3in. deep 6in. high overall. AC mains 200/240V. Supplied absolutely Brand New, completely wired and tested with good quality output transformer.
OUR ROCK BOTTOM BARGAIN PRICE **£2·95** P. & P. 35p

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 13p (Free with parts). **All parts sold separately.** ONLY £7·97. P. & P. 55p. Also available ready built and tested £10·97. P. & P. 60p.

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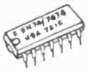

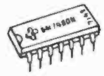

Type	1/11 p	12/24 p	25/99 p
SN7400	0·20	0·18	0·16
SN7401	0·20	0·18	0·16
SN7402	0·20	0·18	0·16
SN7403	0·20	0·18	0·16
SN7404	0·20	0·18	0·16
SN7405	0·20	0·18	0·16
SN7406	0·30	0·27	0·25
SN7407	0·30	0·27	0·25
SN7408	0·20	0·19	0·18
SN7409	0·45	0·42	0·35
SN7410	0·20	0·18	0·16
SN7411	0·23	0·22	0·20
SN7412	0·42	0·40	0·35
SN7413	0·30	0·27	0·25
SN7416	0·30	0·27	0·25
SN7417	0·30	0·27	0·25
SN7420	0·20	0·18	0·16
SN7422	0·48	0·44	0·40
SN7423	0·48	0·44	0·40
SN7425	0·48	0·40	0·35
SN7427	0·42	0·39	0·35
SN7428	0·50	0·45	0·42
SN7430	0·20	0·18	0·16
SN7432	0·42	0·39	0·35
SN7433	0·70	0·61	0·44
SN7437	0·65	0·60	0·50
SN7438	0·65	0·60	0·50
SN7440	0·20	0·18	0·16
SN7441AN	0·75	0·72	0·70
SN7442	0·75	0·72	0·70
SN7443	1·00	0·95	0·90
SN7445	2·00	1·75	1·60
SN7446	2·00	1·75	1·60
SN7447	1·75	1·60	1·45
SN7448	1·75	1·60	1·45

Type	1/11 p	12/24 p	25/99 p
SN7450	0·20	0·18	0·16
SN7451	0·20	0·18	0·16
SN7453	0·20	0·18	0·16
SN7454	0·20	0·18	0·16
SN7460	0·20	0·18	0·16
SN7470	0·30	0·27	0·25
SN7472	0·30	0·27	0·25
SN7473	0·40	0·37	0·35
SN7474	0·40	0·37	0·35
SN7475	0·55	0·52	0·50
SN7476	0·45	0·42	0·39
SN7480	0·80	0·75	0·67
SN7481	1·25	1·15	1·10
SN7482	0·87	0·80	0·70
SN7483	1·00	0·90	0·85
SN7484	0·90	0·85	0·80
SN7486	0·45	0·41	0·38
SN7490	0·75	0·70	0·65
SN7491AN	1·00	0·95	0·90
SN7492	0·75	0·70	0·65
SN7493	0·75	0·70	0·65
SN7494	0·80	0·75	0·70
SN7495	0·80	0·75	0·70
SN7496	1·00	0·97	0·95
SN7497	6·25	5·50	5·00
SN74100	2·50	2·30	2·00
SN74104	1·45	1·35	1·20
SN74105	1·45	1·35	1·20
SN74107	0·50	0·45	0·40
SN74110	0·80	0·70	0·60
SN74118	1·00	0·95	0·90
SN74119	1·90	1·78	1·65
SN74121	0·60	0·55	0·50
SN74122	1·35	1·25	1·10
SN74123	2·70	2·55	2·47
SN74141	1·00	0·95	0·90

Type	1/11 p	12/24 p	25/99 p
SN74145	1·50	1·40	1·30
SN74150	3·35	2·95	2·15
SN74151	1·10	0·95	0·90
SN74153	1·35	1·27	1·20
SN74154	2·00	1·75	1·55
SN74155	1·55	1·47	1·35
SN74156	1·55	1·47	1·35
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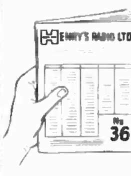

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B1/20	200	30p
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W01	100	35p
W02	200	40p
W06	600	45p
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B2/05	50	35p
B2/100	100	40p
B2/200	200	45p
B2/600	600	50p
B2/1000	1000	60p
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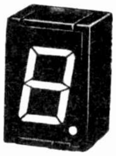

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SILICON PLASTIC RECTIFIERS 1·5A— Brand new wire-ended DO27. **100PIV** at **8p** each or 4 for **30p; 400PIV** at **9p** each or **4** for **34p; 800PIV** at **14p** each or 4 for **50p.**

5p post and packing on all orders below £5.
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TAPE AMPLIFIERS £3
Use 2 × ECC83, EL84, EZ80. Low impedance high sensitivity I/p, 3 ohm 2W O/P. Solenoid operated single motor non-standard deck. 7in. × 4in. speaker. All in polished oak cabinet, **£3** (£1) with cct.
RESISTORS: 300 5%, **60p** (15p); 200 5% Hi-Stabs, **60p** (12p); 100 1% and 2%, **60p** (8p); 100 metal oxide, **60p** (8p); One of each, **£2** (25p). 3W 5% R's: 270, 470, 6K8, 15k, 27k, 33k, 82k, 100 for **50p** (25p). **Meters:** 2½in. 500V d.c., **40p** (10p); 2½in. 10V a.c., **40p** (10p); 2½in. 1,500V electrostatic, **60p** (10p); 2½in. 12½–0–12½μA, **£1** (10p); 3½in. 1mA, **75p** (15p); 2½in. 100V rect. (5mA FSD), **60p** (10p); 5½in. 0–15–50–150–300–500V mirror scale, **£2** (40p). Ferric chloride, 1lb, **40p** (15p); 10lb, **£3·50** (50p). μA709C, **25p;** μA741C, **25p;** 2N3055, [illegible]; BC107–8–9, **8p** or 14 for [illegible] + 20μF/350V, **10p,** 10 for **75p** (25p); 8μF/2,500V, **£2** (40p); Reed switch unit, contains 31 250V 1½A reeds mounted round a drum with magnet inside, also R's plugs, etc., **£1** (25p); 2 for **£1·65** (35p); reeds, **4p.** μA723C, **40p;** 2N1613, **12p.**
TEST GEAR: TF144G sig. gen., recalibrated as new, **£20** (£2); decade res. box 0–9999 ohms, **£7·50** (50p); BSR audio oscillator, 0–16kHz metered O/P, **£9** (£1).
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24 GOODHART WAY, W. WICKHAM, KENT. Tel. 01-777 2001. S.A.E. list. Post in brackets, small parts 3p. Callers welcome. Please ring first (up to 10.30 p.m.)

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TIL302 Large 7 seg display	£3·50
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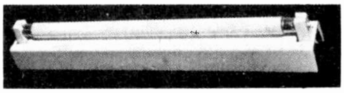
12 VOLT FLUORESCENT LIGHTS

(as illustrated)



Beat power cuts. Be independent. Ideal for caravans, tents, emergency lighting, etc. Works anywhere where 12v is available. Guaranteed for six months. Ready to use at:

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2 kW Slider module now available

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Suitable as stereo 'on' indicator. For above with panel mounting clip and instructions. Only **35p** + p.p.
MC1310P only £2·77 + p.p. 6p

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See close-up work with less eye strain and fatigue. Light-weight adjustable headband. Powerful optically ground lenses from Continental glassworks. Can be worn over normal glasses. An essential aid in electronics, home and workshop, industry, modelling, stamp collecting, jewellers, watchmakers and any fine work 2½ × magnification. **£5·25** + 35p p. & p. 3 × model **50p** extra. State model.

TWIN-BEAM SPEC-LAMP—Worn just like a pair of spectacles. Two powerful spot lamps illuminate working area. **Can be worn with Binocular Magnifier.** Battery operated. **Only £1·90** + 10p p. & p. **Send £2.**

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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. PS01. Flat pins American style rated at 10A 250V. Socket panel mounting. Plug is white and intended for flex. Useful where non standard power outlet is required. Also suitable for speaker leads, etc., etc. Price 25p per pair.

THERMOSTAT WITH PROBE
Our Ref. No. TH01. Made by Ranco. Range 0–107°C 16A 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.

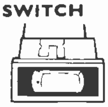
PROCESS SWITCH
Our Ref. No. P301, 6 switches some of which are changeover types. All rated at 10A. Operated by motor which makes 1 rev every 3 mins. Price £1·25 each.

PUSH PUSH SWITCH
Our Ref. No. S04. This is fitted to tablelamps, 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.

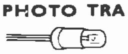
INDUCTION MOTOR
Made by G.E.C. Normal type with approx. 1in of 3/8 spindle. Standard fixing ½in stack. Brand new 65p each less usual quantity discounts. Good stocks available.

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

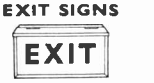
MINIATURE ROCKER SWITCH


Our Ref. RS01. 10A 240V. Self-fixing into hole size approx. 1in × ½in by famous French maker Russemburgh. Price 10p each.

ROCKER SWITCH
Our Ref. RS02. 13A self-fixing into hole approx. 1in × ½in. Made by the Carr Fastener Co. Very reliable. Price 8p each.

PHOTO TRANSISTOR


OCP70—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 × 14in wide × 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 to the equipment. Price 40p per pair—10 pairs £3·60.

LIGHT DIMMERS
We regret that through increased costs our 1kW model has now to be increased to £2·95.

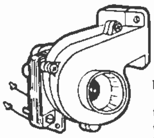
LIGHT DIMMER BOX
Another feature we can supply is box and 13A socket, this makes dimmer suitable for control of portable lights and equipment. This price is 45p extra.

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. Six types available:—

RC1 takes 1 reed—Operates	10–15V	600ohm	30p
RC2 ,, 2 ,, ,,	10–15V	180ohm	25p
RC3 ,, 1 ,, ,,	15–30V	1kohm	35p
RC4 ,, 2 ,, ,,	15–30V	300ohm	45p
RC5 ,, 1 ,, ,,	45–70V	6500ohm	35p
RC5 ,, 2 ,, ,,	45–70V	3500ohm	40p

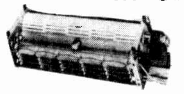
Standard reed switches available 10p each or 10 for 90p, 100 for £8·50.

CENTRIFUGAL BLOWER


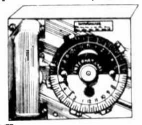
Miniature mains driven blower centrifugal type blower unit by Woods, powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size of blower is approx. 4½in × 4½in × 4in. When mounted by its flange air is blown into the equipment 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 flux 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 10·7HMz 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 £62·50. 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. & P. 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 £2·50 post and ins., 23p. Additional time contacts 50p pair.

COMPUTER TAPE

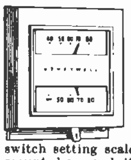

2,400ft of the Best Magnetic Tape money can buy—users claim good results with Video and sound. 1in wide £1·00 plus 33p post and insurance with cassette. ¾in wide £1 plus 30p post and insurance with cassette. ½in wide 85p plus 25p post and insurance with cassette. Spare spools and cassettes—1in 75p, ½in 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 24V 10W. 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 3½in × 2¾ × 1½in 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

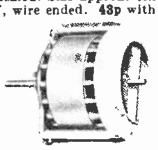

(A 30A Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price £1·50, p. & ins. 23p.

HONEYWELL THERMOSTAT


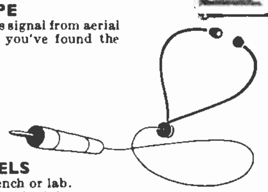
Made by Honeywell for normal air temperatures 40°–80°F (5–25°C). This is a precision instrument with a differential which can be adjusted to better than 1·5°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bi-metal element and adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows thermometer above and switch setting scale below-size approx. 3·8in × 3·2in × 1·4in deep—can be mounted on conduit box or directly on wall. Price £1·25 each or ten for £11·25.

LIGHT CELL


Almost zero resistant in sunlight increases to 10kohms in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by ¼in thick. Rated at 500MW, 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. £1·50 each. Postage one 23p, two 33p. 230V model £3.

RADIO STETHOSCOPE


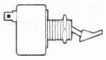
Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stetho-set instead of earpiece 75p extra post and ins. 20p.

DISTRIBUTION PANELS


Just what you need for work bench or lab. 4 × 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 if 10 or more ordered.

CAR PANEL SWITCH


Our Ref. No. S02. 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.

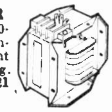
CAR PANEL AUTO SWITCH
Ref. No. S03. Again a flat ended toggle. Made by Arrow. A 3 position double pole changeover switch centre off for auto aerials, reversing motors, etc. 30p each.

3 PIN REVERSE PLUG & SOCKET
Our Ref. PS02. For bringing live leads to equipment. All brown bakelite construction, rated 10A 250V. Price 35p per pair.

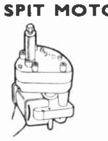
13 AMP JUNCTION BOXES
Made to take 7029 cables so ideal for ring mains. Price 8p each or 10 for 72p.

PORCELAIN FUSE AND CARRIER

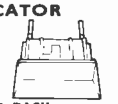

20A 250V MEM Ref. No. 15LBB/15LRHW. Make your own fuse board. Price 20p per pair.

AUTO TRANSFORMER


Primary 220-240V. Secondary 110-120V. Well built and varnish impregnated. 250W intermittent rating. 150W continuous rating. Size approx. 3½in × 3in × 3in. £1 plus 20p post and insurance.

SPIT MOTOR


200-250V Induction Motor, driving a Carter gear box with 1¼in of output 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


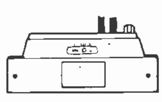
Our Ref. No. P101. Oblong type self-fixing into oblong hole. Suitable for 200/250V. Price 13p each.

MAINS TRANSISTOR POWER PACK
Designed to operate transistor sets and amplifiers. Adjustable output 6V, 9V, 12V for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1, plus 20p postage.

carriage extra at cost.

INSTANT START UNITS
For 2ft tubes. Philip's or Smart & Brown in a tray complete with tube clips and tube ends. Price £1·50 each or 10 for £13·50.

FLUORESCENT TUBES
Standard types—Bipin ends, ideal pelmet lighting as well as for standard replacements—18in 15W, 24in 40W, 36in 40W, 39½in 40W. All first grade tubes offered at one price—£3·50 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. 3½in × 1in × 1½in deep. Size of the display aperture is approx. 1½in × 1in. Light up to 0–9. Ex equipment but unused and in perfect order. Price £1 each.

DIGITAL SWITCHES
Small type S.T.C. number SW21/630CAA. These are a snap in fit hole approx. 1½in × ½in. 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 surface mounting. Size approx. 3½in × 1½in × 2½in. 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.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 50p post free.

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.

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