PRACTICAL
ELECTRONICS
JUNE 1976 35p

RADIO CONTROL

Multi-channel Proportional System...

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RALLY MILOMETER

PRACTICAL
ELECTRONICS

VOLUME 12 No. 6 JUNE 1976

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

COMPETITION

Our July issue will be published on Friday, June 11, 1976
(for details of contents, see page 493)

SEMI-CONDUCTORS

TRANSISTORS

BRAND NEW FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC117K	*0·30	AF178	*0·51	BC169	0·10	BC440	*0·31	BF117	*0·46	BFY53	*0·13	OC75	*0·16	2N706	*0·08	2N2646	*0·34	2N3703	0·09
AC126	*0·18	AF179	*0·51	BC169C	0·10	BC460	*0·37	BF118	*0·71	BSY19	*0·16	OC76	*0·16	2N706A	*0·09	2N2904	*0·14	2N3704	0·08
AC126	*0·14	AF180	*0·51	BC170	0·09	BD115	*0·63	BF119	*0·71	BSX20	*0·16	OC77	*0·26	2N708	*0·11	2N2904A	*0·18	2N3705	0·08
AC127	*0·11	AF181	*0·51	BC171	0·09	BD116	*0·81	BF152	0·56	BSY25	*0·16	OC81	*0·16	2N914	*0·15	2N2905	*0·18	2N3706	0·08
AC128	*0·11	AF186	*0·51	BC172	0·09	BD121	*0·61	BF153	0·48	BSY26	*0·16	OC81D	*0·18	2M918	*0·18	2N2905A	*0·18	2N3707	0·08
AC128K	*0·26	AF239	*0·38	BC173	0·09	BD123	*0·67	BF154	0·48	BSY27	*0·16	OC82	*0·16	2N1131	*0·18	2N2906	*0·12	2N3708	0·08
AC141	*0·18	AL102	*0·75	BC174	0·15	BD124	*0·70	BF155	*0·71	BSY28	*0·16	OC82D	*0·16	2N1132	*0·18	2N2906A	*0·14	2N3709	0·08
AC141K	*0·00	AL103	*0·75	BC175	*0·22	BD131	*0·36	BF156	*0·49	BSY29	*0·16	OC83	*0·20	2N1302	*0·15	2N2907	*0·15	2N3710	0·09
AC142	*0·19	BC107	*0·08	BC177	*0·16	BD132	*0·40	BF157	*0·56	BSY38	*0·19	OC139	*0·20	2N1303	*0·15	2N2907A	*0·18	2N3711	0·09
AC142K	*0·26	BC108	*0·08	BC178	*0·16	BD133	*0·67	BF158	0·56	BSY39	*0·19	OC140	*0·23	2N1304	*0·18	2N2923	0·15	2N3819	*0·14
AC153K	*0·24	BC109	*0·08	BC179	*0·16	BD135	0·41	BF159	0·61	BSY40	*0·29	OC169	*0·26	2N1305	*0·18	2N2924	0·15	2N3820	*0·40
AC176	*0·11	BC113	0·10	BC180	*0·25	BD136	0·41	BF173	*0·15	BSY41	*0·29	OC170	*0·26	2N1306	*0·21	2N2925	0·15	2N3823	*0·16
AC176K	*0·26	BC114	0·16	BC181	0·25	BD137	0·46	BF176	0·36	BSY95	*0·13	OC171	*0·26	2N1307	*0·21	2N2926G	0·09	2N3903	0·12
AC180	*0·20	BC115	0·16	BC182	0·09	BD138	0·51	BF179	*0·31	BSY95A	*0·13	OC200	*0·26	2N1308	*0·24	2N2926Y	0·09	2N3904	0·12
AC180K	*0·30	BC116	0·15	BC182L	0·09	BD139	0·56	BF180	*0·31	BU105	*1·90	OC201	*0·29	2N1309	*0·24	2N2926O	0·08	2M3905	0·14
AC181	*0·20	BC117	0·19	BC183	0·09	BD140	0·61	BF181	*0·31	MJE521	*0·56	OC202	*0·29	2N1613	*0·18	2N2926R	0·07	2N3906	0·14
AC181K	*0·30	BC118	0·09	BC183L	0·09	BD155	*0·81	BF194	0·10	MJE2955	*0·88	OC203	*0·26	2N1711	*0·18	2N2926B	0·07	2N4287	0·18
AC187	*0·17	BC119	*0·31	BC184	0·09	BD175	*0·61	BF195	0·10	MJE3055	*0·57	OC204	*0·26	2N2147	*0·73	2N3053	*0·15	2N4288	0·18
AC187K	*0·23	BC120	*0·81	BC184L	0·09	BD176	*0·61	BF196	0·92	MJE3440	*0·51	OC205	*0·38	2N2148	*0·58	2N3054	*0·40	2N4289	0·18
AC188	*0·19	BC137	0·16	BC186	*0·29	BD177	*0·67	BF197	0·12	MPF102	*0·28	OCP71	*0·44	2N2218	*0·18	2N3055	*0·40	2N4290	0·18
AC188K	*0·23	BC139	*0·41	BC187	*0·29	BD178	*0·67	BF198	0·12	MPF104	*0·26	ORP12/		2N2218A	*0·19	2N3402	*0·21	2N4291	0·18
AD140	*0·49	BC140	*0·31	BC207	0·11	BD179	*0·71	BF199	0·12	MPF105	*0·28	NSL4931	*0·48	2N2219	*0·18	2N3403	*0·21	2N4292	0·18
AD142	*0·55	BC141	*0·31	BC208	0·11	BD180	*0·71	BF257	*0·28	OC19	*0·36	ORP60	*0·41	2N2219A	*0·19	2N3404	*0·29	2N4293	0·18
AD143	*0·49	BC142	*0·31	BC209	0·12	BD185	*0·67	BF258	*0·36	OC20	*0·80	ORP61	*0·41	2N2220	*0·22	2N3405	*0·43	2N5172	0·12
AD149	*0·45	BC143	*0·31	BC212	0·10	BD186	*0·67	BF259	*0·46	OC22	*0·47	TIP29	*0·40	2N2221	*0·18	2N3614	*0·69	2N5457	*0·28
AD150	*0·65	BC145	0·46	BC212L	0·10	BD187	*0·71	BF262	0·56	OC23	*0·49	TIP30	*0·45	2N2222	*0·18	2N3615	*0·76	2N5458	*0·28
AD161	*0·36	BC147	0·09	BC213	0·10	BD188	*0·71	BF263	0·56	OC24	*0·57	TIP31A	*0·52	2N2368	*0·18	2N3616	*0·76	2N5459	*0·28
AD162	*0·36	BC148	0·09	BC213L	0·10	BD189	*0·77	BF270	*0·36	OC25	*0·39	TIP32A	*0·60	2N2369	*0·12	2N3646	0·09	40361	*0·30
AD161 &		BC149	0·09	BC214	0·10	BD190	*0·77	BF271	*0·31	OC26	*0·38	TIP41A	*0·65	2N2369A	0·12	2N3702	0·09	40362	*0·33
AD162(MP)		BC150	0·19	BC214L	0·10	BD195	*0·87	BF272	*0·81	OC28	*0·60	TIP42A	*0·72						
	*0·69	BC151	0·20	BC225	0·26	BD196	*0·87	BF273	0·36	OC29	*0·60	TIS43	*0·25						
AF114	*0·22	BC152	0·18	BC226	0·36	BD197	*0·92	BF274	0·36	OC35	*0·45	UT46	*0·20						
AF115	*0·22	BC153	0·29	BC251	0·10	BD198	*0·02	BFX29	*0·25	OC36	*0·51	ZTX107	0·07						
AF116	*0·22	BC154	0·20	BC301	*0·28	BD199	*0·98	BFX84	*0·19	OC41	*0·20	ZTX108	0·07						
AF117	*0·22	BC157	0·11	BC302	*0·25	BD200	*0·08	BFX85	*0·25	OC42	*0·25	ZTX109	0·07						
AF118	*0·32	BC158	0·11	BC303	*0·31	BD205	*0·81	BFX86	*0·22	OC44	*0·16	ZTX300	0·07						
AF124	*0·28	BC159	0·11	BC304	*0·37	BD206	*0·81	BFX87	*0·22	OC45	*0·13	ZTX500	0·09						
AF125	*0·28	BC160	*0·46	BC327	0·12	BD207	*0·98	BFX88	*0·22	OC70	*0·10	2N696	*0·10						
AF126	*0·26	BC161	*0·51	BC328	0·12	BD208	*0·98	BFY50	*0·13	OC71	*0·10	2N697	*0·11						
AF127	*0·26	BC167	0·10	BC337	0·12	BDY20	*1·02	BFY51	*0·13	OC72	*0·15	2N698	*0·20						
AF139	*0·31	BC168	0·10	BC338	0·12	BF115	*0·15	BFY52	*0·13	OC74	*0·15	2N699	*0·36						

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U32	25 Zener diodes 400mW DO-7 case 3-36 volts mixed	0·60
U36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	*0·60
U45	7 3A SCR. TO66 up to 600 PIV	*£1·20
U46	20 Unijunction transistors similar to TIS43	*0·60
U48	9 NPN Sil. power transistors like 2N3055	*£1·20

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

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
BA100	*0·10	BB104	*0·15	OA10	*0·14	OA91	*0·07
BA116	*0·21	BY100	*0·16	OA47	*0·07	OA95	*0·07
BA126	*0·22	BY126	*0·15	OA70	*0·07	OA200	*0·07
BA148	*0·15	BY127	*0·16	OA79	*0·07	OA202	*0·07
BA154	*0·12	BY128	*0·16	OA81	*0·07	1N914	*0·06
BA156	*0·14	BY164	*0·51	OA85	*0·09	1N916	*0·06
BA173	*0·15	BYX38/30	*0·43	OA90	*0·07	1N4148	*0·06

THYRISTORS

PIV	0·6A TO18	0·8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	*0·13	*0·15	—	—	—	—	—	—	—	—
20	*0·15	0·13	—	—	—	—	—	—	—	—
30	*0·19	*0·22	—	—	—	—	—	—	—	—
50	*0·22	*0·28	*0·20	*0·25	*0·36	*0·36	*0·48	*0·51	*0·54	*1·18
100	*0·25	*0·30	*0·25	*0·25	*0·48	*0·48	*0·51	*0·57	*0·58	*1·43
150	*0·31	*0·38	—	—	—	—	—	—	—	—
200	*0·38	*0·44	*0·25	*0·30	*0·50	*0·50	*0·57	*0·62	*0·62	*1·63
400	—	—	*0·30	*0·39	*0·55	*0·57	*0·62	*0·71	*0·77	*1·79
600	—	—	*0·39	*0·48	*0·69	*0·69	*0·78	*0·89	*0·90	—
800	—	—	*0·58	*0·65	*0·81	*0·81	*0·92	*1·22	*1·39	*4·07

SILICON RECTIFIERS

PIV	300mA (DO 7)	750mA (SO 16)	1 Amp Plastic		1·5 Amp (SO 16)	3 Amp (SO 10)	10 Amp (SO 10)	30 Amp (TO 48)
50	0·05*	0·06*	IN4001	0·05*	0·07*	0·14*	0·19*	0·56*
100	0·05*	0·07*	IN4002	0·06*	0·09*	0·16*	0·21*	0·69*
200	0·06*	0·09*	IN4003	0·07*	0·12*	0·20*	0·23*	0·93*
400	0·07*	0·14*	IN4004	0·08*	0·14*	0·28*	0·35*	1·25*
600	0·08*	0·16*	IN4005	0·09*	0·18*	0·33*	0·42*	1·76*
800	0·11*	0·18*	IN4006	0·10*	0·18*	0·35*	0·51*	1·94*
1000	0·13*	0·28*	IN4007	0·11*	0·23*	0·44*	0·60*	2·31*
1200	—	0·32*			0·28*	0·54*	0·69*	2·88*

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10 Amp	TO48	*0·77	*0·92	*1·12

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R6	30 Mixed 1kΩ–8·2kΩ ½W.	0·60
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REF 60/S	Replacement Brush Velvet Pad and Base Sticker for Model 60	*24p
REF 62	Cassette Head Cleaner (Liquid)	*48p
REF 71	Record 'Dust Off' (Displays of ten)	*66p
REF 71A	Record 'Dust Off' (Bubble Pack)	*70p
REF 75	Indexa Record	*£1·50
REF 76	Stylus Cleaner	*36p
REF 78	Cassette Fast Hand Winder	*98p
REF 83	Cassette Title and Container Labels (20 and 10)	*36p

DYNAMIC MIKES

TYPE B1223. 200 ohms impedance. Complete with stand, on/off switch and 2·5mm and 3·5mm plugs. Suitable for cassette tape recorders.
PRICE £1·67

ANTEX Equipment

SOLDERING IRONS

X25. 25 watt	*£2·45
Model G. 18 watt	*£2·70
CCN240. 15 watt	*£2·90
SK2. Soldering Kit	*£3·90

BITS

102 for model CN240 3/32"	*42p
104 for model CN240 1/8"	*42p
106 for model CN240 3/32"	*42p
1100 for model CCN240 3/32"	*42p
1101 for model CCN240 1/8"	*42p
1102 for model CCN240 1/4"	*42p
1021 for model G240 3/32"	*42p
1021 for model G240 1/8"	*42p
1022 for model G240 1/16"	*42p
50 for model X25 3/32"	*44p
51 for model X25 1/8"	*44p
52 for model X25 1/16"	*44p

ELEMENTS

Model ECN240	*£1·10
Model EG240	*£1·35
Model ECCN240	*£1·55
Model EX25	*£1·20

SOLDERING IRON STAND

ST3 Suitable for all models	*£1·10
Antex heat shunt	*10p

PLUGS & SOCKETS

PLUGS		Price
PS1	DIN 2 Pin (Speaker)	0·10
PS2	DIN 3 Pin	0·10
PS3	DIN 4 Pin	0·14
PS4	DIN 5 Pin 180°	0·15
PS5	DIN 5 Pin 240°	0·15
PS6	DIN 6 Pin	0·16
PS7	DIN 7 Pin	0·17
PS8	Jack 2·5mm Screened	0·17
PS9	Jack 3·5mm Plastic	0·11
PS10	Jack 3·5mm Screened	0·17
PS11	Jack ¼" Plastic	0·14
PS12	Jack ¼" Screened	0·20
PS13	Jack Stereo Screened	0·33
PS14	Phono	0·09
PS15	Car Aerial	0·14
PS16	Co-Axial	0·14

INLINE SOCKETS		
PS21	DIN 2 Pin (Speaker)	0·13
PS22	DIN 3 Pin	0·19
PS23	DIN 5 Pin 180°	0·19
PS24	DIN 5 Pin 240°	0·19
PS25	Jack 2·5mm Plastic	0·15
PS26	Jack 3·5mm Plastic	0·15
PS27	Jack ¼" Plastic	0·28
PS28	Jack ¼" Screened	0·32
PS29	Jack Stereo Plastic	0·28
PS30	Jack Stereo Screened	0·35
PS31	Phono Screened	0·17
PS32	Car Aerial	0·20
PS33	Co-Axial	0·20

SOCKETS		
PS35	DIN 2 Pin (Speaker)	0·07
PS36	DIN 3 Pin	0·09
PS37	DIN 5 Pin 180°	0·09
PS38	DIN 5 Pin 240°	0·10
PS39	Jack 2·5mm Switched	0·11
PS40	Jack 3·5mm Switched	0·11
PS41	Jack ¼" Switched	0·19
PS42	Jack Stereo Switched	0·28
PS43	Phono Single	0·07
PS44	Phono Double	0·09
PS46	Co-Axial Surface	0·09
PS47	Co-Axial Flush	0·19

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In 2 sections. Black or Blue Vinyl covered top and sides and bezels.

No.	Length		Width		Height	Price
BV1	8"	×	5¼"	×	2"	*£1·25
BV2	11"	×	6"	×	3"	*£1·62
BV3	6"	×	4¾"	×	1¾"	0·92
BV4	9"	×	5¼"	×	2¼"	£1·39

20p P. & P. Per Box.

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7" E.P. 18½" × 7" × 8" (50 records) *£2·48
12" L.P. 13¼" × 7½" × 12½" (50 records) *£3·30

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Holds 15. 10" × 3½" × 5". Lock and handle *£1·50

8-Track CARTRIDGE CASES

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Holds 24. 12½" × 8" × 5½". Lock and handle *£3·20

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RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

Col. (1) Coil ohms
Col. (2) Working d.c. volts
Col. 3 Contacts
Col. (4) Price
HD = Heavy duty

1	2	3	4
52	4–8	2 c/o	75p*
58	5–9	6 c/o	85p
185	8–12	6M	65p*
230	9–18	2 c/o HD	85p*
430	15–24	4 c/o	85p*
600	10–20	6M	85p*
700	12–24	2 c/o	65p*
700	16–24	4 c/o	85p*
700	16–24	4M2B	65p*
1,250	18–36	2 c/o	65p*
2,500	31–43	2 c/o HD	65p*
2,500	36–45	6M	65p
15k	85–110	6M	65p*

*Incl. Base. All prices incl. P. & P.

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3 c/o 5 amp contacts. 70 ohm coil. **85p.** Post 15p.
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Twin latching relay, "flip-flop" 2 c/o each relay. Mains contacts. 115V A.C. or 50V D.C. operation. 240V A.C. with 2·5K resistor. **85p.** Post 20p.

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VERY SPECIAL OFFER. Mfg. by C.E.M. 3 amp 250 volt. 10 amp 125 volt. 50 for **£3.** Post 36p. 100 for **£5.** Post 50p. 1,000 for **£45.** Post paid. Bulk purchase means LOW! LOW! prices. DOUBLE POLE C/O or 2 make/2 break micro switch. 10 amp 250v a.c. With detachable roller assembly. 10 for **£2·50.** Post 50p (min. order 10).

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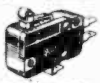

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Approximately 1½lb pull. Size of feet 1⅛" × 1⅛". Price **£1·00.** Post 20p.
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UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ½ inch travel. 6 × approx. 4oz. pull ¼ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price **£2·50.** Post £1. **ABSOLUTE BARGAIN.**

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Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75.** Post 25p.
1,000 watt model, **£4.** Post 25p.
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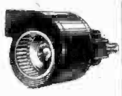

Mfg by Smiths Industries. 230/240V a.c. Miniature Model. Series SE/200. Size 95mm × 82mm × 82mm. Aperture 38mm × 31mm. 12 c.f.m., **£2·75.** Post 50p.
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Extremely powerful. 220/250V a.c. 0·3A 2,700 r.p.m. continuously rated. Capacitor start. Cast construction. Aperture 66mm × 50mm, O/A 200mm. **£12.** Post £1.
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Other types to order at short notice—Phone your enquiries.

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Step up, step down, 0-115/200/220/240 volts at 75 watt **£3.** Post 40p. 150 watt **£4·30.** Post 50p. 300 watt **£6·20.** Post 60p. 500 watt **£9·20.** Post 75p. 1000 watt **£13·50.** Post 90p.

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HY-LIGHT STROBE MK IV
Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation. For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes **£15·40.** Post 75p.

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Range of Xenon tubes available from stock. S.A.E. for details.

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES
4ft 40 watt, £6·05 (callers only).
2ft 20 watt, £4·68. Post 60p. (For use in standard bi-pin). MINI. **12in 8 watt, £1·76.** Post 25p. **9in 6 watt, £1·43.** Post 25p. Complete ballast unit and holders for 9in and 12in tube, **£1·87.** Post 30p. (9in and 12in measures approx.)

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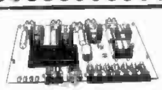
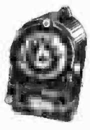


A new conception in light control. Four channels each capable of handling 750 watts of spot lights, flood lights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Price only **£60.** Post 75p. S.A.E. (Foolscap) for further details.

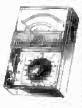
WIDE RANGE OF DISCO LIGHTING EQUIPMENT
6" graphic wheels, 3½" cassettes. S.A.E. (Foolscap) for details.

TIME SWITCH



'Horstmann' Type V Mk. II Time switch. 200/250 volt A.C. Two on/two off every 24 hours, at any manually preset time. 30 amp contacts. 36 hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case, with glass observation window. Built to highest Electricity Board Spec. individually tested. Price **£7·75.** Post 50p. (Total inc. VAT **£8·91**)

WHY PAY MORE?



MULTI RANGE METER. A.C. volts 2·5–500, D.C. volts 2·5–500 (Sensitivity 2000Ω/V d.c. and a.c.). D.c. current 0/1/10/100 mA, Ohms range. Sturdy compact moving coil instrument with 21 ranges. Dimensions 120 × 80 × 44mm. Weight 0·32kg.
SERVICE TRADING CO. Price **£5·00.** Post 50p. (Total price inc. VAT and post £5·94). Incl. leads and battery.

VAT
VAT AT 8% MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED

SERVICE TRADING CO.

ROTARY VACUUM AIR PUMP AND COMPRESSOR

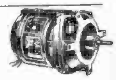
Carbon vane, oilless, 100/115V a.c., 1/12h.p. motor, 50/60 cycle, 2875/3450 r.p.m., 20 in vacuum, comp. 1·25 c.f.m., 10 p.s.i. (approx. figures). New unused surplus stock. Supplied with electrical connection data. FRACTION OF MAKERS' PRICE **£12.** Post £1·00. Suitable 110/240V, 150 watt auto transformer **£3·50.** Post 50p. (Both items together Post £1·25).

GEARED MOTORS

100 R.P.M.
115 lb. ins. 110 volt, 50Hz. 2·8 amp, single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled in-line gearbox. Length 250 mm. Dia. 135 mm. Spindle dia. 15·5 mm. Length 145 mm. Ex-equipment tested **£14.** Post £1·50. Suitable transformer 230/240 volt operation **£8.** Post 75p.

60 R.P.M. REVERSIBLE
220/240V a.c. Small, powerful, continuously rated, reversible motor. M.f.g. Berger (Germany). Size 80mm × 65mm × 65mm. Spindle dia. 6mm × 15mm long. Weight 725g. **£5·50.** Post 50p.

BODINE TYPE N.C.I.

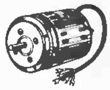


(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. 50Hz. **(Type 2) 28 r.p.m.** torque 20 lb. in. **Reversible** 1/80th h.p. 50Hz.
The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
Price, either type **£6·25.** Post 75p or less transformer **£3·75.** Post 65p.

15 R.P.M.
Type SD48 80 lb. in. Input 100/200 volt A.C. Length incl. gearbox 270 mm. Height 135 mm. Width 150 mm. drive shaft 16 mm. Weight 8·5 Kilos. BRAND NEW. Price **£10.** Carr. £1.
Suitable transformer for use on 220/240 volt A.C. **£3·85.** Post 50p.

20 R.P.M.
230/240 volt a.c. miniature motor. Price **£1.** Post 20p.

REVERSIBLE MOTOR



General Electric, 230V a.c. 1,600 r.p.m. 0·25A. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm × 95mm. Spindle 3/16in. dia. 20mm long. Ex. equipment tested, **£3.** Post 50p.

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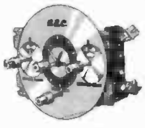
Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. **500V,** 500 megohms, **£36.** Post 80p. **1,000V,** 1,000 MΩ, **£44.** Post 80p.

TRIAC

Raytheon Tag symmetrical Triac. Type TAG. 250/500V, 10 amp, 500 p.i.v. Glass passivated plastic triac. Swiss precision product for long term reliability **£1·00.** Post 10p. (Inclusive of Data and application sheet.) Suitable Diac **18p.**

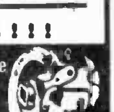
A.C. MAINS TIMER UNIT



Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135mm × 130mm × 60mm. Price **£2·25.** Post 40p. (Total incl. VAT and Post £2·87).

POWER RHEOSTATS ! ! !

Superior Quality Precision Made NEW POWER RHEOSTATS



New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1·5k ohm. **£1·70.** Post 20p.
50 WATT 1/5/10/25/50/100/250/500/1k ohm. **£2·10.** Post 25p.
100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£3·30.** Post 35p.
Black Silver, Skirted knob calibrated in Nos. 1–9 1½in. dia. brass bush. Ideal for above **22p** each.

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AC128	20p	BD131	42p
AC151	20p	BD132	44p
AC176	20p	BF152	20p
AC187	25p	BF173	20p
AC188	25p	BF178	26p
ACY17	22p	BF181	28p
ACY19	31p	BF185	22p
ACY20	19p	BF194	13p
ACY21	28p	BF195	13p
ACY39	27p	BF196	14p
AD161	40p	BF197	15p
AD162	40p	BF244B	24p
m/pr:	80p	BF258	40p
AF117	20p	BF337	42p
AFY19	32p	BF338	40p
AF239	44p	BF458	48p
ASY26	29p	BFW11	40p
ASY27	33p	BFW43	28p
ASZ23	27p	BFX11	23p
BC107	10p	BFX48	35p
BC108	10p	BFY18	16p
BC109	10p	BFY50	16p
BC116A	15p	BFY51	16p
BC118	11p	BFY52	16p
BC119	21p	BFY64	25p
BC126	20p	BFY77	14p
BC139	24p	BFY90	96p
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BC158	11p	OC35	80p
BC159	13p	OC42	12p
BC161	22p	OC71	12p
BC171	13p	OC81D	10p
BC172	14p	OC171	28p
BC182	11p	OC200	42p
BC183	12p	OC206	64p
BC184	13p	TIP41A	65p
BC208	9p	TIP42A	70p
BC212	12p	TIP2955	96p
BC213	13p	TIP3055	42p
BC214	14p	2N706A	14p
BC267	13p	2N708	14p
BC297	16p	2N711	42p
BC328	13p	2N1990	54p
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BC348	10p	2N2369A	22p
BC461	28p	2N2646	50p
BC548	11p	2N2926G	13p
BC549	11p	2N3053	21p
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All types: 25+ less 15%. 100+ less 25%.

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200 assorted mainly out of spec transistors, mostly unmarked—NPN, PNP plastic, TO5, TO18, RF, AF, small signal and TO3 power devices. About 75% usable devices. Only **£1·60**.
1,000 unmarked 1N4148 diodes, 95% OK. Only **£4**.
100 unmarked BC108, untested **£2·10**.

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Mullard CR25 ⅓W 5% (10% over 1MΩ). All values in E12 Series from 1 ohm to 10MΩ **1½p** each. Metal Film 1W 5%. All values in E12 series from 27 ohms to 10MΩ **2½p** each.
2½W wirewound **8p**; 5W wirewound **10p**; 15 W wirewound **12p**.
1% and better. S.A.E. for list

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400 mW BZY88 series, all voltages from 3V to 30V **10p** each. 1 Watt plastic: all voltages from 3V to 200V **20p** each.

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Wire ended horizontal mounting (some of the smaller values may be vertical mounting)

0·47µF	25V	5p	250µF	16V	7p
1µF	25V	8p	470µF	16V	9p
2·2µF	25V	6p	470µF	25V	11p
4·7µF	25V	6p	470µF	35V	13p
10µF	25V	8p	470µF	63V	18p
22µF	25V	6p	1000µF	10V	11p
47µF	25V	8p	1000µF	16V	15p
47µF	40V	7p	1000µF	25V	18p
47µF	63V	7p	1000µF	50V	32p
100µF	10V	6p	1000µF	63V	40p
100µF	25V	7p	2200µF	10V	18p
100µF	40V	8p	2200µF	16V	22p
200µF	10V	6p	2200µF	25V	27p
200µF	50V	13p	2200µF	40V	48p
220µF	25V	9p	4700µF	16V	40p
220µF	30V	10p			

POLYESTER C280 250V
0·01, 0·015, 0·022, 0·033, 0·047, 0·068, all **3p** each. 0·1, 0·15, **4p**; 0·22, **6p**; 0·33, **7p**; 0·47, **8p**; 0·68, **10p**; 1µF, **13p**; 2·2µF, **16p**; 3·3µF 63V, **22p**.

CERAMIC PLATE 50V
22pF to 820pF E12 series **2p** each; 1000pF **3p**.

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1411,	205 × 140 × 75mm	£3·25
1412,	205 × 140 × 110mm	£4·20

Plastic Boxes—Professional quality, two tone grey polystyrene boxes with threaded inserts for mounting PC boards.
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Supplied complete with base and PK screws. Big reduction for quantity.

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AB9	102 × 70 × 38mm	55p
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AB12	76 × 51 × 25mm	48p
AB13	152 × 102 × 51mm	80p
AB14	178 × 127 × 64mm	£1·06
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AB17	254 × 114 × 76mm	£1·22
AB19	305 × 203 × 76mm	£2·00

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For 4 × HP7 2 by 2 or side by side. Both types **16p**. For 4 × HP11, 2 by 2 or side by side. Both types **24p**.

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10, 47, 68µH **9p**. 1·5, 2·5, 5, 7·5 10mH **30p**.

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400mW zeners 5%, 10 each 3V to 30V, 260 in all. Only **£14**.

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7401	11	7453	13	74156	71
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7403	11	7460	11	74161	95
7404	13	7464	21	74163	90
7405	13	7465	21	74164	1-10
7406	22	7472	22	74165	1-25
7407	22	7473	26	74166	1-15
7408	14	7474	26	74173	95
7409	14	7475	41	74175	95
7410	11	7476	26	74176	95
7411	16	7483	70	74177	85
7413	29	7485	80	74180	80
7416	22	7486	24	74181	2-50
7417	22	7489	1-50	74182	80
7420	11	7490	40	74184	1-55
7422	22	7491	71	74185	1-30
7423	22	7492	44	74190	95
7425	22	7493	44	74191	95
7426	23	7494	49	74192	90
7427	22	7495	49	74193	85
7430	12	7496	55	74194	95
7432	22	74100	1-00	74195	72
7437	25	74105	60	74196	1-00
7438	21	74107	27	74197	75
7440	11	74121	28	74198	1-70
7441	60	74122	50	74199	1-70
7442	55	74123	55	74200	3-90
7443	55	74125	50		
7444	60	74126	50	74132	-50
7445	75	74141	68		
7446	85	74145	75		
7447	73	74150	75		
7448	80	74151	60		
7450	12	74153	71		

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74L03	16	74L71	18	74L93	89
74L04	18	74L72	27	74L95	89
74L06	18	74L73	38	74L98	1-53
74L10	16	74L74	38	74L164	1-53
74L20	16	74L78	44	74L165	1-53
74L30	16	74L85	85		
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74LS08	25	74LS74	40	74LS193	1-30
74LS10	23	74LS90	80	74LS197	1-20
74LS20	23	74LS93	80		

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74S03	23	74S20	23	74S74	23
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74H10	16	74H52	18	74H102	35
74H11	16	74H53	20	74H103	40
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74H21	16	74H60	21	74H108	40

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8123	88	8551	91	8831	1-42
8130	1-20	8552	1-37	8836	27
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DTL

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932	10	944	10	962	10
936	10	946	10	963	10

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IN 2990A Zener (Stud Mt.)	33V	-75	10/5-
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IN 3600 Sw. Diode	50V	-12	10/-80
IN 3604 Sw. Diode	75V	-12	10/-80
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MISC. DEVICES

ULN2208	FM gain block 34dB mDIP	-90
ULN2209	FM gain block 48dB mDIP	-90
2513	64 x 8 x 5 character generator	6-
CA3046	Transistor array 14 pin DIP	-50

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4000A	£ 18	4016A	40	4049A	42
4001A	18	4017A	85	4050A	42
4002A	18	4020A	1-06	4066A	63
4006A	96	4021A	98	4068A	31
4007A	19	4022A	78	4069A	31
4008A	1-27	4023A	18	4071A	19
4009A	41	4024A	63	4072A	25
4010A	38	4025A	18	4073A	28
4011A	19	4027A	42	4075A	28
4012A	18	4028A	70	4078A	28
4013A	32	4030A	32	4081A	19
4014A	1-06	4035A	90	4082A	25
4015A	1-06	4042A	1-05	4528A	1-14
				4585A	1-49

74C00	£0-21	74C74	£0-63	74C162	£1-78
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74C04	41	74C107	82	74C164	1-92
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74C10	36	74C154	1-92	74C195	1-65
74C20	36	74C157	1-20	80C95	82
74C42	1-18	74C160	1-78	80C97	82
74C73	.85	74C161	1-78		

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.1 mfd	35V	12p	6.8 mfd	6V	15p
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1 mfd	35V	12p	10 mfd	25V	18p
2.2 mfd	20V	12p	15 mfd	10V	18p
2.2 mfd	35V	12p	33 mfd	10V	20p
4.7 mfd	16V	15p	47 mfd	6V	20p

LED's

MV108	Red TO 18	£0-14
MV50	Axial leads	8
MV5020	Jumbo Vis. Red (Red Dome)	18
	Jumbo Vis. Red (Clear Dome)	18
ME4	Infra red dill. dome	18
MAN1	Red 7 seg. .270"	1-38
MAN2	Red alpha num .32"	2-72
MAN3	Red 7 seg. .127" straight pins	16
MAN4	Red 7 seg. .190"	1-18
MAN5	Green 7 seg. .270"	1-62
MAN6	.6" high solid seg.	3-81
MAN7	Red 7 seg. .270"	74
MAN8	Yellow 7 seg. .270"	2-17
MAN66	.6" high spaced seg.	2-55
MCT2	Opto-iso transistor	38

MULTIPLE DISPLAYS

NSN33	3 digit .12" red led 12 pin fits IC skt.	£-90
HP45082 7405	5 digit .11 led magn. lens com. cath	1-80
HP5082 7414	4 digit .11 LED magn. lens comm. cath.	1-70
SP-425-09	9 digit .25" neon direct interface with MOS/LSI. 180 VDC. 7 seg.	98

SHIFT REGISTERS

MM5013	1024 bit accum. dynamic mDIP	£1-20
MM5016	500/512 bit dynamic mDIP	1-10
SL5-4025	QUAD 25 bit	95
2504	1024 bit multiplexed dynamic shift register	4.95

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12 Digit — 4 function with memory — chain operation .... £-89

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MM 5330 — P channel device provides all logic for 4½ digit volt meter. 16 pin DIP with data £8

UV ERASABLE PROM
1702A — 2048 bit static PROM 256x8 elect programmable & erasable TTL/DTL comp. 24 pin DIP £8

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7001 CLOCK CHIP
4-6 digit. 12-24 hr. alarm, timer & date circuits with data £4-00

6 DIGIT LED CLOCK KIT
INCLUDES:
MM314 clock circuit
6 FND70 LED displays (.250" red 7 segment)
All necessary transistors, resistors & capacitors
1 double sided PC board accommodates LED's & clock circuitry
Schematic & instructions
Does not include 12V-300 ma transformer, switches & case £ 7

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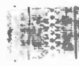

£1

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Solder tail - low profile

8 pin	£-11	24 pin	£-25
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16 pin	-13	40 pin	-42
18 pin	-19		

wire wrap - gold plate
14 pin £-30

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±1% ¼ WATT

QTY	PRICE EACH	PRICE MINIMUM 10 PER VALUE	PRICE MINIMUM 100 PER VALUE
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10-100		£-08	
100-1000		06	£-05
1000-			04

RESISTANCE (OHMS)

22.6	71.5	182	887	11.8K	40.2K
23.7	78.7	187	1.15K	13.0K	45.3K
25.5	84.5	191	1.5 K	15.0K	48.7K
30.9	105	205	2.49K	18.2K	54.9K
34.8	110	232	3.57K	19.1K	60.4K
40.2	115	243	4.75K	19.6K	64.9K
45.3	137	499	5.49K	22.6K	69.8K
51.1	147	604	6.04K	24.9K	84.5K
61.9	158	715	7.15K	28.0K	
64.9	178	806	8.25K	37.4K	

MEMORIES

1101	256 bit RAM MOS	96
1103	1024 bit RAM MOS	2-72
2102-2	1024 bit static RAM	2-00
5260	1024 bit RAM	1-20
5261	1024 bit RAM	1-20
5262	2048 bit RAM	2-00
7489	64 bit ROM TTL	1-50
82S23	Programmable ROM	2-72
74200	256 bit RAM tri-state	3-90
2602	1024-bit static RAM, N-channel DTL/TTL compatible	2-
F93410	256 bit RAM	1-50

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5001	12 DIG 4 funct fix dec	£1-46
5002	Same as 5001 exc btry power	1-95
5005	12 DIG 4 fuct w/mem	2-42
MM5725	8 DIG 4 funct chain & dec	1-10
MM5736	18 pin 6 DIG 4 funct	2-42
MM5738	8 DIG 5 funct K & mem	2-42
MM5739	9 DIG 4 funct (btry sur)	2-92
MM5311	28 pin BCD 6 dig mux	2-42
MM5312	24 pin 1 pps BCD 4 dig mux	1-94
MM5313	28 pin 1 pps BCD 6 dig mux	2-42
MM5314	24 pin 6 dig mux	2-42
MM5316	40 pin alarm 4 dig	2-42

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300	Pos V Reg (super 723) TO-5	£43
301	Hi Perf Op Amp mDIP TO-5	18
302	Volt follower TO-5	43
304	Neg V Reg TO-5	49
305	Pos V Reg TO-5	52
307	Op AMP (super 741) mDIP TO-5	38
308	Mciro Pwr Op Amp mDIP TO-5	60
309K	5V 1A regulator TO-3	91
310	V Follower Op Amp mDIP	65
311	Hi perf V Comp mDIP TO-5	58
319	Hi Speed Dual Comp DIP	71
320	Neg Reg 5.2, 12, TO-3	74
320T	Neg Reg 5, 12, 15 TO-220	89
320K	Neg Reg 5.2, 12 TO-3	89
322	Precision Timer DIP	60
324	Quad Op Amp DIP	1-07
339	Quad Comparator DIP	92
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1-20
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1-07
370	AGC/Squelch AMPL DIP	80
372	AF-IF Strip detector DIP	44
373	AM/FM/SSB Strip TO-5	30
376	Pos V Reg mDIP	33
380	2w Audio Amp DIP	81
380-8	.6w Audio Amp mDIP	69
381	Lo Noise Dual preamp DIP	98
382	Lo Noise Dual preamp DIP	98
531	High Slew rate Op Amp	£1-80
540	Power driver TO-5	1-20
550	Prec V Reg DIP	54
555	Timer mDIP	44
556A	Dual 555 Timer DIP	89
560	Phase Locked Loop DIP	1-94
562	Phase Locked Loop DIP	1-94
565	Phase Locked Loop DIP TO-5	1-20
566	Function Gen mDIP TO-5	1-20
567	Tone Decoder mDIP	1-20
709	Operational AMP TO-5 or DIP	27
710	Hi Speed Volt Comp DIP	21
711	Dual Difference Compar DIP	44
723	V Reg DIP	38
733	Diff. video AMPL TO-5	-55
739	Dual Hi Perf Op Amp DIP	65
741	Comp Op Amp mDIP TO-5	25
747	741 Dual Op Amp DIP or TO-5	44
748	Freq Adj 741 mDIP	27
1304	FM Mulpx Stereo Demod DIP	65
1307	FM Mulpx Stereo Demod DIP	45
1456	Int. compensated Op Amp mDIP	-79
1458	Dual Comp Op Amp mDIP	38
1800	Stereo multiplexer DIP	1-50
LH2111	Dual LM 211 V Comp DIP	1-07
3900	Quad Amplifier DIP	33
7524	Dual core memory sense Amp	1-04
7525	Dual core memory sense Amp	-80
8038	Voltage contr. osc. DIP	3-20
8864	9 DIG Led Cath Drvr DIP	1-37
75150	Dual Line Driver DIP	1-10
75451	Dual Perepheral Driver mDIP	21
75452	Dual Peripheral Driver mDIP	21
75453	(351) Dual Periph Driver mDIP	21
75491	Quad Seq Driver for LED DIP	50
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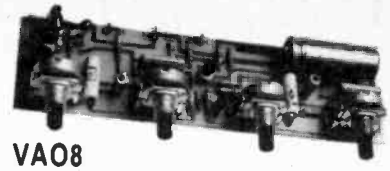
PRE AMPLIFIERS



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VAO8 Vol. Treb, Mid and Bass controls. HI. IMP. FET. I/P suitable Mid. Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble +35dB at 16kHz. Mid +20 −15dB at 1kHz Bass ×20 −10dB at 40Hz. **£6·50**

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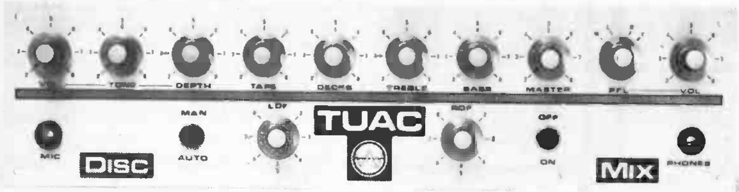
SVAO8 STEREO PRE AMP Vol, Treb, Mid and Bass controls, I/P suitable, Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble +35dB at 16kHz. Mid +20 −15dB at 4kHz. Bass +20 −10dB at 40Hz Plus Full Balance Control. Full I/C operation supply voltage ±15VDC. **£12·50**

MONO DISCO MIXER WITH AUTO FADE

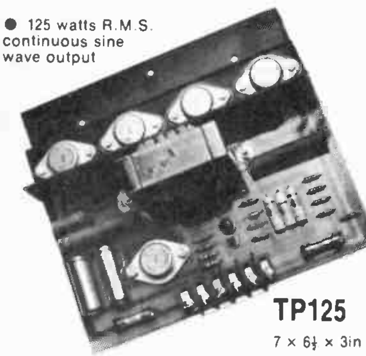


Designed for the discerning D.J. of professional standard. Offering a vast variety of functions. Controls: Mic Vol; Tone, over-ride depth, auto/Manual Sw; Tape Vol; L & R Deck Faders; Deck Volume; Treble and Bass; H. Phon Vol Selector; Master Vol On/Off Sw. Max output 1V RMS.
Specification: Deck Inputs—50mV into 1MΩ; Deck Tone Controls—treble +20 −10dB at 12kHz, Bass +22 −15dB at 40Hz; Mic Input—200 ohms upwards, 2mV into 10kΩ; Mic Tone Control—Total Variation Treble 15dB, Total Variation Bass 10dB; Tape Input—30mV into 47kΩ; Power Requirements—30–50 volts at 50mA.

£31·50
PANEL SIZE
18 × 4½in
DEPTH 3in

★ TUAC AMPLIFIER MODULES ★ POWER AND QUALITY ★

- 125 watts R.M.S. continuous sine wave output



TP125

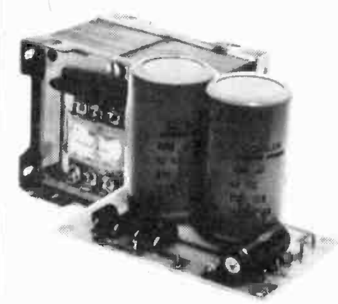
7 × 6½ × 3in

£19·50

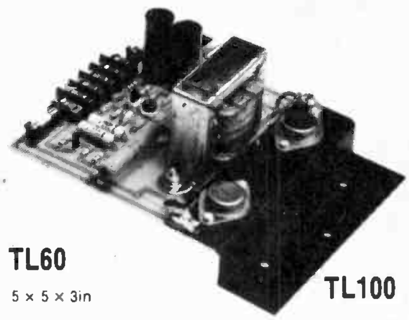
- 4 R.C.A. 150 watt 15 amp output transistors

- Rugged layer wound driver transformer
- Short—Open—and Thermal overload protection
- Only 6 connections

Power supplies vacuum impregnated. Transformers with supply board incorporating pre-amp supply.



PS 250 for supplying 2 TP125s	£22·00
PS 60/60 for supplying 2 TL60s	£19·50
PS 125 ± 45 volts for TP125	£13·75
PS 100 ± 43 volts for TL100	£12·00
PS 60 ± 38 volts for TL60	£11·50
PS 30 ± 25 volts for TL30	£7·50
PSU 2 for supplying disco mixer	£5·50



TL60

5 × 5 × 3in

- 60 watts R.M.S. continuous sine wave output
- 2 R.C.A. 110 watt 15 amp transistors

£13·50

TL100

5 × 5 × 3in

- 100 watts R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£16·25

Specification on all power modules: All output power ratings ±0·5dB; Output impedance 8–15 ohms; THD at full power 2% typically 1%; Input sensitivity 60mV into 10kΩ; Frequency response 20Hz–20kHz ±2dB; Hum and noise better than −70dB.

STOCKISTS—CALLERS ONLY

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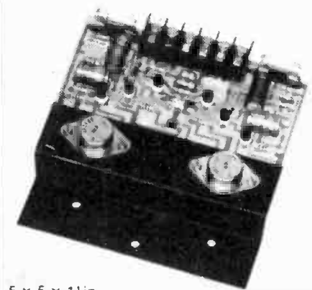
Arthur Sallis Ltd., 28 Gardner Street (Tel. Brighton 65806)
Bristol Disco Centre, 26 The Promenade, Gloucester Road (Tel. Bristol 41666)
Socodi, 9 The Friars (Tel. Canterbury 60948)
Cookies Disco Centre, 132 West Street (Tel. Crewe 4739)
Leighton Electronics Centre, 59 North Street (Tel. Leighton Buzzard 2316)
A1 Music Centre, 88 Oxford Street, Manchester (Tel. 061-236 0340)
Damon Electronics, 99 Carrington Street (Tel. Nottingham 53880)
Electra Centre, 58 Lancaster Road (Tel. Preston 58488)
Mitchell Electronics, 64 Winchester Street (Tel. Salisbury 23689)
Mitchell Electronics for Southampton area



5 × 5 × 1½in

TL30

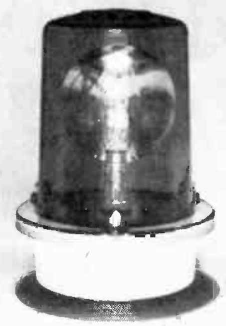
NEW FROM TUAC TL30 D.C. COUPLED POWER AMPLIFIER MODULE.

- Output power 30 watts R.M.S. continuous sine wave
- Output impedance 8–15 ohms
- T.H.D. at full power 0·5%
- Signal to noise ratio −85dB
- Input sensitivity 60mV into 50k ohms
- Frequency response 25Hz–50kHz
- 8 transistors
- 4 diodes
- Only six connections

£9·75

Send large stamped addressed envelope with all enquiries or send £1 (refundable against purchase) for fully illustrated 20 page catalogue.

FUZZ LIGHT



RED GREEN BLUE AMBER

240V a.c. Long Life Candle Bulb, Revolving Reflector, adds a new dimension to disco lighting effects. **£19·50**

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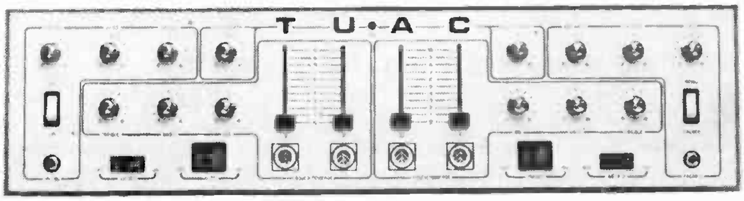
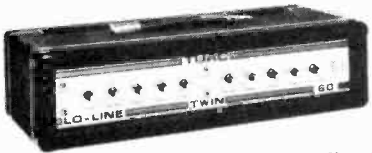
TUAC STEREO DISCO MIXER



INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble, and bass controls for each pair of sliders. Sensitivity mag., 3mV (R.I.A.A. comp.). Flat 50mV at 1kHz. Bass controls ±18dB at 60Hz. Treble controls ±18dB at 15kHz.
OUTPUT: Up to 3 volts (+12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz–25kHz ±1dB.
P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.
Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switch. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.

£97·50

Size: 25in long × 6in high × 3in deep



TWIN 60

£80·00

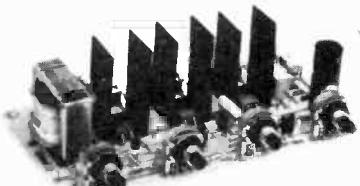
Output power 60 watts R.M.S. Four inputs, two channels each with volume, treble, middle and bass controls. Variable wave form control.

- ★ **Lo-Line Twin 125** (125 watts version) **£98·00**
- ★ **Lo-Line 60** (single pre-amp version) **£65·00**
- ★ **Lo-Line 125** (single pre-amp version) **£81·00**
- ★ **Lo-Line 125** slave output power 125 watts R.M.S. **£70·00**

▲▼ All Lo-Line Amplifiers are 25½in long × 11½in high × 6½in deep ▲▼

NEW TUAC LO-LINE STEREO 250 125 WATTS PER CHANNEL—£130

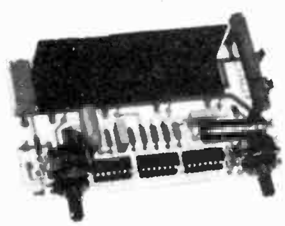
3 CHANNEL LIGHT MODULATOR



- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control
- 12 easy connections

£15·50 (Single Channel Version 1500 Watts £7·25)

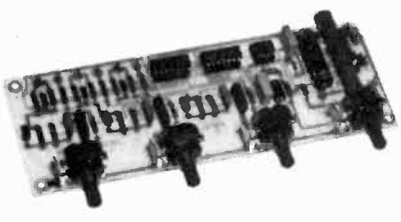
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER—4LSMI



- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from ½W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection
- Full wave control
- 13 easy connections

Patents applied for **£17·25**

ADD SEQUENCE CHASING AND DIMMING EFFECTS TO YOUR TUAC 3 CHANNEL LIGHT MODULATOR



- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel
- 9 easy connections

SEQUENCE DIMMER MODULE—3SDMI **£11·75**

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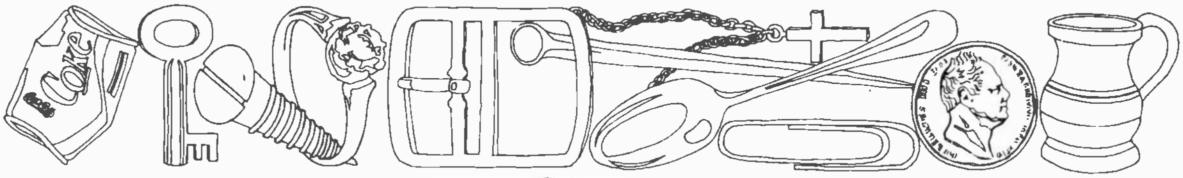
ACCESS AND BARCLAYCARD ACCEPTED—JUST SEND OR PHONE US YOUR NUMBER HP ENQUIRIES INVITED

A few interesting (and not so interesting) things you could find with a Heathkit Metal Locator.



With a Heathkit Metal Locator in your hand you can find buried metal objects as small as a halfpenny.

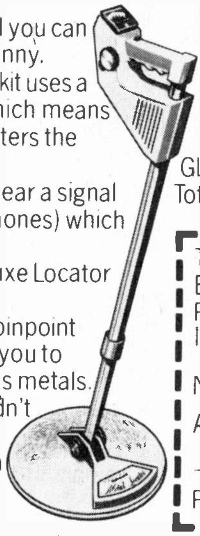
And, unlike many other locators, the Heathkit uses a special 'induction balance' search system, which means you hear no tone at all until a metal object enters the locator's search field.

But, once a metal object is located you'll hear a signal through the loudspeaker (or optional headphones) which increases in volume the closer you get.

Two models are available: the GD-348 Deluxe Locator and the GD-48 Economy Locator.

Both models have a front-panel meter to pinpoint your find. And the Deluxe model even allows you to differentiate between ferrous and non-ferrous metals.

And of course, being Heathkits, they couldn't be easier to build. The kits come absolutely complete – with a comprehensive instruction manual that takes you step by step through the assembly.



You'll find them both in the latest Heathkit catalogue. Just send us 10p for postage and we'll send you your copy.

Besides the metal locators, you'll find a lot of other interesting things in it.

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(P.E. Mains Clock Feb./Mar. 76)

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P.E. CAR CLOCK with Journey Timer

6 digit clock for use in any car with 12V battery, with an independent journey timer incorporated. Bright Jumbo LED display comes on with ignition—automatic intensity control. Complete kit of all parts needed including case, PCB's and all components. Full instructions. £39·50

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CD4006	1·02	CD4035	1·02	CD4067	3·12	CD4520	1·08	SN75491	0·81
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CD4011	0·18	CD4040	0·92	CD4072	0·20	MC14528	1·38	20WAY 1M	
CD4012	0·18	CD4041	0·73	CD4073	0·20	MC14534	6·04		1·00
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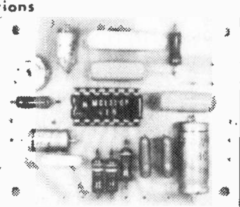

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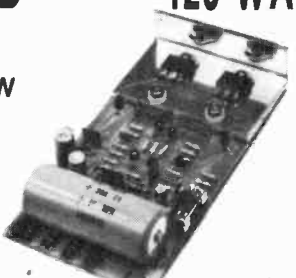
SA 1208D 120 WATT RMS POWER AMP

USES 150W 16A RCA DEVICES



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- Send for details

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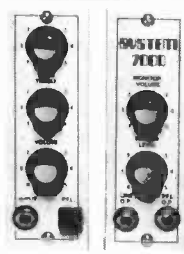
Stereo £12·00

MIXER
Mono £8·50
Stereo £12·00

Power supply P10M18 £7·50



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AF126	28p	BC132	11p*	BC182L	11p*	BC287	20p	BD132	38p
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AF186	50p	BC136	16p*	BC183L	10p*	BC301	26p	BD135	37p*
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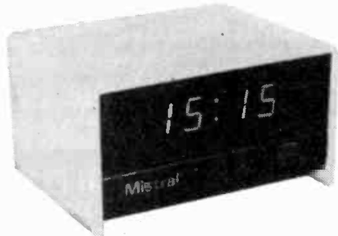

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- ★ DATE
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£29·50 inc. VAT
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Features:
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- ★ MINUTES
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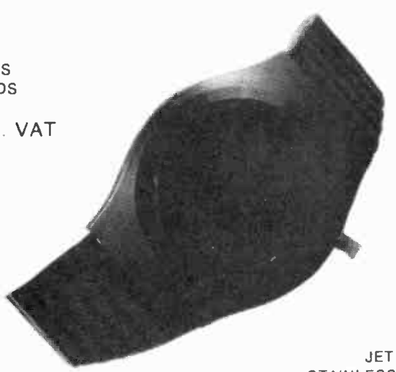

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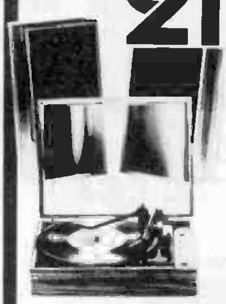
RT-VC

ELIZABETHAN STEREO TUNER AMPLIFIER

This compact Tuner Amplifier gives you full medium wave and V.H.F. coverage and FM stereo. With inputs for your turntable and tape recorder. It has rotary tuning. Volume. Balance. Bass and Treble controls and push button selection switches for Phono/tape FM Stereo, FM mono,, Medium wave and A.F.C. has built-in stereo beacon and switched headphone socket.
Technical Specifications 15 transistors. 11 diodes. integrated circuit. Power output 8 watts. Size of tuner amplifier: 4" x 10" x 15½" approx. Finished in selected rosewood veneer with brushed aluminium front panel and matching controls. Output into 15 ohms speakers only.

£29.00 + p&p £1.50

*STEREO 21



COMPLETE ONLY
£23.20 + p&p £4.00

INCORPORATING A GARRARD DECK
Garrard 3 speed Deck automatic, manual facilities together with stereo cartridge and cueing device.

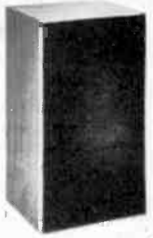
Stereo 21, easy to assemble audio system kit. No soldering required. The unit is finished in Sim Teak . and the acrylic top presents an unusually interesting variation on the modern deck plinth.
Includes – **3 speed deck**, automatic manual facilities together with stereo cartridge and cueing device.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications – For the technically minded.
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs – radio, tape, etc., and outputs for taping discs.
Overall Dimensions. Speakers approx 12" x 9" x 5". Complete deck and cover in closed position approx. 15½" x 12" x 6".
Extras if required. Optional Diamond Styli **£1.60.**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance **£5.80.**

BSR DECKS WITH PLINTHS AT FANTASTIC REDUCTIONS

MP 60 Type *(illustrated)* *Less Cartridge*	£16·00 p&p £2·00
C141 *(not illustrated)* *Auto. with Cue Fitted Stereo Cartridge*	£12·00 p&p £1·50

All plinths finished in matching Teak veneer.

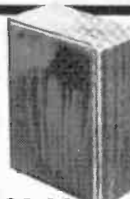
EASY TO BUILD SPEAKER KITS



These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" x 8" woofer, 3½" tweeter and matching crossover.
Easily put together with just a few basic tools.
Specification (each speaker); Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20-20,000 Hz. Size 20" x 11" x 9½" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

£22.00 pair complete + £5.20 p&p
Complete with crossover Components and circuit diagram.

THE 'COMPACT' EASY BUILD SPEAKER KIT



A compact bookshelf speaker system giving a high electro accoustic efficiency for the low powered amplifier.
The professional finish can be obtained with the minimum of tools, the infinite baffle type enclosures come ready mitred and professionally finished, and fix together with masking tape till glue dries.
The cabinet measures 12" x 9" x 5" deep approx finished in simulated teak, incorporating a quality 7" x 4" elliptical speaker, power handling 4 watts, flux density 30,000 maxwells, impedance 8-15 ohms nominal, voice coil dia ¾" magnet size 2⅞" approx.

£6.00 + p&p £1.70
PAIR INCLUSIVE

EMI 350 KIT

£7.25 + £1.20 p & p.
Complete with crossover Components and circuit diagram

System consists of a 13" × 8" approx. woofer with a 3" tweeter, crossover components and circuit diagram. Frequency response: 20 Hz to 20 KHz. Power handling 15 watts RMS into 8 ohms. (Peak 30 watts.)

VISCOUNT IV STEREO AMP

NOW AVAILABLE IN KIT FORM! 30x30 WATTS RMS

£27.50 + p&p £1.50

COMPLETE 20x20 SYSTEMS

SYSTEM 1A £69.00

The new 20 + 20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.
The VISCOUNT IV has a comprehensive range of controls – volume, bass, treble, balance mono/stereo, mode selector, and scratch filter.
Front panel socket for stereo headphones. And a host of sockets at the rear – for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.
SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion at 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. – 3 millivolts at 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. – 50 millivolts at 50 K ohms (R.I.A.A.); 3, 4, 6. Tape Tuner/Aux. – 140 millivolts at 50 K ohms (flat frequency response); 5. Microphone – 3 millivolts at 50 K ohms (flat frequency response).
CONTROLS: Push button ON/OFF, stereo/mono, scratch filter. 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. **Frequency response:** 25 Hz to 25 kHz at full rated output. **Signal to noise ratio:** better than –50 dB on all inputs. **Tone control range:** Bass ±15 dB at 50 Hz; Treble ±12 dB at 10 KHz. **Power requirements:** 250V A.C. mains at 60 watts.
Approx size: 15¼" x 3" x 10". **MP60 type** deck with magnetic cartridge, de luxe plinth and cover. Two Duo Type 11a **matched speakers** – Enclosure size approx. 19½" x 10¾" x 7¾" in simulated teak. Drive units 13" x 8" with 3" tweeter. 15 watts handling. 30 watts peak.

Complete System with these speakers
£69.00 + £6.50 p&p.

SYSTEM 2 £85.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers – Enclosure size approx. 27" × 13" × 11½". Finished in teak simulate. Drive units 13" × 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range – 20 Hz to 18,000 Hz.
Complete System with these speakers £85.00 + £7.60 p & p.

PRICES: SYSTEM 1a

Viscount IV R103 amplifier	£27.50+£1.90 p & p.
2 Duo Type IIa speakers	£30.00+£6.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover	£22.00+£3.30 p & p.
Total if purchased separately:	£79.50
Available complete for only:	£69.00 +£6.50 p & p.

PRICES: SYSTEM 2

Viscount IV R103 amplifier	£27.50+£1.90 p & p
2 Duo Type III speakers	£46.00+£7.50 p & p
MP60 type deck with Mag. cartridge de luxe plinth and cover	£22.00+£3.30 p & p.
Total if purchased separately:	£95.50
Available complete for only	£85.00 +£7.60 p & p.

Scotland and the Orkneys P & P Surcharge System 1a £1.75 System 2 £3.50

Note: 30x30 kit available only as a separate item.

PUSH BUTTON CAR RADIO KIT–THE TOURIST TT*

*If you can solder correctly on a Printed circuit board, you can build this kit correctly.

NOW YOU CAN BUILD YOUR OWN PUSH-BUTTON CAR RADIO!

This construction kit comprises of a fully built and aligned R.F. I.F. module; Printed circuit board, with ready mounted integrated circuit output stage and all other components. The push button tuning mechanism is full built and tested ready to mate with the printed circuit board (once it is assembled). **Note**: No test equipment is required for alignment, but remember you must have the ability to solder on a printed circuit board. **TECHNICAL SPECIFICATION**: (1) Output 4W RMS output. For 12V operation on negative or positive earth. (2) Integrated circuit output stage, pre-built three stage IF Module. Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size: chassis 7in wide, 2in high and 4¾in deep approx. Speaker including baffle and fixing strip £2 + 45p P. & P. Car Aerial Recommended—fully retractable £1·60 + 40p P. & P.

Price **£8·20** P. & P. £1·05

SPECIAL OFFER

The Tourist 1 Kit.
Complete with speakers, fixing kit and fully retractable aerial.

£10·50 P. & P. £1·50

STEREO CASSETTE TAPE DECK KIT*

Kit comprises of ready built cassette tape transport mechanism. Featuring pause control, solenoid assisted auto-stop. 3 digit tape counter, belt-driven balanced fly wheel, DC motor with electronic speed control, ready built and mounted record/replay PC board, and two VU meters, power supply. PC board, mains transformer. Input and output sockets and two level controls. Specification power source 240 AC 50Hz. Output more than 0.5v impyt mike −65dB 10KΩ. DIN −47dB 100KΩ. Track system 2 channel stereo record play-back. Tape speed 4.8CM/SEC. Frequency response 50-12.00Hz signal to noise ratio −42dB. Recording system AC Bias. Erasing system AC erase. Bias frequency 57KHz. Size of mechanism 8" x 5" x 3½" approx. unit easy to mount into your cabinet 3" required to clear base of mechanism approx.

*** This is an advanced kit not suitable for those without electrical knowledge and those unable to solder**

£32.50
+ p&p £1.50
or send SAE for complete details.

*DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties. Output 20 watts RMS into 8 ohms (suitable for 15 ohms).
Inputs *4 electrically mixed inputs. *3 individual mixing controls. *Separate bass and treble controls common to all 4 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid· State circuitry. *Attractive styling.
INPUT SENSITIVITIES – Input – 1). Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity.) – Inputs – 2), 3), 4). Medium output equipment – ceramic cartridge, tuner, tape recorder, organs, etc. – all 250mV sensitivity. AC Mains, 240V operation. Size approx: 12½"×6"×3½"

£20.00 +£1.35 p & p.

8 TRACK HOME CARTRIDGE PLAYER

Elegant self selector push button player for use with your stereo system. Compatible with Viscount IV system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV.

Yours for only
£14.00 +£1.70 p & p.

SPECIAL OFFER

As above but complete with build yourself Unisound Amplifier Kit (see opposite panel) + 2 'Compact' easy to build speaker kits (see opposite page)

£25.00
+ p & p £2·00

BUILD YOUR OWN STEREO AMPLIFIER*

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

Also available with 2 speakers (7"x4") £10 + £1.75 p & p. **£8.95** £1.05 p & p.

Also available with the 'Compact' (see opposite page) easy build speaker kit £13.50 + £2 p & p

PORTABLE DISCO CONSOLE*

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables. Two B.S.R. MP60 type single play professional series decks, fitted with crystal cartridges.

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

Console size –
Unit Closed – 17¾"×13¾"×8¾" (app.)
Unit Open – 35¾"×13¾"×4¾" (app.)
This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

Yours for only
£49.00 +£6.50 p & p.

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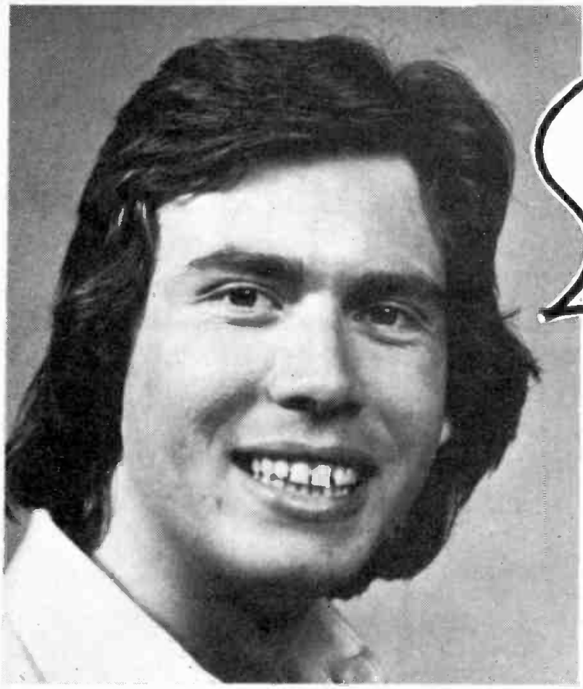

As you know, I'm fairly well in with the Managing Director of Home Radio Components Ltd. He was deep in thought when I called on him the other day. "Cooking up something new?" I said. "Yes," he replied, "I'm thinking of giving a piece of Vero Board to everybody who buys one of our catalogues, but I'm wondering if the idea is a bit gimmicky." "Certainly not," I assured him, "several electronic magazines have done it before and I'm sure lots of customers appreciate it." Encouraged, he went on, "I thought that if I offered four projects for which the board could be used it would make it even more useful and interesting." That set the ball rolling, and with the co-operation of Vero Electronics Ltd. and of Mr. Fred Bennett, Editor of "Practical Electronics" he is now able to make this unique offer . . . to every purchaser of a Home Radio Components Catalogue will be sent a piece of Vero Board and four projects for using it. The offer lasts for one month from the publication date of this journal. If you have not already got a current Home Radio Components Catalogue here is a wonderful opportunity to correct the omission (no constructor should be without one) and at the same time to win a useful piece of material and four interesting projects—A Touch Switch, a Thermometer, a Waa Waa Unit and a Light Operated Switch. The catalogue costs only 99p (including 34p for packing and postage) and it includes vouchers to the value of 30p if used as directed. This is too good to miss—send the coupon below with your cheque or P.O. for 99 pence. Why delay? Do it today!

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PE

RISING TO THE CHALLENGE

A FAIRLY tough task faced entrants for the *How Inventive Are You?* competition, the results of which appear this month. The starting point was a circuit developed for use in a gas ignitor. Not perhaps the most exciting of topics or the most versatile of circuits to provide the trigger to the thought processes. But any such beliefs were soon dispelled when the astonishing range of ideas sent in was examined. Clearly the opportunity to pit one's wits against a simple circuit in order to extract further usefulness from it was irresistible to a great number of our readers.

Recognising the limitations presented by the selected circuit, the ideas submitted were all the more laudable. Clearly much midnight oil was burnt in many instances. Some of the proposed applications were refreshingly new and not a little surprising. All in all they caused light to be cast upon many unsuspected or neglected regions. The results were both revealing and encouraging to our industrial co-sponsor no less than to ourselves.

An exercise such as this inevitably prompts the question—how much untapped inventive wealth lies within the minds of people who would not ordinarily consider themselves to be designers, inventors. or what have you? Our competition has revealed but the tip of the iceberg, that is our confident guess.

The sad fact is that the importance of harnessing or channelling the inventive powers of private persons is hardly recognised nationally. And now we are thinking in broad terms, not merely within the confines of the electronic territory. Maybe it will be claimed that anything akin to officialdom and organisation is the antithesis of the inventive spirit. And yet we know this is not true; war time innovations give the lie to such belief.

The talents are there, unrecognised and mostly unsuspected even by the individual owners, until the challenge comes. This much has been proved, on a modest scale at anyrate. by the outcome of the Plessey/Practical Electronics *How Inventive Are You?* competition.

A WELCOME CUT

The halving of the 25 per cent rate of V.A.T. in the April Budget is warmly welcomed. Electronic components that come under the higher rate of V.A.T. will now be rated at 12½ per cent, like consumer goods such as electrical appliances and home entertainment equipment.

In view of this easing of the constructors' burden it may seem ungrateful to carp at the Chancellor's proposals. But the continuance of a two-level tax system with the arbitrary division of goods into luxury and non-luxury categories is to be regretted. The administrative and accountancy problems it creates when dealing with orders for miscellaneous components and kits of parts are only too well known by component suppliers. The Chancellor should keep in mind the overall advantages of one rate of V.A.T., as the trade has strongly recommended.

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Rally MILOMETER

By P. LEAH

THIS Digital Milometer was designed specifically for use on car rallies or applications where accurate map reading and navigation from a car are essential. The basic requirements for such a unit are summarised below:

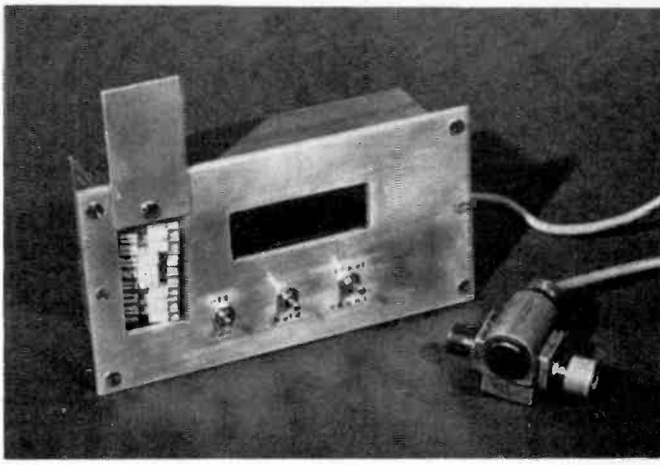
(a) Compactness: The design must be capable of fitting into an already overcrowded dashboard without hindrance to other equipment.

(b) Accuracy: The design should be capable of reliably measuring at least to the accuracy that a map can be read.

(c) Visibility: The display should be easily visible, during day and night, by both driver and navigator.

(d) Robustness: The milometer must be capable of withstanding vibration and shock associated with the rough handling experienced on a car rally.

(e) Cost: The cost should be kept to a minimum.



The completed unit showing the pulse sender unit and the cutouts for the displays and switches S2, 3a-d

CHOICE OF TECHNOLOGY

To avoid interface problems, it was decided that the counting and display driving should use a single type of technology, which would preferably drive the display directly and use a single supply voltage.

The voltage supply should be reliable even when the car is starting up, and should be derived from the 12V car battery. The technologies considered were TTL, CMOS, and a MOS counter and display chip.

The MOS counter and display chip was rejected initially because of its cost but also because the high supply voltages could not be derived directly from the 12V car battery. Further, the displays best suited to this type of integrated circuit are high voltage low current types which introduce similar voltage supply problems.

Complementary MOS (CMOS) technology was also rejected because of the difficulties of directly driving the display and the higher component cost as compared with TTL. The advantages of low power consumption and high noise immunity do not outweigh the disadvantages, since the car battery is easily capable of supplying high currents and the noise immunity of TTL is adequate for the environment of a car.

Consequently, normal TTL was chosen for counting and display driving, mainly because of its low cost and easy availability. Also the regulated 5V supply voltage could readily be derived from the car battery and the 7447 seven-segment display drivers could drive directly a Minitron display from the 5V regulated supply.

Minitrons were preferred to an l.e.d. display only because of their lower cost.

ACCURACY

The accuracy of the milometer is dependent on the method of taking the basic measurement. In a car two possibilities are open:

(1) Measure the revolutions of the wheel.

(2) Measure the revolutions of the speedometer cable.

The wheel on a Mini is approximately two yards in circumference. If wheel revolutions are counted to measure a distance of one tenth of a mile the accuracy is within 2 ÷ 176 = 1·1 per cent. If the milometer is required to measure to one tenth of a kilometer the accuracy is reduced to 1·8 per cent which is less than the accuracy with which an Ordnance Survey metric map may be read.

Further, the pick up from the wheel would need to be particularly resistant to shock since it would not have the protection afforded by the shock absorbers and the car suspension which the chassis and engine enjoy.

Measurement from the speedometer cable has the advantages of shock protection and greater accuracy. The speedometer cable rotates approximately 144 times per tenth of a mile in a Mini giving an accuracy of 0·7 per cent. This reduces to 1·1 per cent when measuring tenths of a kilometer.

It was thought necessary to only measure to one tenth of a mile as this is equivalent to the distance which an O.S. map can be measured. Measuring to one hundredth of a mile would only be accurate to seven per cent without introducing a pulse multiplier, and even then the accuracy would not be improved when measuring to one tenth of a mile.

ELECTRONIC REV COUNTER

The method of converting revolutions of the speedometer cable to pulses again offers a number of alternatives.

The speedometer relies on the rotation of a permanent magnet for its operation; the higher the speed of the car, the faster the rotation of the magnet. However, speedometers in most cars are sealed units and this magnet is difficult to utilise. The magnetic field is too weak to operate a reed relay and a magnetic coupler was rejected owing to the difficulty in accurately positioning the coil and the inaccuracy of the method at low speeds when the change on the magnetic flux would be too slow to pick up.

The method used employed a magnet fixed to the cable whose rotation was sensed by a Hall effect integrated circuit. Fig. 1b shows how the device is mounted.

The pick up unit consists of a Halda T-piece, which is attached to the back of the speedometer, and a Sprague Hall effect chip type ULN-3000M. Halda manufacture an accurate mechanical milometer and produce T-pieces for every different type of speedometer.

The Hall effect chip is mounted inside the T-piece while a magnet is attached to the barrel of the T-piece. Once every revolution of the speedometer cable, the magnetic field is at a maximum with respect the chip which produces an output pulse.

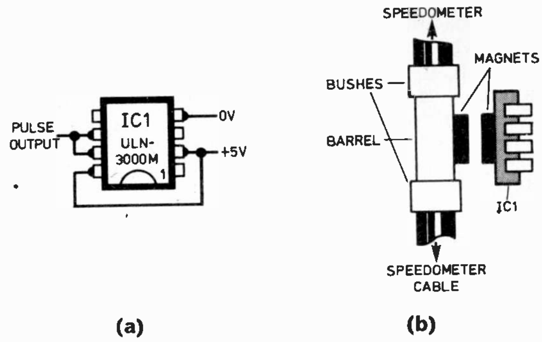


Fig. 1. Details of the pulse sender unit. (a) shows the pin connections to the ULN-3000M Hall-effect i.c. and (b) shows the method of mounting in the T-piece

The ULN-3000M is TTL compatible, the output pulses being fed directly to the counting unit. Three wires run from the pulse sending unit to the main box: one for the output pulses, one for 5V and one for OV. Fig. 1a shows the connections to the i.c. which comes in an 8-pin dual-in-line package.

The i.c. is fixed into the T-piece using epoxy resin to obtain a rigid support. Two small magnets are necessary, one being attached to the barrel of the T-piece the other being fixed to the top of the i.c. to give magnetic bias to the Hall effect probe. Both magnets are attached using epoxy resin.

CIRCUIT OPERATION

The electronics in the main part of the milometer take the pulses from the Hall effect chip and when the number of pulses equivalent to one tenth of a mile have been received the display is incremented by one. The pulse counter then resets to zero and begins to count again. The milometer may thus be separated into three parts: the pulse sender; the pulse counter; and the display counter and display.

PULSE COUNTER

The pulse counter, Fig. 2, consists of two presettable up/down counters (IC2, IC3) in cascade. The required number of pulses to indicate one tenth of a mile is programmed into the unit using eight switches contained in two dual-in-line packages (S2, S3a-d).

The number (up to 256) is set on the switches which are accessible from the front panel for easy adjustment. The switches are "on" to give a logical 0 and off to give a logic 1, the 1kΩ pull-up resistors (R4 to R11) acting to give the required voltage at the counter inputs.

Each time a pulse is received from the pulse sender the counters count down by one. After counting the programmed number of pulses the counters are at zero which produces a pulse to the display counters and also resets the counters to the number programmed on the switches.

The clock pulses from the pulse sender are fed to a two-input Schmitt gate (IC4a) which prevents the slow rise time of the received pulses causing false triggering of the counters. The other input to gate IC4a is counted to the HOLD switch S1. To inhibit counting the HOLD switch is closed which holds the output of gate IC4a at logic 1, thus preventing any clock pulses reaching the counters.

The capacitor across the switch (C1) prevents contact bounce which could cause false triggering.

Gates IC4b and IC4c perform the PRESET and RESET functions. A logic 0 at either input of gate IC4c will cause the output to go to logic 1 which causes the two counter i.c.s to be preset to the programmed number. When counting normally, both inputs to gate IC4c are at logic 1.

No capacitor is required to prevent contact bounce on the reset switch (S4) since the first pulse will preset the counters and any subsequent pulses will have no effect. Gate IC4b is simply connected as an inverter to produce the correct plarity PRESET pulse.

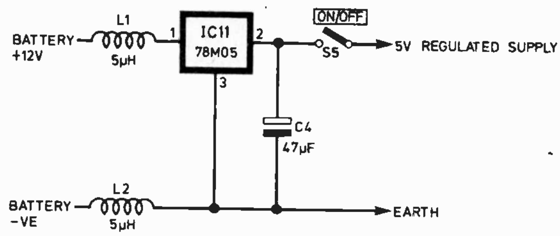


Fig. 4. Circuit diagram of the 5V regulator section. The chokes suppress transients in the leads

DISPLAY AND COUNTER

The counter for the display consists of three decade counters in cascade (IC8 to IC10). The binary coded decimal (b.c.d.) output from each counter is decoded by a b.c.d. to seven-segment display driver (IC5 to IC7) which drives the Minitrons directly, Fig. 3.

The maximum count is 99·9 miles but this can easily be extended to 999·9 miles by the addition of another counter/decoder/display stage but it was not thought necessary and did not warrant the extra space.

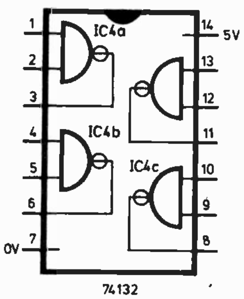
The RESET is common to all counters, operation of switch S4 causing them all to be set to zero.

POWER SUPPLY

The 5V regulated power supply for the integrated circuits is derived from the car battery using a 5V 500mA regulator chip (IC11). The complete circuit is shown in Fig. 4.

The battery voltage may fluctuate between 9V and 15V which is within the input limits of the regulator.

The capacitor (C4) decouples the output and two 0·01μF capacitors on the logic board again decouple the supply. Two chokes (L1, L2) are inserted in the supply rails from the car battery to suppress any noise on the leads.



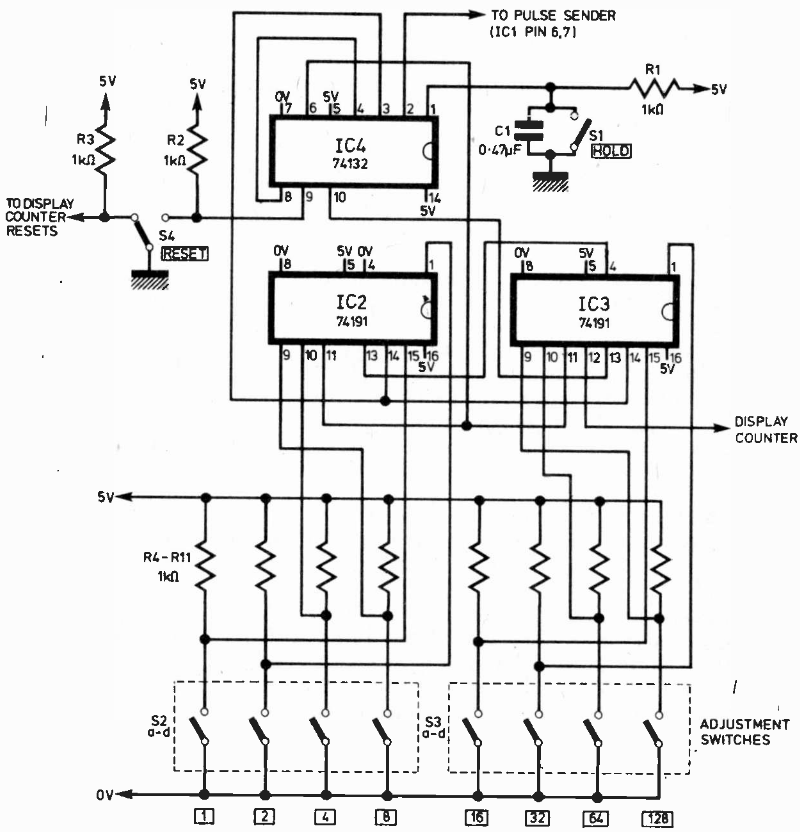


Fig. 2. Circuit diagram of the pulse counting section of the Digital Milometer. The internal configuration of IC4 is shown above. Wiring of the component boards should be ascertained from the Figs. 2, 3 and 4

COMPONENTS . . .

Resistors
R1–R11 1kΩ ½W carbon (11 off)

Capacitors
C1 0·47μF polycarbonate
C2, C3 0·01μF disc ceramic (2 off)
C4 47μF 6·3V tantalum

Inductors
L1, L2 5μH chokes (2 off)

Integrated circuits
IC1 ULN-3000M (Sprague)
IC2 SN74191N
IC3 SN74191N
IC4 SN74132N
IC5–IC7 SN7447 (3 off)
IC8–IC10 SN7490 (3 off)
IC11 78M05 5V ½A regulator

Displays
LP1–LP3 Minitron 3015F (3 off)

Switches
S1 Sub miniature toggle
S2, S3 4-pole 2-way dual-in-line switch (2 off)
S4 Sub miniature toggle
S5 Sub miniature toggle

Miscellaneous
0·1in matrix Veroboard 114 × 66mm.
d.i.l. printed circuit board 114 × 66mm.
Aluminium box 133 × 70 × 38mm.
Perspex 65 × 40mm, 1·5mm aluminium 153 × 83mm.
Three way terminal block. Halda T-piece (Halda Ltd., Taximeters, 4 Brandon Rd., London N7).
Two small magnets.

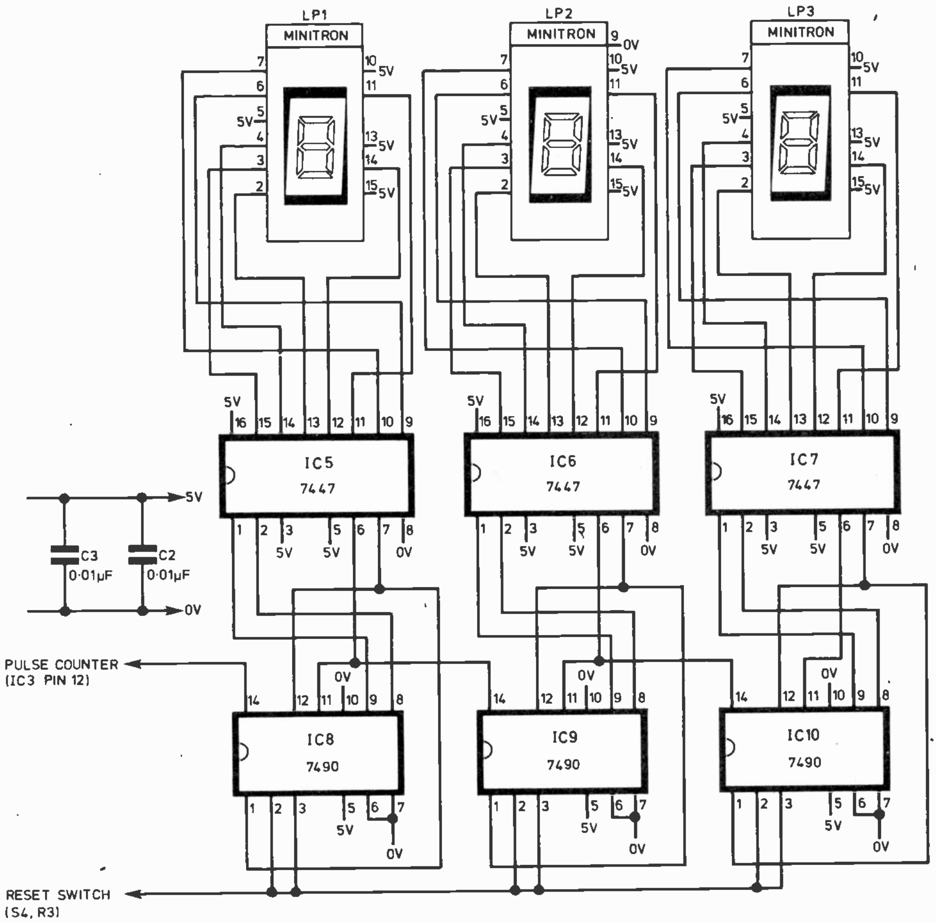
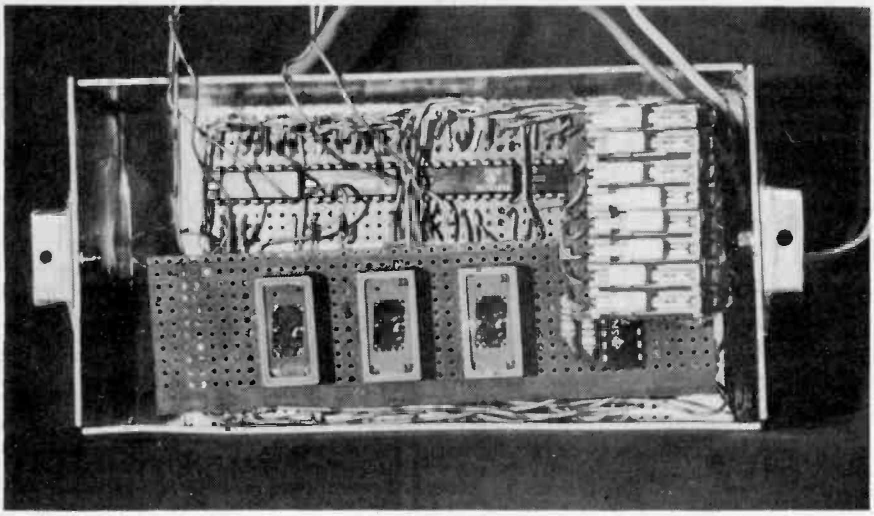


Fig. 3. Circuit diagram of the display counter, decoder and display section of the Milometer



Interior view of the Milometer showing the dual-in-line switches and general layout of display board

CONSTRUCTION

The components for the Digital Milometer were mounted on two boards which fit on top of one another in a small aluminium box. All the counters and display drivers were mounted on the lower board (Fig. 6) which was part of a board designed specifically for dual-in-line i.c.s.

The display, the 74132 and the dual-in-line switches were mounted on an L-shaped piece of 0·1in matric Veroboard, see photograph above for rough guide.

The front panel was made from 1·5mm aluminium sheet in which a rectangular hole was cut to view the display (see Fig. 5). The hole was backed with red Perspex to enhance visibility. Another hole is cut in the panel for access to the dual-in-line switches.

The three switches for RESET, HOLD and ON/OFF are also mounted on the front panel.

The interconnecting cable between the main unit and the pulse sender could not be a permanent fixture as the milometer fitted into the dashboard whilst the sender fitted onto the speedometer. A three-way terminal strip connector was mounted on the back of the milometer which terminated the cable and allowed the pulse sender to be easily separated from the main unit.

A twisted-pair screened cable was used for the interconnection which was screened to the milometer earth and used one wire for the pulse, and one for the 5V supply.

The regulator chip was mounted on the aluminium case of the milometer which acts as a heatsink. It was found necessary to completely isolate the car chassis from the milometer voltage supplies, particularly on positive earth cars such as Minis.

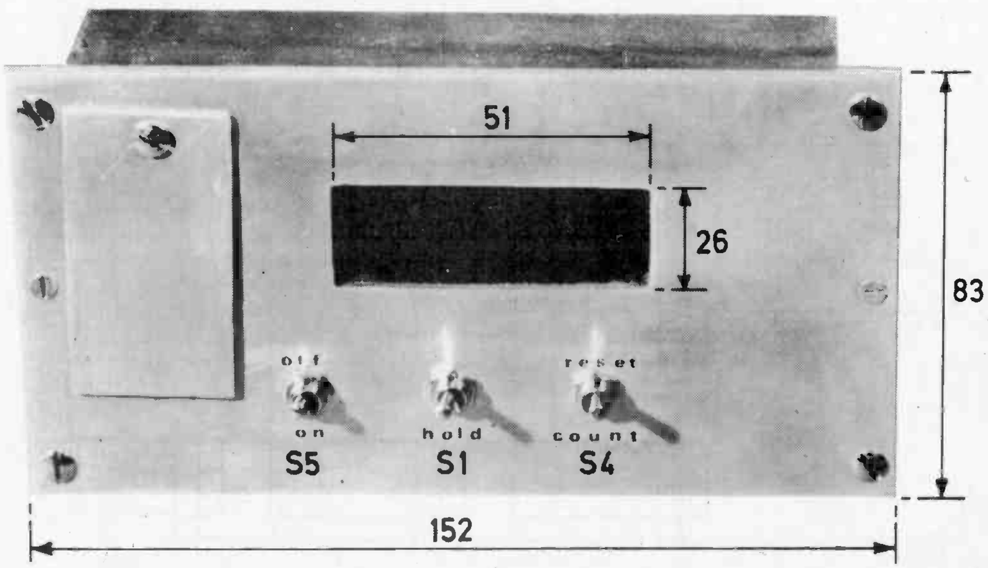
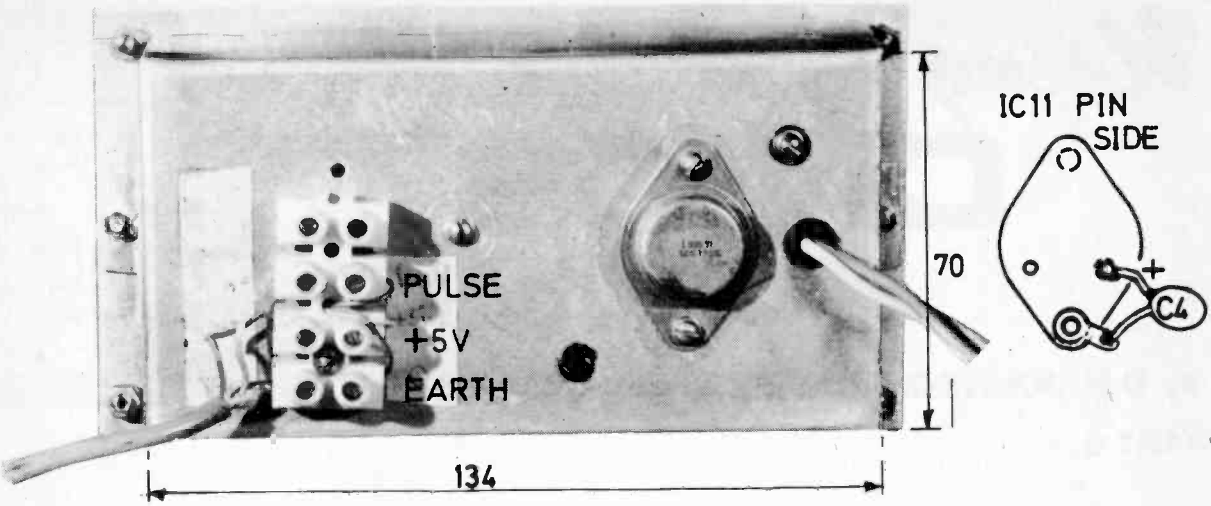


Fig. 5. Front panel details and overall measurements. The dual-in-line switches cutout measures 32 × 45mm



Rear view of the Milometer showing the three-way terminal block, regulator i.c. and measurements. Note that C4 is wired directly to the i.c. as shown on the right

TESTING

Testing the circuit is relatively easy as logic circuits are used, and each input or output will be at either a logic 1 or 0.

Connect the 12V and 0V leads to a suitable supply point. The programme switches S2 and S3 determine the number of pulses to be counted within the range 16 to 256, counting in binary. To work out the required number set the switches to 100 (decimal) which is 01100100 in binary. Then drive a known distance—the longer and straighter the route the greater the accuracy.

The distance indicated on the milometer display will be a percentage of the actual distance. The milometer should then be calibrated by changing the setting of 100 by the percentage error.

$$\text{New setting} = \frac{100 \times \text{Actual distance}}{\text{Indicated distance}}$$

The milometer could then be double checked by driving back along the same route when the reading should then be correct.

Once set up the only recalibration found necessary has been caused by tyre changes and wear, and then the change was only a few per cent.

Should any faults be encountered the following procedure should be used. First check that pulses are being correctly received from the sender by observing the output of gate IC4a with an multimeter as the barrel of the T-piece is revolved with a screwdriver. The outputs of the 74191 counters should then be checked. The counters should count down as pulses are fed in and should preset to the number set on the switches when zero is reached.

The 7490 counters can be tested by observing the Minitron displays. With each pulse from the 74191 counters the display should increment by one.

The voltage supply from the regulator should be between 4·75V and 5·25V. Under no circumstances should it exceed 5·5V as damage to the TTL i.c.s will result.

When testing for logic levels, the logic 0 state should be between 0 and 0·8V and logic 1 at least 2V. ★

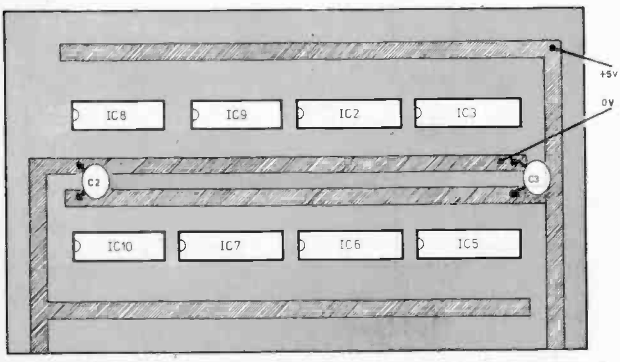
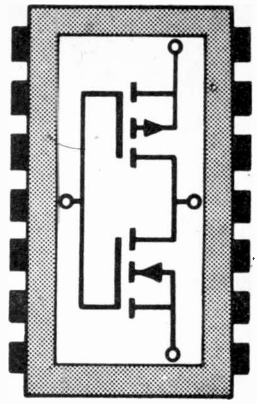


Fig. 6. Layout of the components on the dual-in-line board

Using CMOS digital I.Cs



By D.B. JOHNSON-DAVIES & A.M. MARSHALL B.A.

PART 6

THIS month retriggerable monostables, digital filters and three-state output devices will be discussed.

RETRIGGERABLE MONOSTABLE

In some circumstances it is very useful to be able to retrigger the monostable; in other words, start the timing period afresh at each new input pulse. The difference between these two types of operation is shown in the waveforms of Fig. 6.2 (a) and (b). A large amount of additional gating is needed to provide this retriggering facility, and so it is very convenient that two such circuits are available in a single package in the CMOS family, designated either 4098 or 4528 according to the manufacturer (Fig. 6.1).

Two inputs are provided, the TR+ triggering on the leading edge of the input pulse and the TR— triggering on the trailing edge. If not used they should be tied to V_{SS} or V_{DD} respectively. To prevent retriggering when this facility is not required the output can be fed back to the input to inhibit the input for the duration of the pulse. The four different possible modes of operation are shown in Fig. 6.2.

The period of the output pulse is determined by the externally connected timing capacitor and resistor, and can be varied over the range 1 sec. to 100 nanosecond. It is approximately equal to RC seconds, but can vary by 10 per cent between two monostables in a package and by as much as ±80 per cent between different devices. Where a precise pulse width is required the need for initial calibration can be avoided by using the 4538, which incorporates linear circuitry to achieve a more accurately specified period.

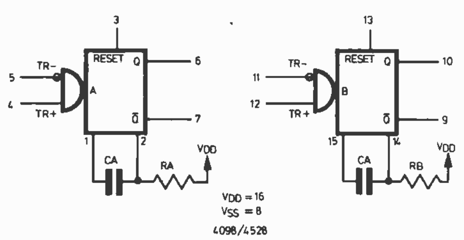


Fig. 6.1. Pin connections for the 4098 or 4528 dual retriggerable monostable. R_A and R_B can be between 5kΩ and 10MΩ. C_A and C_B can be any value, and the period is given approximately by T=RC seconds

DIGITAL FILTERS

From the waveforms of Fig. 6.2 (a) and (c) it is clear that in the retrigger mode the output will remain high as long as the period of the input is shorter than the period of the output pulse. These two circuits therefore act as digital low-pass filters,

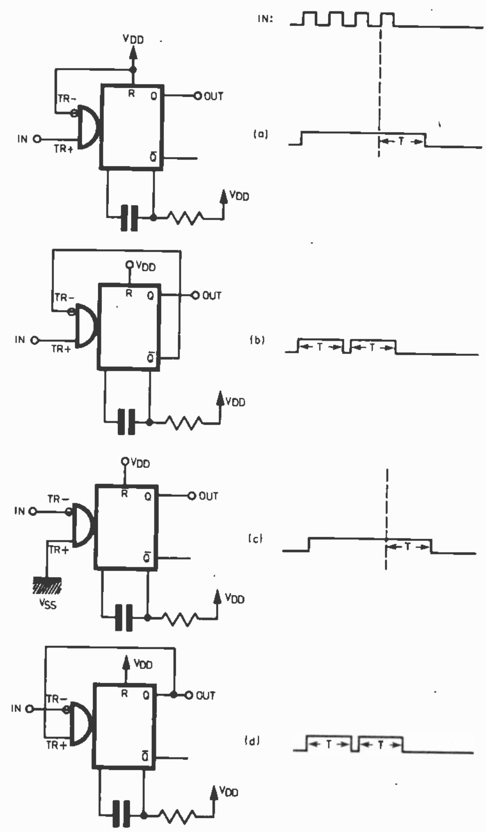


Fig. 6.2. The four possible modes of operation of the 4098/4528 monostable, and the four outputs obtained with the input shown

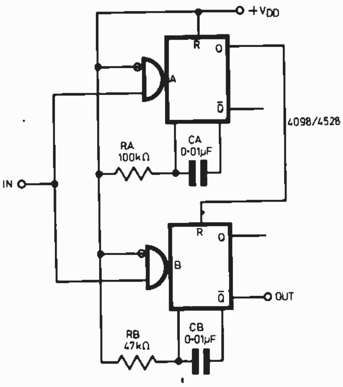


Fig. 6.3. Digital bandpass filter constructed from a single 4098/4528 package. If the input pulse interval lies between the periods of the monostables, the output follows the input. Otherwise the output is permanently held either high or low. With the values given only frequencies lying between 1kHz and 2kHz will be transmitted

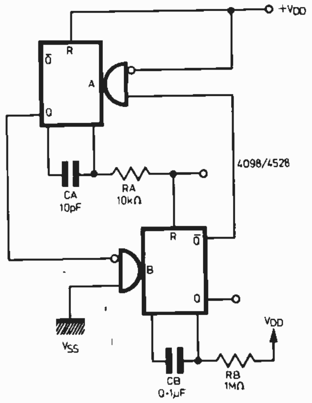


Fig. 6.4. Multivibrator using two monostables. With the values given the "on" and "off" times are about 0·1 secs and 0·1 μsecs respectively

admitting only frequencies of less than 1/T. They can be used as envelope detectors, demodulation signals such as the pulse-modulated output of the gated oscillator described earlier. The values of R and C should be chosen to give a period just greater than that of the modulating frequency.

A bandpass filter can be built from a single package as shown in Fig. 6.3. This will only pass a pulse train whose pulse interval lies between the periods of the two monostables. The period T_A should be greater than the period T_B. The operation is as follows. If the pulse interval of the input is less than T_B, monostable B is repeatedly retriggered before it has a chance to deliver a full output pulse, and its output Q_B remains low. If the pulse interval is greater than T_A, monostable A delivers an output pulse for each input pulse, and these are fed to RESET_B. Therefore on the arrival of each pulse RESET_B is low and monostable B remains untriggered with the output $\bar{Q}_B$ permanently high. In the third condition where the pulse interval lies between the periods T_A and T_B monostable A is repeatedly

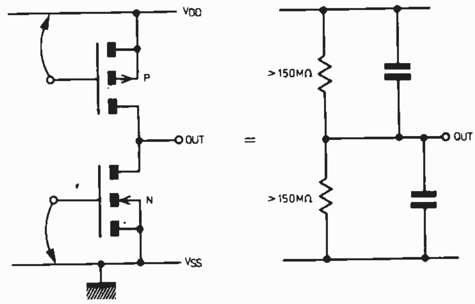


Fig. 6.5. Complementary pair with both devices biased "off" forms a disabled output which is floating with respect to the supply rails

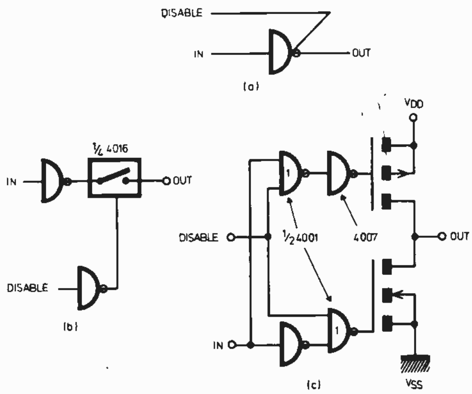


Fig. 6.6. (a) Symbol for an inverter with a three-state output. (b) Three-state output using a bilateral switch. The extra inverter is to make the disable input active when "high". (c) Three-state output using the connections to the gates of the individual MOSFETs, made available in the 4007

retriggered holding RESET_B high, so that monostable B is free to give an output pulse for every input pulse.

Finally, two monostables can be arranged to trigger one another, forming a multivibrator in which the "on" and "off" periods can be varied independently. With the values given in Fig. 6.4 the mark-space ratio is 1 : 10^7.

THREE-STATE OUTPUTS

In Part 1 of this series it was shown that the CMOS complementary pair output stage can be in one of two states; either the upper *p*-type is "on" holding the output to V_{DD}, or the lower *n*-type is 'on" holding the output to V_{SS}. However, a third state can exist in which both devices are off, and this facility has several useful applications. Fig. 6.5 (a) shows a complementary pair in which both devices are "off", and (b) the equivalent electrical circuit shows that the output is floating with respect to both supply rails. Several CMOS parts are available with such three-state outputs. These usually have an "output disable" pin which, when taken to a logic "1" level puts all the outputs in the floating state; the 4502 strobed hex buffer inverter has already been mentioned.

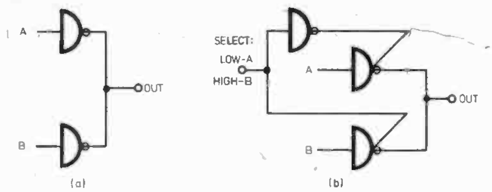


Fig. 6.7. (a) Inadvisable commoning of normal gate outputs. (b) Common bussing of two three-state outputs, where all but one are disabled at any time

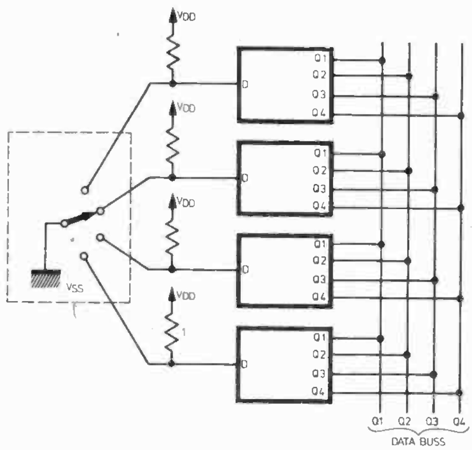


Fig. 6.8. Common bussing illustrated with hypothetical devices (such as the 4043) where only one set of outputs needs to be accessed at any time

It is also possible to build three-state outputs from discrete parts, and Fig. 6.6 shows two approaches. These are both inverters with three-state outputs, the symbol of which is shown in (a). In (b) a bilateral switch is added after the gate output. When the disable input is high, the switch is open leaving the output floating. Circuit (c) uses a 4007 package and two gates from a 4001 package to the same end. The disable input biases both output MOSFETS "off". The two inverters are formed from the remainder of the 4007 package.

OUTPUT SHARING

Three-state make possible 'common-bussing': the sharing of output lines between several outputs. In Fig. 6.7 (a) two normal outputs are commoned in an inadvisable arrangement. If the gates are in opposite states the output will be at around half the supply voltage, which is not a usable logic level. However, the arrangement is possible if the gates have three-state outputs, and all but one of the outputs are disabled as in (b). In this example the same result could be achieved using two 2-input gates, but in larger systems the gate saving becomes substantial. Fig. 6.8 shows four devices each with four three-state outputs sharing the same four buss. The switch ensures that all but one set of the outputs are disabled at any time, and would be replaced by control logic in an application.

Next month: More circuit variants and devices listed.

NEWS BRIEFS

Quad Achievements

For the first time exports of Quad equipment exceeded one million pounds in a year. This represents a contribution of more than £7,000 to the United Kingdom's balance of payments per employee.

This is a fine achievement in the highly competitive field of High Fidelity, which is widely regarded as being the exclusive domain of the Japanese.

Major overseas customers, each accounting for more than ten per cent of the total are United States, Japan, Canada and Benelux, with other European markets close behind.

Quad now looks to an even better year in 1976/77 thanks to the unprecedented success of the recently introduced Quad 405 current dumping amplifier, for which export orders of £400,000 have already been received.

A further achievement for Quad is the 405 amplifier winning a Consumer and Contracts award for good design, issued by the Design Council. This is the second Design Council award for Quad, the first was won in 1969 when their 33/303/FM3 system was selected.

Big Hit for Night Attack Missile

The Navy's new Night Attack Missile scored a direct hit at night on a moving M48 tank, marking the second successful demonstration of the Night Attack Weapon System. The test took place at the Naval Weapons Center, China Lake, California.

The missile was launched from a Navy A-6 aircraft at the longest range yet recorded for any contemporary infrared air-to-surface weapon. The target was a standard, unaugmented M48 tank moving perpendicular to the aircraft flight path. Detection of the tank was accomplished using a forward looking infrared system (FLIR). Handoff from the FLIR to the missile seeker was accomplished automatically, without operator assistance, using the weapon system boresight computer.

The test was the second in a series whose purpose is to demonstrate that the weapon system technology is within the current state-of-the-art. In its first free-flight test, the system scored a direct hit on an M53 self-propelled gun in daylight. Night Attack programme objectives include clear day/night, fire-and-forget operation, minimum operator workload, and a low-cost expendable round.

Design objective of the Night Attack non-imaging Maverick system is to provide a first pass multiple launch capability at AAA standoff ranges against such tactical sea/land targets as tanks, trucks, and patrol boats. Test results to date have validated that capability.

New Electronic Exchange in Service

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The new exchange is in Birmingham. Of the type known as TXE4, it was brought into service when 3,000 customers previously connected to the Sutton Coldfield exchange were transferred to the new exchange.

The successful bringing into service of the new exchange, called Rectory, marks a positive step forward in Post Office plans for further improving the quality of Britain's automatic telephone service. Under this scheme, the present Strowger electro-mechanical telephone exchanges will be progressively replaced by modern electronic systems capable of giving improved service and reliability. Between now and March 1980 the Post Office expects on present plans to spend about £330M on electronic exchanges at current price levels.

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BY FRANK W. HYDE

THE LARGE SPACE TELESCOPE

The long discussed space telescope which seemed until recently to be relegated to sometime in the future, is to be an international project. This telescope has the unanimous support of most astronomers. It is claimed that it could revolutionise present knowledge if it can be placed in orbit above the distorting layers of the Earth's atmosphere. Second thoughts on size have made it possible for the telescope to be in orbit as early as 1982.

To meet the request of the Congressional Committee to cut the cost, the size has been reduced from 3 metres to 2·4 metres for the mirror diameter. Restricting the effective diffraction diameter to 2 metres allows large savings in the cost of stabilisation. This decision satisfied the minimum standards but the advantages are still great.

A good comparison would be that it could be some 20 to 30 times better than a ground based telescope of equivalent size. The pointing accuracy of the instrument, better than 0·005 arc-seconds, will be achieved by star sensors and precision gyroscopes set at the rear end of the assembly. In addition its ability to concentrate the light accepted by the large aperture, to an image only 0·1 arc-second is unique.

This facility affords very considerable extension of the limits of observation particularly in the case of extra-galactic faint objects.

All this has enabled Congress to take a most unusual decision to put the project back into the budget for this year. The cost of the modified design is of the order of 350 million dollars. The unit will weigh about 7·5 tonnes and will therefore be capable of being collected by the Space Shuttle when maintenance periods and the normal procedures of up-dating is required. The designed life is 15 years.

The European participation in this international project will not involve the capital cost of the telescope but rather the input of experiments and instrumentation.

SORE POINTS IN SPACE OCCUPATION

The launching of Russia's Statsionar, the first of its operational satellites, designated *Raduga*, is geostationary over the Indian Ocean at 80 degrees East ± 5°. It operates on the standard frequencies of 4 to 6 GHz. The USSR have announced that they will place two more in orbits at about 35° and 50° East. They further announce that they will be launching another seven over the Pacific, Atlantic and the Indian Oceans to establish a global network.

Since Indonesia has announced that she plans a communications system, and also the fact that one of the Statsionar's is to be placed at 58° East (only 2° away from an operational *Intelstat 4*) interference could be a serious problem especially as the new *Intelstat 4As* is operational.

Is it possible that near space is to have traffic problems at this early stage?

THE NEW ERA OF SPACE ACTIVITY

At the Kennedy Space Centre great changes are taking place. By 1978 the scene must be set for the Shuttle programme. Already a runway 15,000 feet long and 300 feet wide has been started. This will be used as the landing strip for returning Orbiters from space. It will also accommodate the pickaback Boeing 747-Orbiter combination.

After returning from space the Orbiters will be towed from the runway to a processing area near the vehicle assembly such loads would include Spacelab. Other loads would be mounted on the Orbiters while on the launch pad.

There are plans for a double two man crew and selected astronauts will be trained to be ready for the first flight tests scheduled for mid 1977. The men selected have been named. The commander of the first crew is Fred W. Haise. He is the only crew man in the group to have flown in space. He was Lunar Module pilot for *Apollo 13* and back up commander for *Apollo 16*. Charles G. Fullerton will be pilot in the first crew. He was appointed to the NASA astronaut team in 1969. The second crew will be Joe H. Engle in command, and Richard H. Truly.

Approach and landing test-flights will be made. Drop tests will be made at the Edwards Air Force Base. The Orbiters will be carried up on specially designed Boeing 747 aircraft. The Orbiters will be released at 25,000 feet and make free flight landings.

ALSEP 14 SLEEPS FOR A MONTH

The operation of the Lunar Packages have been so constant and reliable that it was something of a shock when Alsep 14, set up by the *Apollo 14* mission, suddenly ceased to function. The team at the Johnson Spaceflight Centret have not so far been able to explain the cessation of operation, and still less its recovery after a month.

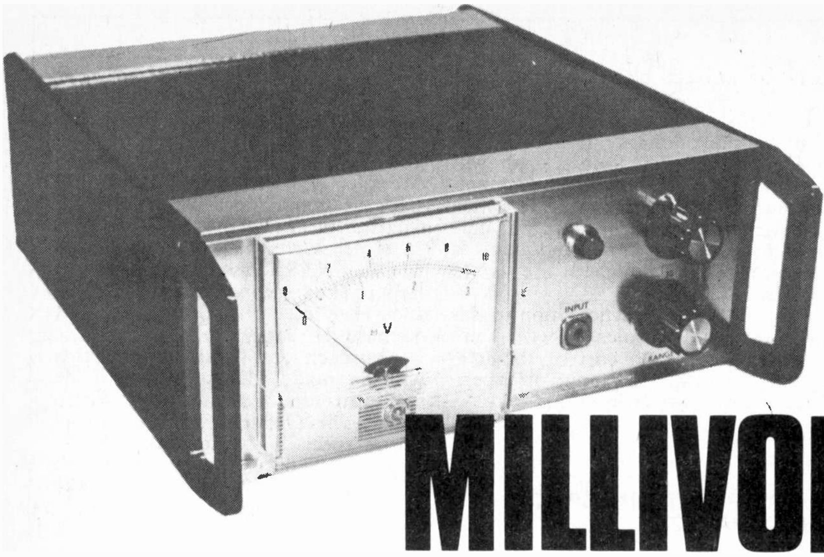
Not only did all experiments and equipment come to life, but one worked even better than before.

This was the system which was concerned with the investigation of charged particles near to the surface of the Moon. Previously the experiment did not work during the Lunar day because of temperature conditions. Now it works continuously and more efficiently round the clock.

NOTE FOR POSTERITY

Things in the sky are a part of our composite memory and there now tends to be a somewhat blasé approach to it all. While it is still true that "what goes up must come down" the "come down" may take a very long time in terms of the length of civilisations.

For a specific set of "time stones" of the future there is the *Cosmos 761* with a life of 7,500 years. *Cosmos 765* will be expected to survive 10,000 years with replacement satellites, and whose rocket will remain for 20,000 years. Or take *Titan 3C* which will be around after many civilisations rise and fall, for more than a million years. In the not too distant future too, there is another with an estimated life of two million years.



AUDIO MILLIVOLTMETER

By R. A. PENFOLD

IF one considers virtually any major audio amplifier parameter (noise level, distortion, frequency response voltage gain, etc.), it will be apparent that some form of sensitive a.c. voltmeter is required in its measurement. An a.f. millivoltmeter is thus an essential piece of test equipment for anyone involved in the design or testing of audio equipment.

The millivoltmeter described in this article covers seven ranges with full scale deflection sensitivities of 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, and 1V. The —3dB frequency response is approximately 20Hz to better than 200kH, and the response is virtually flat over the audio frequency spectrum. The input impedance is 1MΩ, which ensures a low level of loading on the equipment under test. A mains power unit is used to provide the stabilised supplies for the circuit, which is based on four inexpensive operational amplifiers.

FEEDBACK LOOP

A millivoltmeter does not merely consist of an amplifier driving a meter via a rectifier, as this would not give accurate results. The reason for this being that semiconductor diodes will not conduct heavily unless their forward conduction threshold voltage is exceeded. This voltage varies with different types of diode, and with temperature, but is about 0·65V for a silicon diode and 0·2V for a germanium one. This voltage drop would obviously have a profoundly degrading effect upon the linearity of the circuit.

It is possible to overcome this forward voltage drop by including the meter and rectifier in a negative feedback loop connected in the output amplifier circuit. The basic arrangement for this is shown in Fig. 1a.

Until the diodes begin to conduct, there can obviously be no negative feedback, and the amplifier will have a high voltage gain. It will, in fact, have its open loop gain.

Any input signal, even a very small one, will cause the forward conduction threshold of the diodes to be quickly reached by the output of the amplifier.

As this threshold is reached and the diodes begin to conduct, an increasing level of negative feedback will be introduced into the circuit. The preset resistor sets the maximum available level of feedback, and hence also the effective voltage gain of the amplifier.

Fig. 1b shows the waveform which results at the output of the amplifier when a sinewave is fed into the input. The fast leading edge of the waveform overcomes the forward threshold voltage of the diodes

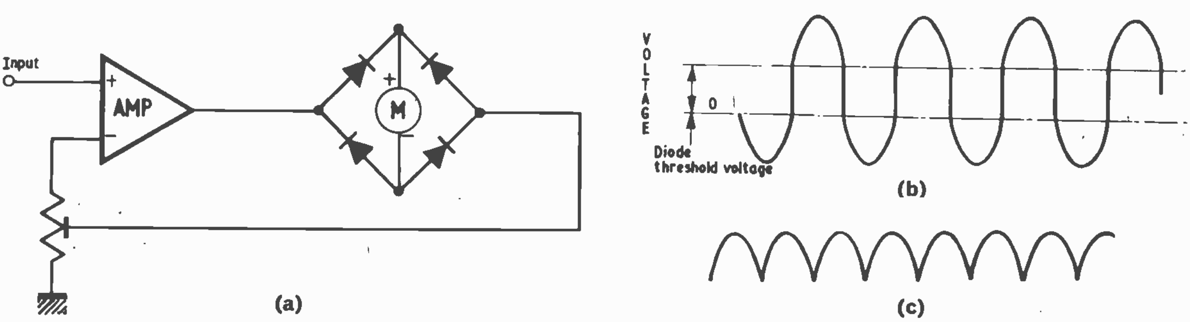


Fig. 1. (a) Overcoming diode forward voltage drop by placing them in the feedback loop of an amplifier. (b) The output waveform produced by the amplifier with a sinewave input. (c) Current waveform through meter

almost instantaneously, and then the relatively undistorted part of the waveform is fed to the meter, but is full wave rectified. A signal closely resembling a full wave rectified sine wave thus appears across the meter, as shown in Fig. 1c. This is, of course, exactly what is required.

Simply stated, the non-linearity of the diodes is cancelled out by the non-linearity of the voltage gain produced by including the diodes in the feedback loop.

PRACTICAL CIRCUIT

The circuit diagram of the audio millivoltmeter is shown in Fig. 2.

A 741 operational amplifier is used as the input stage. This is connected as a unity voltage gain buffer amplifier with a 100% negative feedback loop between its output and inverting input. R1 provides the bias voltage for this stage and sets the input impedance at 1MΩ. C1 provides d.c. blocking at the input. The output of this stage is taken to the attenuator via C2.

This simple arrangement provides a high input impedance and a low output impedance, and it also has a very low noise level. One slight disadvantage, however, is that at high frequencies (at about 100kHz and above) this stage may not be able to handle a signal of around 1 volt r.m.s. properly. This results in a reduced upper frequency response on the 1V range with readings approaching f.s.d.

ATTENUATOR

The attenuator section really consists of six separate attenuators, one for each range from 3mV to 1V. The lower resistor of each attenuator also forms the input bias resistor for the non-inverting input of IC2. In the 1mV position no attenuator is required, and R3 provides the input bias for IC2. The attenuator is connected in a low impedance part of the circuit so that stray capacitances have no significant effect on the unit's frequency response, and no frequency compensation is necessary.

IC2 is used as a non-inverting amplifier. Its closed loop voltage gain is controlled by the two feedback resistors, R15 and R16, and is approximately equal to (R15 + R16) R15. This gives a voltage gain of about 10 times (20dB) with the values shown. C3 is the compensation capacitor.

IC3 is used in a virtually identical configuration to that adopted for IC2. The two stages are capacitively coupled via C4. R17 provides the bias for the non-inverting input. C5 is connected in parallel with feedback resistor R18, and at high frequencies where the impedance of this capacitor is low, it boosts the gain of this stage. This gives the millivoltmeter an improved high frequency response. IC3 is direct coupled to the output stage.

This uses IC4 in the arrangement shown in Fig. 1, which was discussed earlier. As the meter and rectifier circuit is direct coupled to the output of the i.c., it is

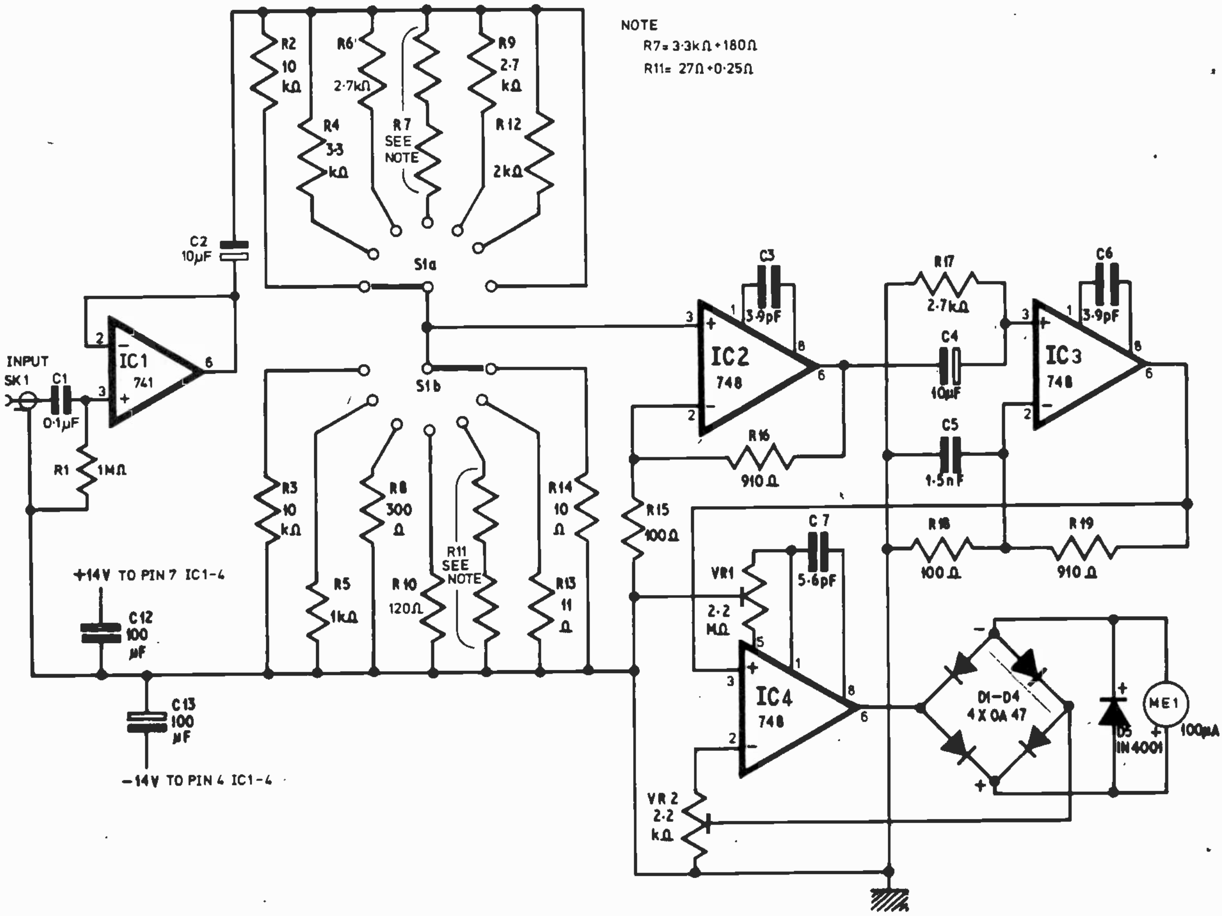


Fig. 2. Circuit diagram of the Audio Millivoltmeter

necessary to have an offset null adjustment circuit. This is the function of VR1. VR2 permits adjustment of the sensitivity of the circuit, and allows the unit to be calibrated against an a.c. voltage of known value. Gold bonded diodes are used in the rectifier as these have a low forward conduction threshold voltage.

As the 748 i.c. is capable of giving a large enough output to damage a 100μA meter in the event of a fault or considerable overload, it is essential to have some form of overload protection for the meter. D5 has been included for this purpose, and it is used here as a sort of low voltage zener diode. This limits the voltage across the meter to about 0·5V, which is insufficient to damage most meters, even if sustained.

C12 and C13 are supply decoupling capacitors.

COMPONENTS . . .

Resistors

R1	1MΩ	R12	2kΩ 1%
R2	10kΩ 1%	R13	11Ω 1%
R3	10kΩ 1%	R14	10Ω 1%
R4	3·3kΩ 1%	R15	100Ω
R5	1kΩ 1%	R16	910Ω
R7	{180Ω 1% / 3·3kΩ 1%}	R17	2·7kΩ
		R18	100Ω
R8	300Ω 1%	R19	910Ω
R9	2·7kΩ 1%	R20	2·7kΩ
R10	180Ω 1%	R21	2·7kΩ
R11	27Ω+0·25Ω 1%		

All resistors ¼W 5% unless otherwise stated

Potentiometers

VR1 2·2MΩ
VR2 2·2kΩ

Capacitors

C1 100nF plastic
C2 10μF 10V elect.
C3 3·9pF ceramic
C4 10μF 10V elect.
C5 1·5nF disc ceramic
C6 3·9pF ceramic
C7 5·6pF ceramic
C8 400μF 25V elect.
C9 400μF 25V elect.
C10 100μF 16V elect.
C11 100μF 16V elect.
C12 100μF 16V elect.
C13 100μF 16V elect.

Semiconductors

IC1 741 8 pin d.i.l. (plus socket)
IC2, 3, 4 748 8 pin d.i.l. (3 off plus sockets)
TR1 BC148
TR2 BC158
D1–4 OA47 (4 off)
D5–7 1N4001 (3 off)
D8, 9 BZY88C15V (2 off)

Transformer

T1 Mains transformer with 6–0–6V at 100mA

Miscellaneous

Instrument case, approx. 215 × 215 × 85mm metal
100μA moving coil meter (see text).
D.P.S.T. mains rotary switch.
Mains panel neon with internal series resistor.
Miniature Maka-switch parts (see text).
Materials for p.c.b. manufacture.
20 s.w.g. aluminium for screen.
Two pointer knobs.
Sundry hardware.

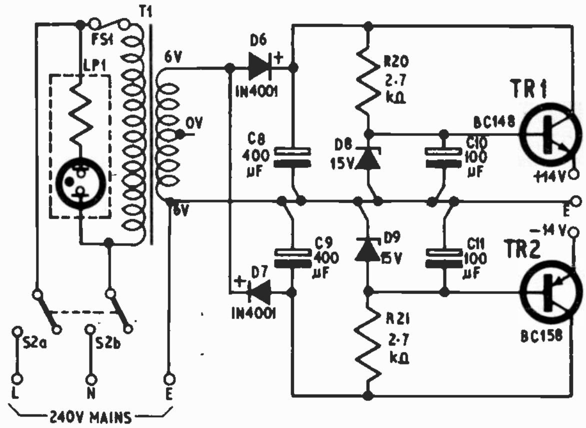


Fig. 3. Power supply circuit

POWER SUPPLY

Fig. 3 shows the circuit diagram of the mains power supply unit. Stabilised supplies are provided even though the gain of the millivoltmeter circuit is largely independent of the supply voltage. A stabilised supply ensures good stability of the direct coupled output stage. The p.s.u. fulfils the usual op. amp. requirement of equal positive and negative supplies with the central supply line being earthed.

The circuit consists of two halfwave supplies, one using D6 and C8 and providing a positive supply, and the other using D7 and C9 to provide a negative supply.

Electronic smoothing regulation of the positive supply are provided by R22, D8, C10, and TR1. These are connected in a well known configuration with TR1 operating as an emitter follower series regulator. An identical but complementary arrangement is used for the negative supply.

Although only half wave rectification is used, the outputs of the supply are well smoothed and regulated and provide about ±14V to the main circuit.

COMPONENTS

Any 100μA moving coil meter should work in the circuit, but, as RS dual scaled 0–3 and 0–10 meter is most suitable. If an ordinary 100μA meter is used, it will be necessary to add a 0–3 scale by hand, which is not at all easy to do accurately.

In order to be sure of good accuracy on all ranges it is essential to use close tolerance resistors in the attenuator unit. 2% tolerance should be regarded as a minimum requirement for these components, and 1% types are preferable.

S1 is a seven way two pole rotary switch, and can be made from RS Miniature Maka-Switch parts. The parts required are one shafting assembly, two single pole wafers, and eighteen 3·2mm spacers. The adjustable end stop is set for seven-way operation, and the wafers are mounted one at the extreme front of the shafting assembly and one at the extreme rear.

R11 needs to have a value of about 0·27 ohms, but this value may be difficult to obtain in a low wattage. Four 1 ohm 1/8 watt resistors wired in parallel (0·25 ohms) were used for this component on the prototype.

METER CIRCUIT BOARD

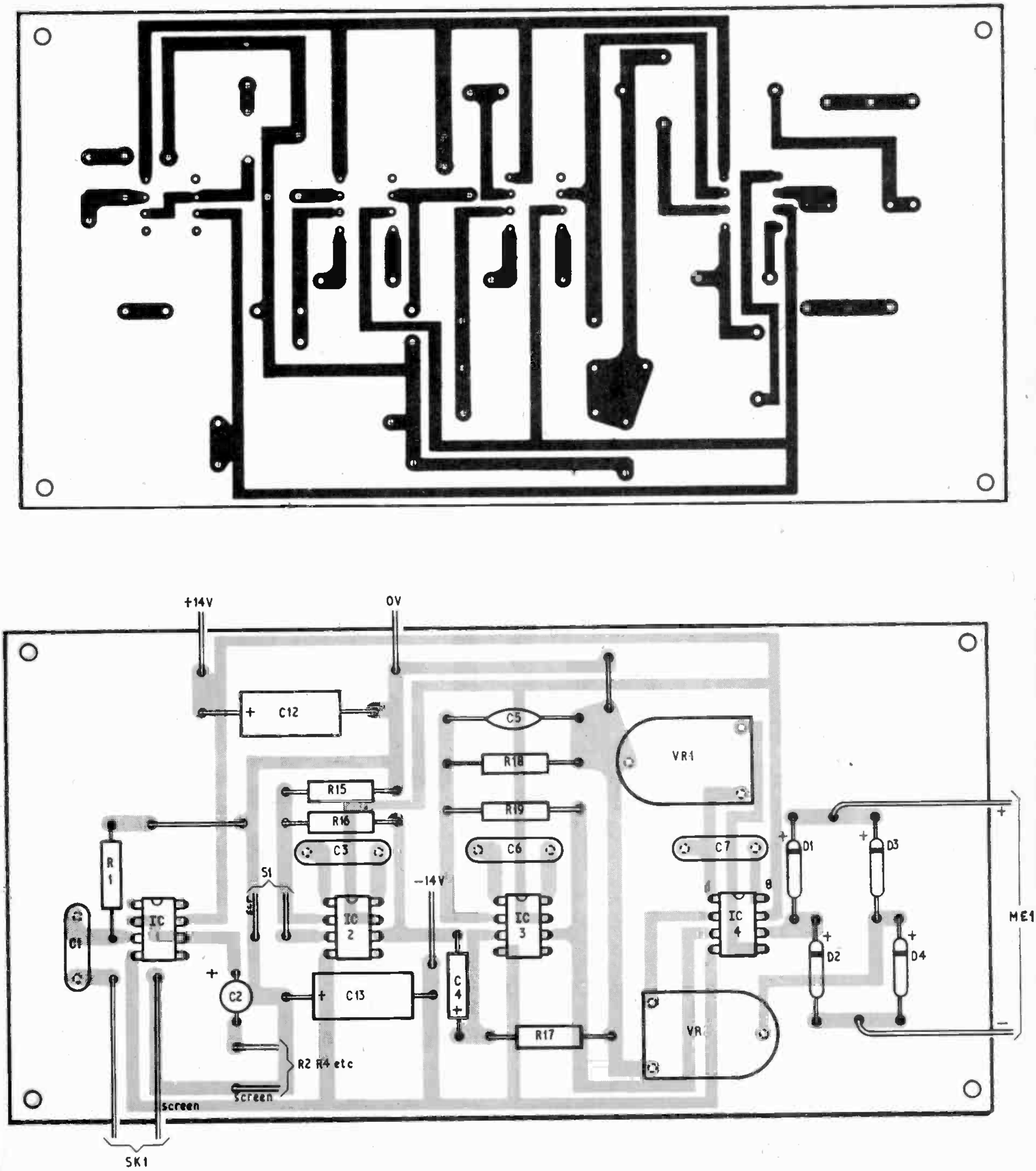
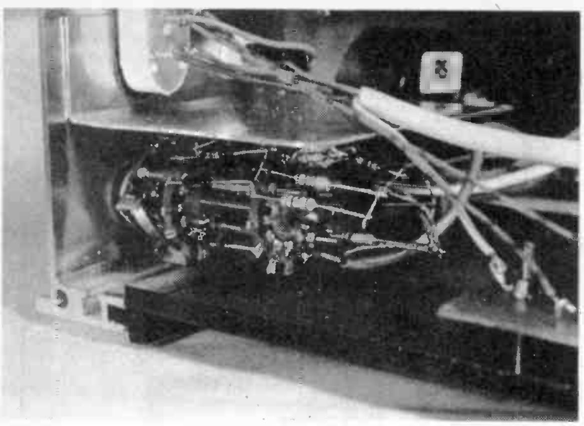


Fig. 4. Component layout and p.c.b. master for main board



The input socket screen and attenuator resistors mounted on the selector switch

Any case which will comfortably accommodate the components can be used to house the unit, with the one proviso that it must be constructed of metal. The prototype is constructed in a "Swift Half Rack Width" case, and this can be obtained from West Hyde Developments Ltd.

CONSTRUCTION

Mechanically construction is quite straight forward, and the general layout of the prototype can be ascertained by reference to the accompanying photographs. It is strongly recommended that this layout is adhered to, as the circuit is very sensitive and stray pick-up of mains hum is the likely result of a careless layout.

An L-shaped 20 s.w.g. aluminium screen is used to isolate the attenuator unit and input socket from the mains wiring around the on/off switch. The screen is secured to the front panel by, in effect, being bolted to the panel using S2 and LP1. The large cutout for the meter can be made using a fretsaw.

The attenuator resistors and R3 are wired up on S1, the upper set of resistors (R2, R4, etc.) being mounted

POWER SUPPLY BOARD

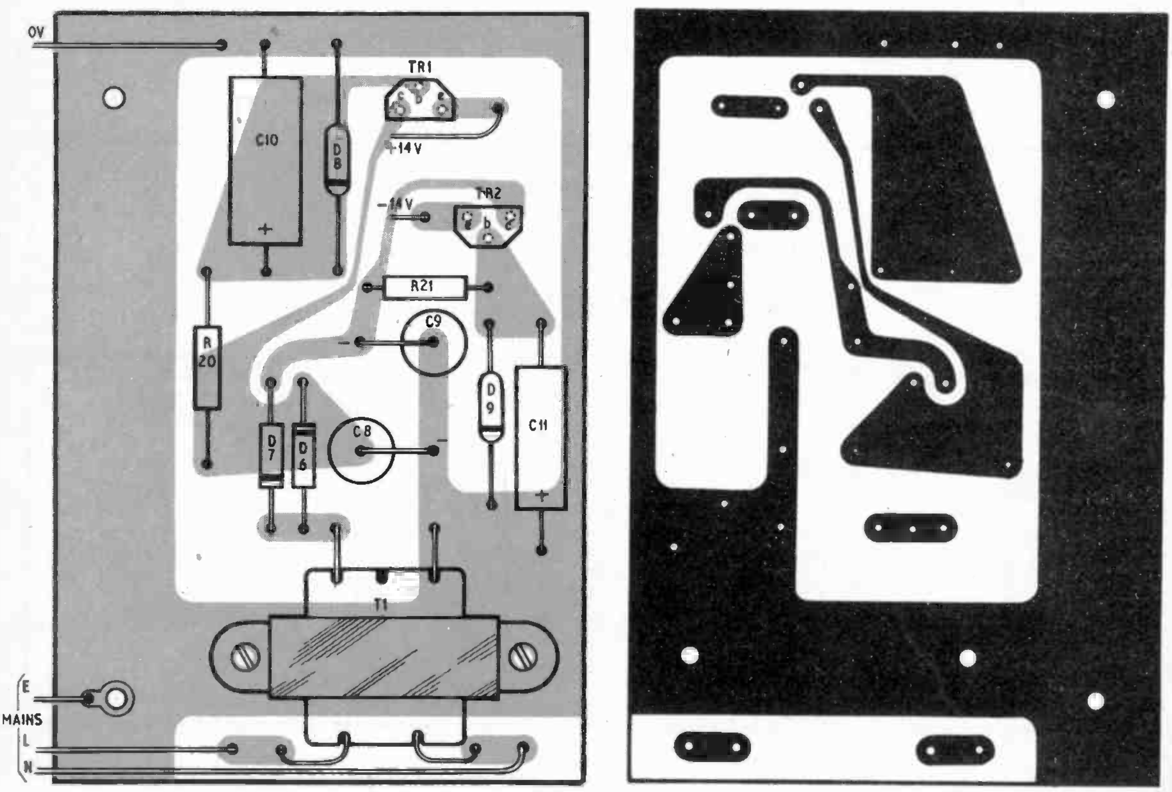
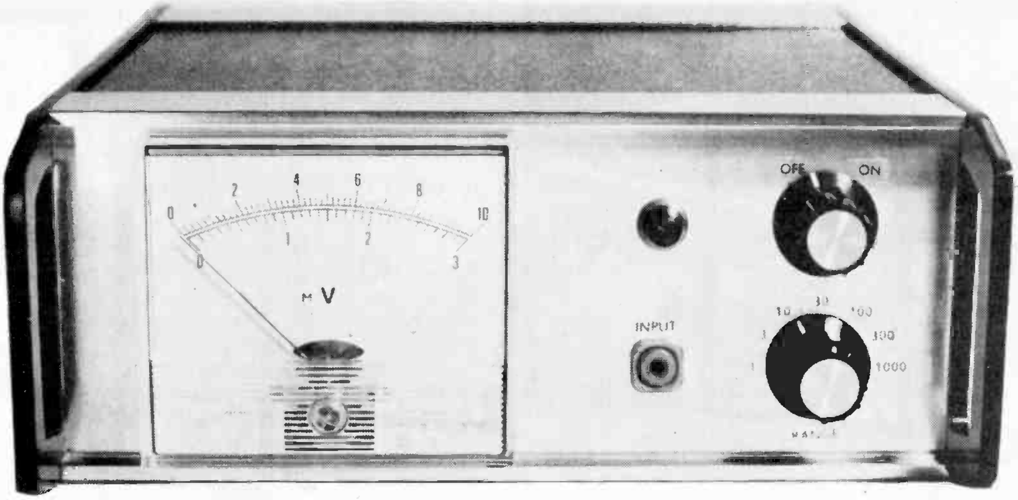


Fig. 5. Details of power supply p.c.b.



Front of the Audio Millivoltmeter showing the range switch and input socket

on the front wafer, and the lower set (R3, R5, etc.) being mounted on the rear one. This is not quite as simple as it may at first appear, as there is not a great deal of space for the resistors and their leads must be cut quite short. The resistors are wired up before the switch is mounted.

The main circuitry is contained on two printed circuit boards, one for the meter circuitry and the other for the p.s.u. The etching patterns and component layouts of these boards appear in Figs. 4 and 5 respectively. These have been kept as simple as possible and it should not be too difficult for the average constructor to produce his own p.c.b.s. It is not recommended that any other form of construction should be tried.

Veropins are used where leads will connect to the boards, so that when the boards have been mounted it will be a simple matter to wire up the unit. The two p.c.b.s. should be mounted as far apart as possible. Screened leads must be used at the three places specified in Fig. 4.

D5 is wired directly across the meter terminals.

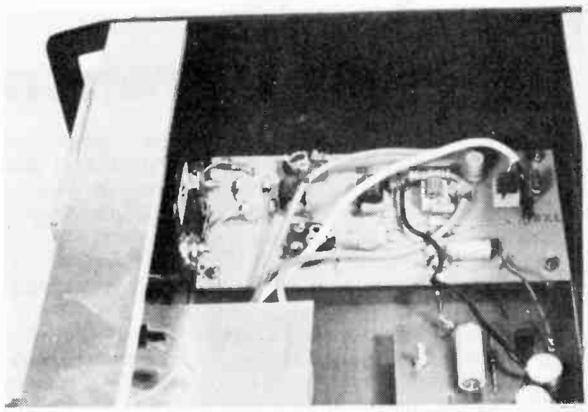
CALIBRATION

Before switching on the finished unit, set VR1 and VR2 with their sliders at approximately the centres of their tracks and check that the meter is properly zeroed. Upon turning on, the meter should give a small positive indication, and VR1 is then used to zero the meter again.

For calibration an audio tone of around 250Hz to 2kHz with an amplitude between about 1mV and 1V r.m.s. is required. The precise amplitude of this signal must be known. Most signal generators have a calibrated output, but this can only be relied upon for a high degree of accuracy on the more expensive generators.

To calibrate the unit using such a signal generator it is merely necessary to set it for an output level which is the same as one of the full scale sensitivities of the millivoltmeter. With the millivoltmeter switched to the appropriate range it is then connected to the output of the signal generator. VR2 is then adjusted to give full scale deflection of the meter.

It is possible to use a less sophisticated signal generator as a signal source, but in the interests of accuracy it is advisable to measure the output rather than rely upon the calibration of the generator.



Interior of the unit showing position and interwiring of boards

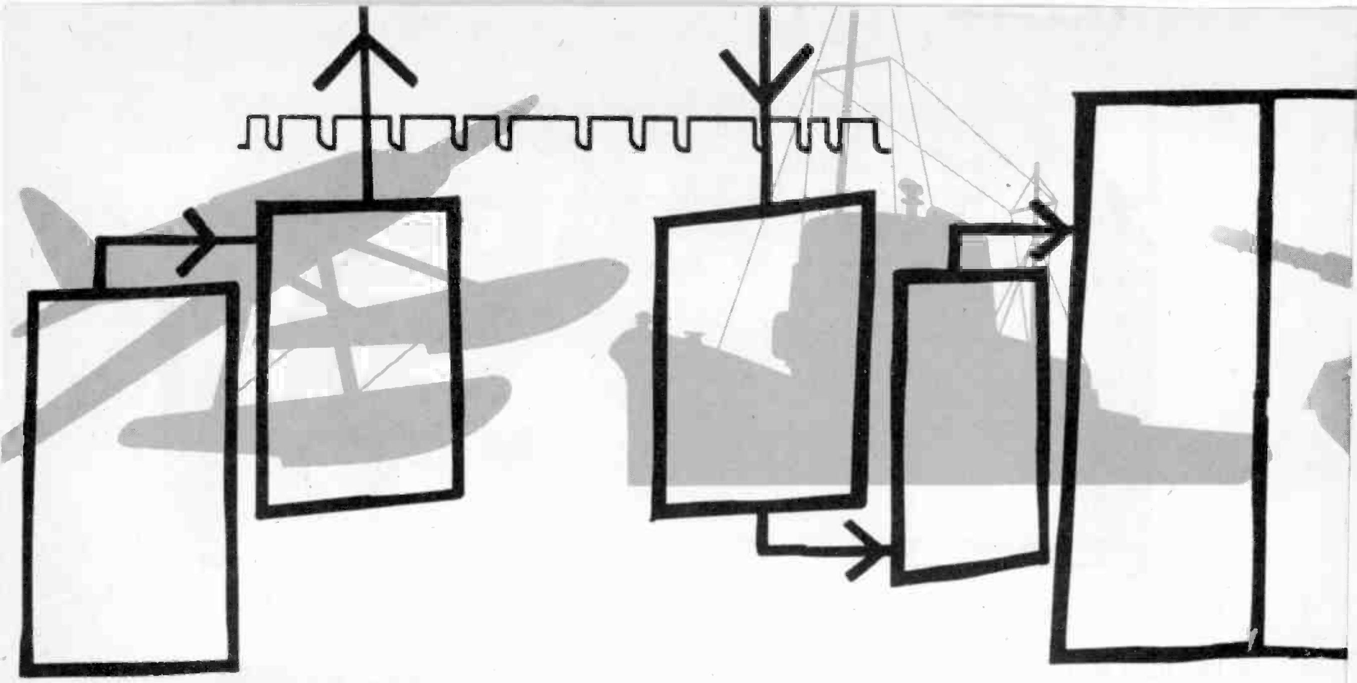
For the average constructor the most practical method of calibrating the millivoltmeter is probably to use an ordinary multimeter set to a low a.c. volts range to enable the generator's output level to be accurately measured and set at 1V r.m.s. The millivoltmeter can then be measured on the 1V range.

One should aim to obtain a calibration signal which has its amplitude set with the highest possible accuracy, and great care should be taken to adjust VR2 with great precision since the accuracy of the finished unit largely depends upon these two factors.

INPUT IMPEDANCE

An input impedance of 1MΩ should be more than adequate for virtually all tests, but if for some reason an increased input impedance should be required, this can be accomplished by merely increasing the value of R1 (up to a maximum of about 10MΩ).

Note, however, that increasing the input impedance also increases the risk of stray pick-up, and means that very careful screening of the input leads and circuitry would then be required. ★

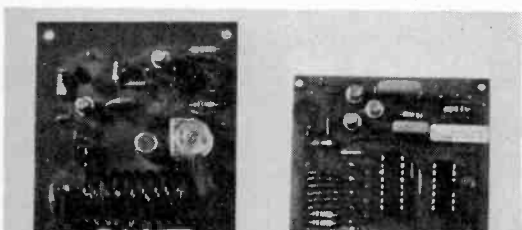


PART 1 Transmitter and Coder

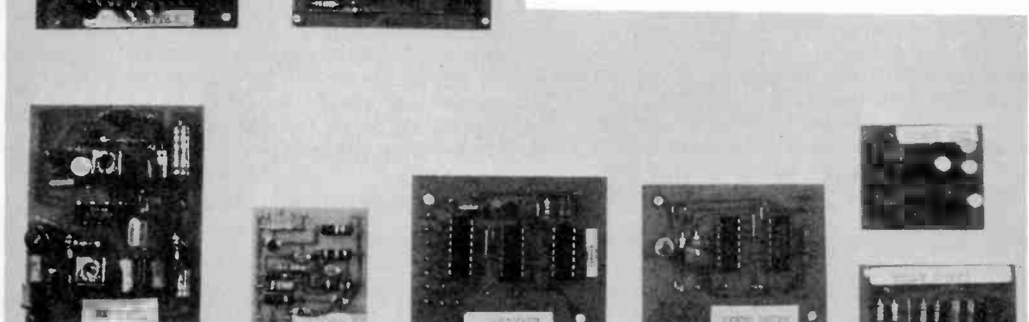
THIS series of articles describes the design and construction of a 9-channel radio control system, which operates at 27MHz, and has the option on each channel of either fully proportional control or on/off type switched control. All aspects of the system are covered: transmitter, receiver, coder, decoder, relay-drive and servo-drive. A block diagram is given in Fig. 1.

The system operates on a time-division multiplex principle whereby the outputs of each of the channels are scanned one after the other to form a pulse train of 9 comand pulses of varying length. These are then followed by a sync pulse, the whole scan taking approximately 20ms. The proportional information is contained in the length of the pulse of each respective channel. In the case of the purely switching channels a pulse-width comparator is used to provide the on/off information, a short pulse denoting on, a long pulse: off.

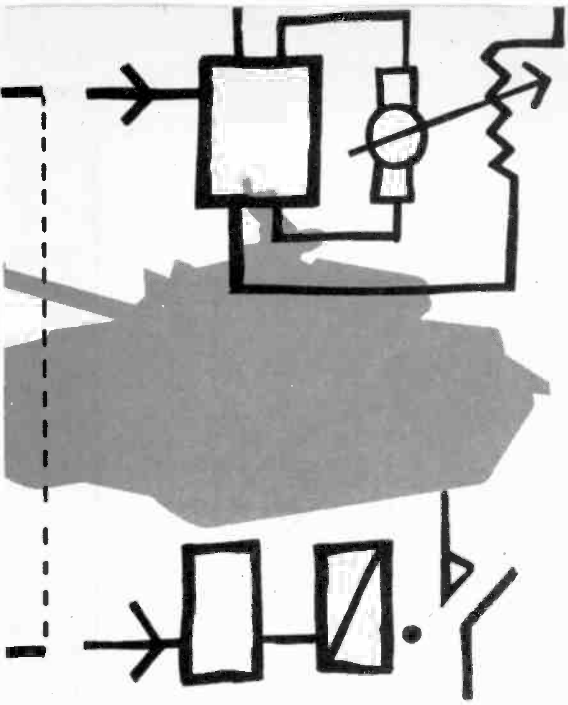
At the receiver the pulses are first shaped and converted to t.t.l. operating levels, and then routed to the appropriate channels. A servo-system then controls a motor unit which provides the final mechanical output.



★ ***9 Independent Channels***
★ ***Fully Proportional Design***
★ ***Option of Proportional or Relay Output On Each Channel***
★ ***Suitable Servo System Included***



THE COMPLETE SYSTEM



Proportional RADIO CONTROL SYSTEM

By D. J. WHITELEY

The author has had a similar system operating in a model boat for some two years and finds it to be compatible with commercial equipment costing around £150.

The system will be described together with full constructional details section by section, commencing with the transmitter and coder.

CODER

The coder circuit diagram is shown in Fig. 2. This generates a repeating pulse train of a 0·5ms sync pulse followed by the 9 command pulses of widths set between 1–2ms depending on the setting of the resistors VR1–6 and R3–5, the sync pulse is sampled approximately every 20ms. This forms the basis of the coder, having 9 channels, each potentially fully proportional.

Transistors TR1–3 are connected as an astable multivibrator, the base of TR2 being connected to the open-collector outputs of the b.c.d. decoder IC2 via the control resistors (either potentiometers or fixed resistors with switches across them). The discharge-time of C2 will therefore be determined by the setting of the potentiometers, the channel chosen being determined by the decoder. The decoder receives its b.c.d. input from the 7490 decade counter which in turn is clocked by the other "half" of the astable TR2/3. This half generates fixed duration spaces of shorter length (0·25ms).

When the count 0000 appears at the output of the counter a sync pulse is generated of approximately 0·5ms. At the receiver this is then detected and used to synchronise the receiver counter, thus allowing the command pulses to be routed to their respective channels.

An output is taken from the collector of TR3 to the modulator input of the transmitter.

CHANNEL OPTIONS

The circuit given for the coder shows 6 proportional channels and 3 switched. Any channel can be either proportional or switched, depending on

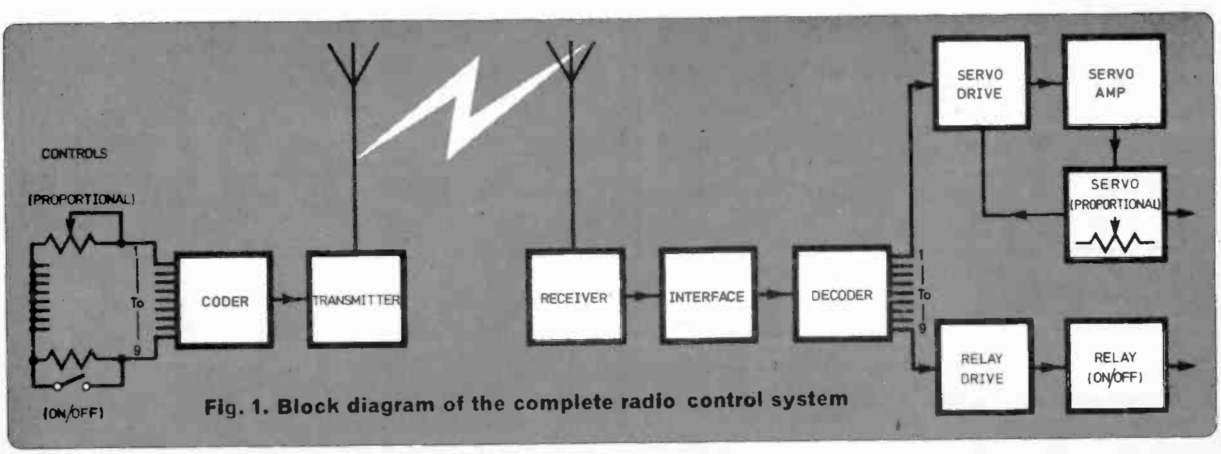


Fig. 1. Block diagram of the complete radio control system

CODER

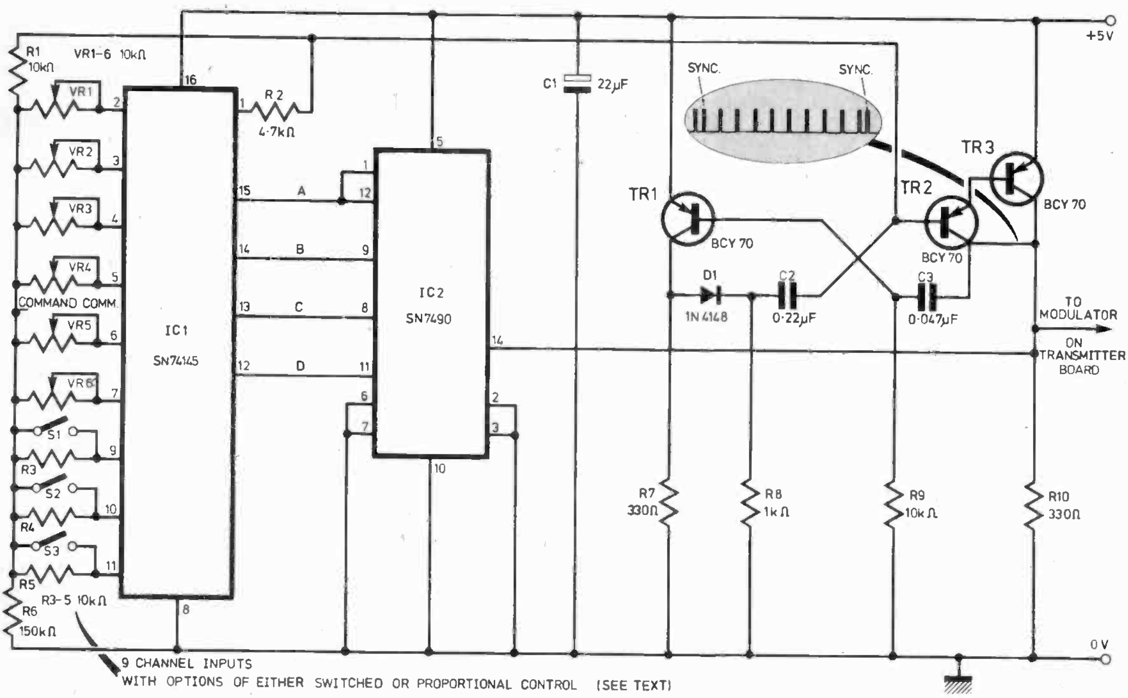


Fig. 2. Circuit diagram of the Coder

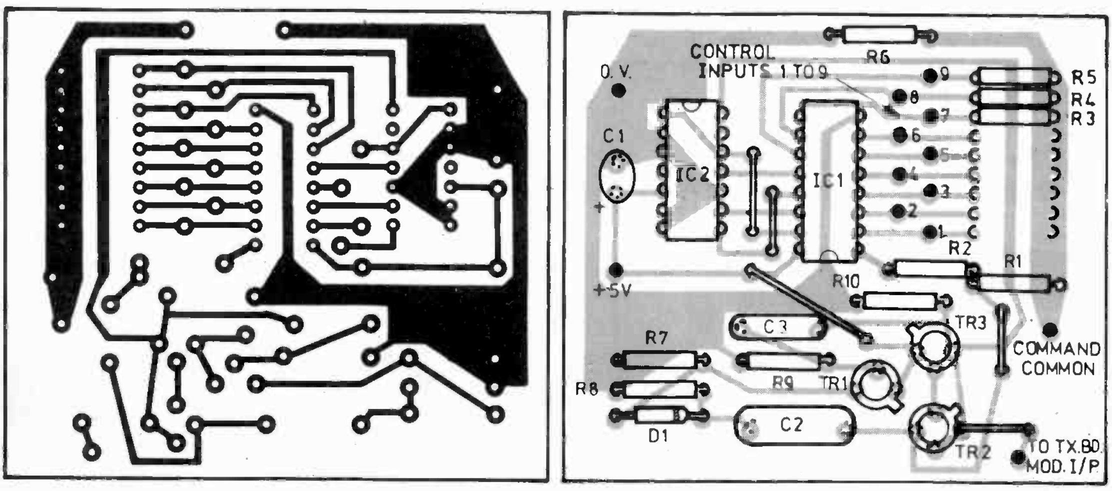


Fig. 3. Printed circuit master and component layout details for the Coder (full size)

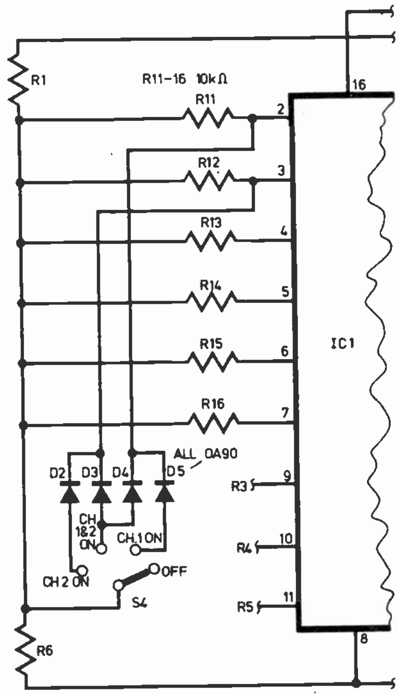


Fig. 4. Method of diode gating to give simultaneous control of channels in addition to individual control

COMPONENTS . . .

CODER

Resistors

R1	10kΩ
R2	4·7kΩ
*R3	10kΩ
*R4	10kΩ
*R5	10kΩ
R6	150kΩ
R7	330Ω
R8	1kΩ
R9	10kΩ
R10	330Ω

All resistors $\frac{1}{8}$W 5%

Capacitors

C1	22μF 10V Tantalum
C2	0·22μF plastic or ceramic
C3	0·047μF plastic or ceramic

Potentiometers

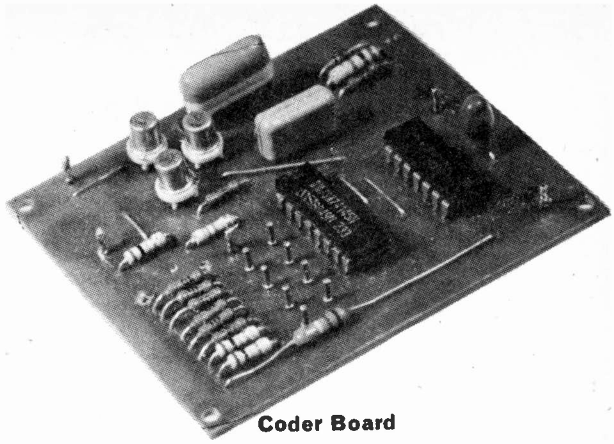
*VR1–6 10kΩ

Semiconductors

TR1–3	BCY70 (3 off)
IC1	74145 b.c.d.-to-decimal decoder
IC2	7490 decade counter
D1	1N4148

Miscellaneous

P.C.B. 72mm × 61mm
Circuit board pins
*S1–S3 s.p.s.t. switches (3 off)
*Components given for 6 proportional channels and 3 switched. See text.



Coder Board

the constructor's requirements. If a channel is desired to be proportional then a 10kΩ linear pot. suffices as the control element. If a switched channel is wanted then a 10kΩ resistor is inserted into the control position, a simple switch across it then providing the on/off function.

The system can be used with less than 9 channels (i.e. if 9 channels are too many) providing 10kΩ resistors are inserted into the control positions of the unwanted channels. This maintains correct operation of the sync detector at the receiver.

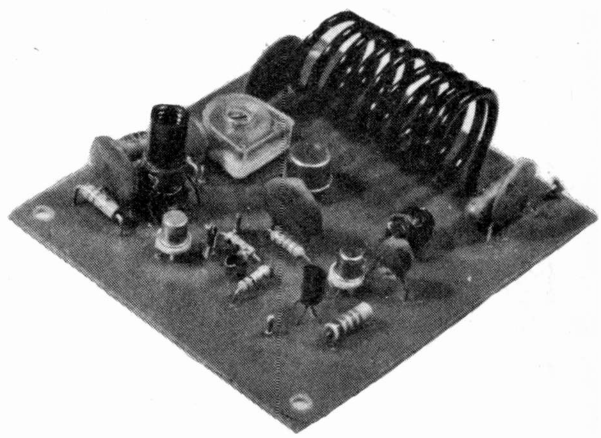
If commercially manufactured "Joy-Stick" controls are used, it may be necessary to replace the pot. with a 50kΩ lin. in order that the 10kΩ resistance sweep can be covered by the small angular sweep of the control lever.

Fig. 4 illustrates a method of diode gating to the command resistances in order that simultaneous control of channels can be achieved in addition to individual control.

CONSTRUCTION

A full size drawing of the copper side of the board is shown in Fig. 3, together with a layout of the components and connecting links.

It is important that a fine tipped iron and thin gauge solder is used when the components are fitted to the board as solder runs are difficult to remove and can cause damage to the copper.



Transmitter Board. Note the crystal is not shown in position

TRANSMITTER

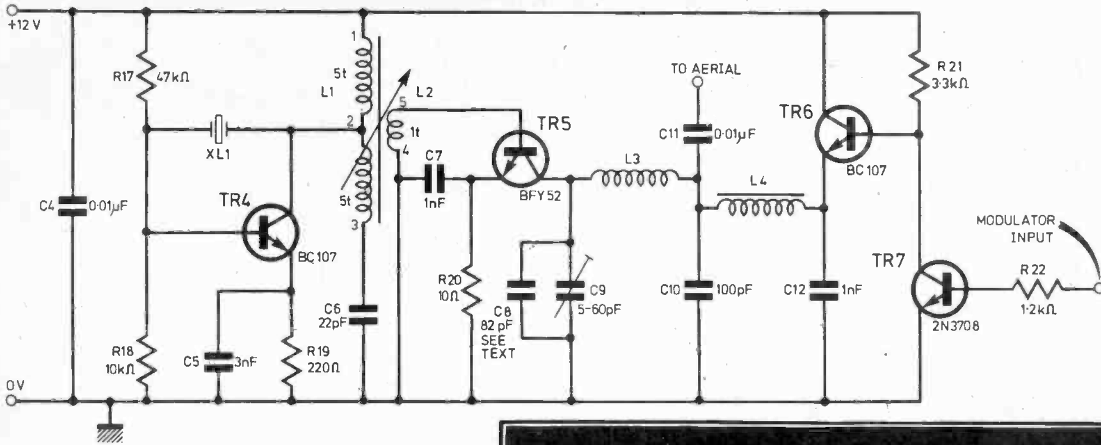


Fig. 5. Circuit diagram of the Transmitter

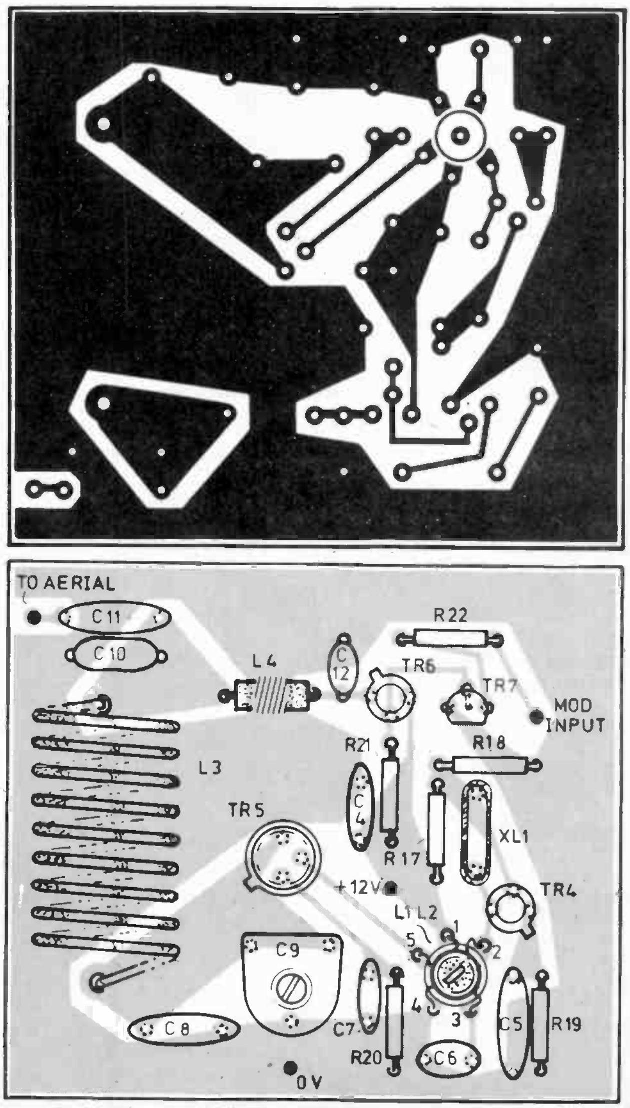


Fig. 6. Full size printed circuit master and component board layout for the transmitter. For coil details see text

COMPONENTS . . .

TRANSMITTER

Resistors

R17	47kΩ
R18	10kΩ
R19	220Ω
R20	10Ω
R21	3·3kΩ
R22	1·2kΩ

All resistors $\frac{1}{8}$W 5%

Capacitors

C4	0·01μF disc ceramic
C5	0·003μF disc ceramic
C6	22pF ceramic
C7	1000pF ceramic
C8	82pF ceramic
C9	5/60pF trimmer (p.c.b. mounted type)
C10	100pF ceramic
C11	0·01μF ceramic
C12	1000pF

Transistors

TR4	BC107B
TR5	BFY52
TR6	BC107B
TR7	2N3708

Crystal

XL1 Crystal of the range 26·995–27·245MHz (to match with receiver crystal). These are sold in pairs.

Miscellaneous

P.C.B. (70mm × 83mm) and etchant
Circuit board pins
7mm Aladdin coil former
Enamelled copper wire: 14 and 30 s.w.g.
R.F. choke (L4) 20 to 40μH

SETTING UP

If an oscilloscope is available the output to the modulator can be viewed showing the inverted pulse train with the 0·25ms spaces at the top. When a command is operated, the corresponding pulse will reduce in width from 2ms to 1ms causing the pulse train to contract. The current drawn will be about 65mA at a supply of 5V, if a higher current than this is observed then the circuit must be checked again.

TRANSMITTER

The transmitter follows the design of a medium power 27MHz crystal controlled and t.t.l. modulated piece of equipment. The modulation is applied to a depth of 100 per cent on the r.f. carrier. From the circuit (Fig. 5) it will be seen that TR4 and the overtone crystal form the oscillator with L1 tuned to resonance.

The base of TR5 is coupled to the oscillator by L2, the collector is tuned by L3, C9, C12 to match the aerial loading. An r.f. choke prevents the r.f. from reaching the modulator stage TR6, TR7. The action of the modulator is that of a switch with TR6 turned hard on by R21, taking the base to the positive rail, and with TR5 connected to its emitter network r.f. is fed to the aerial. When TR7 base is driven positive by an incoming pulse, the base of TR6 is brought down, hence cutting off the transistor and switching off the output.

CONSTRUCTION AND COIL DETAILS

From the full size p.c.b. design shown in Fig. 6 a printed circuit board can be made. A hole is drilled in the board to accommodate a 7mm coil former on to which is wound L1/L2. L1 is a 10 turn centre tapped winding of 30 s.w.g. enamelled covered copper wire close wound with L2 a single turn of the same gauge wire on top of L1 at the positive end. L3 is an open winding consisting of 9 turns of 14 s.w.g. copper wire of 16mm inside diameter and the windings arranged to cover a length of 38mm.

SETTING UP THE TRANSMITTER

Before connecting the 12V supply, bring the core of L1/L2 to the top of the former and adjust C8 to minimum. Connect a voltmeter of about 3V f.s.d. across R20 then switch on the supply. Adjust the core L1/L2 for maximum reading on the voltmeter indicating that the oscillator is running, then adjust C8 to obtain a peak reading on the meter. Final tuning is best carried out when the equipment is housed and an aerial of 1m is connected, also the oscillator must be netted to the receiver in which case the "S-meter" connection can be used on the receiver and optimum power achieved. This is the method adopted by the author and is very fast and straightforward, providing the aerial is first removed from the receiver and a suitable distance separates the two pieces of equipment to allow a peak reading to be obtained. An ammeter connected to the supply should indicate a current of about 40mA when tuning is correct.

Acknowledgement: The coder, decoder, servo driver and servo amplifier used in this system are based on designs by M. F. Bessant and originally published in Wireless World.

Next month: the receiver, interface and decoder circuits will be described.

NEWS BRIEFS

Army on the Air

THE Ministry of Defence is to buy a unique mobile sound broadcasting facility which will enable the British Army deployed anywhere in the world to provide a local radio service of general interest and current news.

Under the terms of a £180,000 contract Marconi Communication Systems Limited is to supply two medium wave sound broadcasting transmitters, together with studio equipment, h.f. receivers, antenna arrays, a demountable mast, an aerial tuning unit and a range of associated test equipment for this facility. All of this equipment is to be mounted in two Army containers so that the resultant 'station' can be quickly air transported by Support Command to any destination and brought into operation at short notice.

One of the containers for the new facility will be fitted with two sound broadcast transmitters providing a full 2kW of power.

The second container will function as the sound broadcasting studio and will be fitted with a twelve channel sound mixer, microphones, disc reproducers, tape recorders and sound monitoring equipment. A separate compartment within this container will mount h.f. receivers operating in space diversity to enable overseas broadcasts to be received and re-transmitted as required. Additional ancillary equipment to provide a complete operational station is also included.

Delivery of this new facility to the Army is scheduled for mid-1977.

'HOW INVENTIVE ARE YOU' COMPETITION

These were your Inventions

FULL LIST OF PRIZE WINNERS

1st PRIZE £250

AWARDED TO
G. G. HUTCHIESON and B. RAY, PLYMOUTH (Group Entry)

for a HIGH INTENSITY BEACON

2nd PRIZE £100

AWARDED TO
S. CROFT, HITCHIN, HERTS.

for a PORTABLE HEART START

3rd PRIZE £50

AWARDED TO
R. CURRY, NEWTON AYCLIFFE, CO. DURHAM

for a ALPHA/BETA PARTICLE DETECTOR

WELL, you can now see the ideas which won prizes in our *How inventive are you?* competition. The entries submitted covered a very wide range of concepts so, it is not surprising that the major prize winning ideas were drawn from widely differing applications.

Our first prize goes to a High Intensity Beacon. The general idea on which this is based was the subject of several entries. Having established the principle that this idea was a potential prizewinner (based on the following facts: (*1*) the portable ignitor circuit can be modified very simply to drive a Xenon flash tube, so the technology is known; (*2*) market potential for a flashing warning beacon is good, so it is not difficult to generate a substantial list of applications in a wide range of market areas; and (*3*) the product could be manufactured at a cost which would be economically viable) the main problem for the judges was then to decide which particular entry or entries in this group had the greatest merit. The decision was in part based on the presentation of the entries (clarity of description and diagrams) and in part on the technical merit (use of minimum number of components, choice of component values, detailed circuit design, etc).

The eventual winner was the unanimous choice of the judges. This was a group entry so the prize money is shared equally between G. G. Hutchieson and B. Ray.

RUNNERS-UP

The following 25 readers each receive a MAGISPARK GAS IGNITOR

A. R. Knight, Oxford	*Neon Ornament Circuit*
R. F. Fletcher, Lowestoft, Suffolk	*Neon Light Flasher*
G. Rochfort, Lymington, Hants.	*Distress Beacon*
A. Curry, Newton Aycliffe, Co. Durham	*H.V. Source For Physics Experiments*
D. W. Lloyd, Potton, Beds.	*Flasher Warning Buoy at Sea*
T. V. Mayhew, Poole, Dorset	*Flashing Beacon*
Q. A. Rice, Mitcham, Surrey	*Distress Signal*
R. Atkinson, Slaithwaite, Huddersfield	*Electric Fencer Unit*
R. Robertson, Chorley, Lancs.	*Muscle Stimulator*
B. Simpson, Mexborough, Yorks.	*Paraffin Heater Ignitor*
G. E. Dunning, Morden, Surrey	*Vacuum Leak Detector*
P. Smith, Barnsley, Yorks.	*Gas Detector*
J. P. Wilkinson, Alford, Lincolnshire	*Engine Combustion Improver*
R. W. Bleach, Durleight, Somerset	*Plastic Weld Tester*
E. Jones, Corfe Mullen, Dorset	*Safety Tester*
G. T. Theasley, Riddlesden, West Yorks.	*Car Plug Tester*
J. A. Logue, Clondalkin, Ireland	*Spark Plug Tester*
M. J. B. Franklin, Eaglescliffe, Cleveland	*Fly Killer*
M. G. Wadlow, Ealing, W.5	*Electronic Record Cleaner*
G. S. Foreman, Denton, Sussex	*Multipurpose Welding Torch Lighter*
E. A. Ferrand, Fareham, Hants.	*Spark Plug Tester*
M. Woodman, Seaton, Cumbria	*Safe Ignitor for Chemical Apparatus*
C. Wolfe, Cambridge	*Paper Tape Puncher*
T. C. E. Probert, Penarth, Glamorgan	*Telephone Ringer*
H. V. Morris, Birmingham, 8	*Anti-Static Device*

The following 25 readers each receive a One-Year Subscription to PRACTICAL ELECTRONICS

C. A. Adamson, Osbaldwick, York.	*Record Cleaner*
G. A. Sergeant, Walton-on-Thames, Surrey	*Fluorescent Tube Starter*
C. I. Johnston, Malahide, Ireland	*Flashing Beacon*
P. J. Mann, Ampleforth College, York.	*General Purpose EHT Unit*
R. W. Whittaker, Bracknell, Berks.	*Emergency Beacon*
D. Huddart, Melksham, Wilts.	*Flashing Beacon*
G. M. Rossetti, West Alvington, S. Devon	*Emergency Lamp*
G. W. Rose, 20 Field-Workshop, R.E.M.E., BF PO 29	*Anti-theft Device (for suitcase)*
W. V. Legge, Tidworth, Hants.	*Touch Switch Electrical Fence*
R. Clarke, Clevedon, Avon.	*Electrostatic Spray Unit*
P. A. Turner, Heywood, Lancs.	*Electronic Dial Tester*
G. Clift, Luton	*Explosive Gas Indicator*
J. G. Ransome, Southmoor, Oxon.	*Gas Detector*
J. Allesbrook, Stapleford, Notts.	*Engine Ignition*
W. A. L. Smith, Redhill, Surrey	*Car Lubricant Checker*
P. F. Walker, West Bridgford, Notts.	*Switched Output Insulation Tester*
B. A. Barnett, Hall Green, Birmingham	*Spark Plug Test*
N. J. Goddard, Tilehurst, Reading	*Insect Killer*
D. H. Dalby, Sholing, Southampton	*Anti-Static Device*
H. G. Taylor, Newbury, Berks.	*Arc Initiator Circuit*
C. H. Hughes, Ardley, Oxon.	*Animal Goad*
J. Grice, Gorleston, Norfolk	*Cattle Goad*
W. G. Clack, Annalong Newry, Northern Ireland	*Weed Killer*
K. Drake, Gosford, Staffs.	*Electric Organ*
G. T. Massey, Stockport, Cheshire	*Miniature Ozoniser*

The second prize—a Portable Heart Start—was a unique entry and proposed a kind of application Plessey had not themselves previously considered. Because of this it scored very highly on novelty alone, apart from the excellent and commendable social connotations behind the idea. Evaluation of the Heart Start idea required discussion and correspondence with authorities from the medical and medical electronics fields. Great concern was expressed over the use of such a device by people not fully instructed in its operation and although the entry was well detailed it was obvious that considerable further development would be required before the idea could be demonstratably effective, safe and viable. Nevertheless the judges were sufficiently impressed to award this idea the second prize.

The third prize was awarded for an Alpha/Beta Particle Detector. This was selected from a number of ideas for school laboratory or similar applications. The method of operation is very straight forward; for instance, the electrodes of the portable ignitor can be separated to the point at which breakdown *just* no longer takes place. The passage of beta particles through the air generates ions and if the particle passes within the vicinity of the electrodes ionization causes breakdown across the electrodes. Redesign of the mechanical side of the portable ignitor and some limited modification of the circuitry could provide a simple and cheaper high voltage source which would detect ionising radiation (alpha and beta particles, ultra violet light) and flame ionisation, as well as serve as a general purpose high voltage source.

From the subjects included amongst the list of runners-up a good indication can be obtained of the very wide range of ideas proposed by the entrants to the competition. Some were highly original and reflect well on the inventive powers of their proposers.

As already mentioned in the *Initial Report from the Judges* (April 1976) all entries were initially grouped under applications and inevitably it was revealed that two or more, sometimes many, entrants had submitted the same or a very similar kind of idea. The next step was to place all entries of a grouping in some order of merit and then finally to select the winners, including the 50 runners-up. At least one award was made in each application grouping.

Finally, readers will be interested to know that many of the proposed circuits will be published in PRACTICAL ELECTRONICS during forthcoming months. We shall also be keeping readers up to date with the progress of selected ideas towards production and ultimate launch onto the market.

Our first three prizewinners will be given the opportunity to visit Plessey at Titchfield to see the portable ignitor and other products being manufactured.

The Plessey Company join with Practical Electronics in warmly congratulating all winners, and express thanks to all who participated in this really testing form of competition.

SEMICONDUCTOR UPDATE . . . By R.W. COLES

ZN425E **MC14422**
VMP-1 **MC14423**

GET CONVERTED

If you are used to thinking of Digital to Analogue and Analogue to Digital converters as exotic devices available only to a favoured band of professional engineers—then it's time you got converted!

A big breakthrough has been made by Ferranti who have introduced a new bipolar integrated circuit to their c.d.i. family which is about to make A to D and D to A converters about as run-of-the-mill as op-amps and NAND gates.

The new device, type **ZN425E,** contains an 8-bit binary counter, a precision resistor ladder, a set of logic controlled switches and even a 2·5V reference source, all crammed into a 16-pin plastic d.i.l. package with an extremely low price tag.

The ZN425E can be arranged to convert analogue voltages into an equivalent 8-bit binary word, or to convert an 8-bit binary word into an equivalent analogue voltage, with the minimum of ancillary components and with a very creditable degree of precision.

The secret of the new chip is it's R2R resistance ladder which hitherto has been impossible to produce as part of a cheap monolithic circuit because of the close tolerances required of the resistors, traditionally a weak point with monolithic devices.

Don't go on thinking that D to A's and A to D's are only useful if you happen to have a computer, either, a cheap component like the ZN425E is ideal for use as a precision ramp generator for oscilloscope or display tube deflection, or as the heart of an analogue readout using the new bar-l.e.d.s.

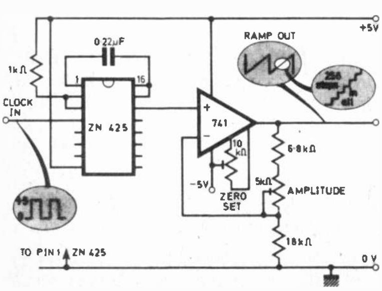


Fig. 1. Linear ramp generator

M.O.S. POWER

M.O.S.F.E.T. technology has always seemed a more reasonable way to conduct one's solid state affairs than the rather more mysterious bipolar approach. It's easy to understand, and one can think in terms of voltage rather than current, and without having to remember which are the minority carriers and which the majority variety either. Of course, it's not possible to turn one's back on BC107's and 2N3055's in the same way that you might have done with triodes and pentodes, because the m.o.s.f.e.t. ensemble still exhibits a few glaring shortcomings.

I suppose everyone knows about the dreaded "Nylon-knickers" effect which strikes down m.o.s.f.e.t.s in their prime when high voltage static charges punch holes in the vanishingly thin gate-oxide, requiring all those who come into contact with such devices to be securely earthed and conservative in their choice of underwear!

Well, cotton knickers you can learn to love, but if your electronic vocabulary includes the words amps or watts then m.o.s.f.e.t.s start to look a bit puny and it certainly seemed until recently as though 2N3055's would continue to kick sand in the faces of their m.o.s. rivals for a long time yet. The remedy for this sad state of affairs is just around the corner however, and it comes not from Charles Atlas but from Siliconix, champions of the underdog, and m.o.s.f.e.t. makers extraordinary who have just introduced a new device, the **VMP-1,** which actually lives in a TO3 can!

Appearances are not deceptive either, the VMP-1 is a true power device, and although its maximum drain current of 2 amps is low by 2N3055 standards, its traditional m.o.s.f.e.t. characteristics make it extremely attractive.

The VMP-1 is a 35W device which can switch 1A in 5 nanoseconds and can be driven directly by c.m.o.s. logic gates, all with a complete absence of the thermal-runaway and second-breakdown effects which plague their bipolar cousins. I won't make any promises, but the inherent linearity of the m.o.s.f.e.t. characteristic should make it ideal for high quality audio amplifiers too. And don't lose any sleep over your trendy nether-garments, the VMP-1 has a Zener gate protection diode!

REMOTE CONTROL

Remote control of t.v. sets, Hi-Fi systems, light dimmers and other electronic home comforts has of course always been possible. Back in the 1950's t.v. sets were often fitted with a socket into which could be plugged a cable type remote control box, but these were not very popular for obvious reasons. Today, with a handful of phase-locked loop chips, a few op-amps and a PP9 or two, it is possible to build a remote control system which requires no cable and which relies on an Acoustic or Infra-Red carrier link for its operation.

Of course there is a problem, phase locked loops are not cheap, and this tends to restrict the control facilities available to the basic essentials. PP9's can set you back a few bob too, and it's all too easy to leave the remote unit switched on so that the batteries run down quickly. The march of electronic progress could not allow this state of affairs to continue for long, and, typically, it is Motorola c.m.o.s. expertise which has come to the rescue in the shape of the new **MC14422** and **MC14423** ultrasonic remote control transmitter chips which appear to offer the ideal solution to this control problem.

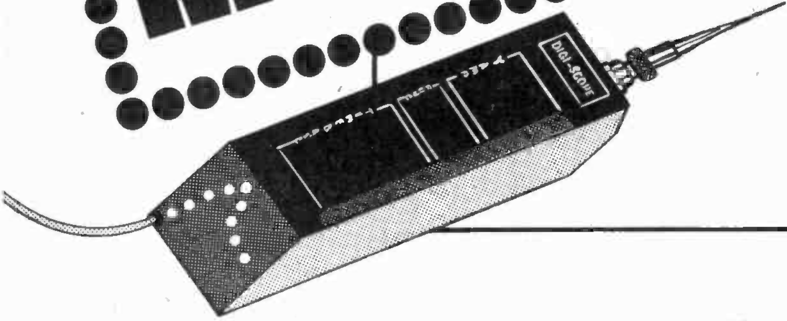
The two devices are similar but operate at different frequencies so that both could be used in the same domestic situation without interference. Each can provide no less than 22 separate control channels and include all the logic necessary to encode the correct command from a 22 switch keyboard. The key closures are used to produce a unique sequence of up to five acoustic tones between 34·688KHz and 42·755KHz with an output ready to drive a piezo-electric transducer via a single external transistor and transformer.

Power consumption of the c.m.o.s. circuit is very low, so low in fact that it is not necessary even to use an on-off switch!

With an 8V supply, current drain in the "Idling" condition is typically 0·4µA, which promises almost shelf-life from the batteries used. An n.m.o.s. receiver chip, the MC6525, will soon be available to complement the transmitter devices, but I have no data on this at present. The MC14422 and MC14423 are packaged in 16 pin d.i.l's and cost around **£4.**

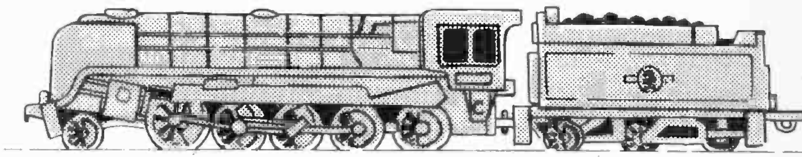
NEXT MONTH!

P.E. DIGISCOPE



An entirely new concept in oscilloscope design which puts many advantages of the traditional instrument into a pint sized package but uses an 8 × 10 l.e.d. matrix to form a flat screen display

AUTOSTOP for Model Railways...



A design to halt a model train for a predetermined time at a station. Needs no external supplies and only two connections to the track

FLUORESCENT LIGHT INVERTER

Designed to drive a mains fluorescent lamp from a 12V supply this inverter will prove a boon to campers and caravanners and can also provide emergency lighting when required

RADIO CONTROL SYSTEM Part 2

Part two of this series describes the receiver, decoder and t.t.l. interface circuitry

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Please Note
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

DIGITAL CALENDAR

THIS circuit is useful wherever a 24th-hour pulse is available. The pulse transferred to the input of the day's counter, IC1 and IC2, which can be reset after 28, 30 or 31 days; Mono 1 and OR gate G1, G2 ensure that the counter is reset to a binary count of 1 (i.e. the 1st of the month). The reset pulses are counted by ÷ 12 counter IC3 which provides a binary indication of the relevant month, Mono 2 and G3, G4 ensure the counter is reset to a count of 1 (since January is designated month number 1).

The 4-16 line decoder IC5 provides a decimal count of 12 from a binary input, which is used to determine where the day's counter resets. Inverter G7 gives a positive going output during February. G8 will only give an output when all inputs are at logical one which only occurs on 29th Feb (a transient state). C13 is effectively a NOR gate since output pulse to LOGICAL1 occurs when logical 0 is applied to either of the inputs) and will reset the day's counter and increment the month's counter via G13. G9, G10 and G13 reset the day's counter after 30 days.

When the input to G9 is April, September, or November G10 of course being enabled by a transient input of 31. In the same way G11, G12 and G13 reset the counter after 31 days during the remaining months.

No facilities for leap years have been included, but since a yearly pulse is available at the output of G5, it would be a relatively simple matter to cater for 29 days in February, with the inclusion of a ÷4 counter and a few extra gates!

In the prototype the days were indicated by seven segment displays and their associated decoders. And the months by a binary readout of four lamps, mainly for the purpose of resetting. When resetting it is advisable to take the counters through all of their states to ensure that state 0 does not occur due to random outputs after switch on.

D. E. Clarke,
Colchester,
Essex.

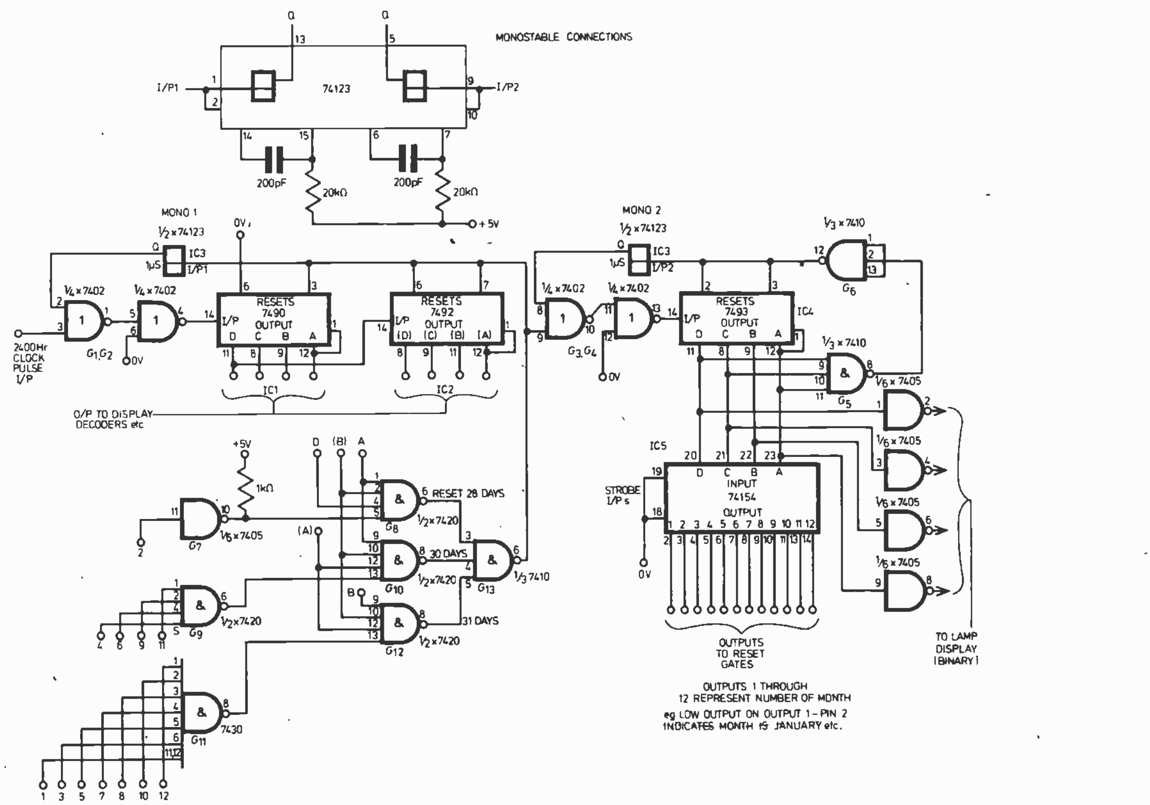

Fig. 1

ELECTRONIC DOORBELL

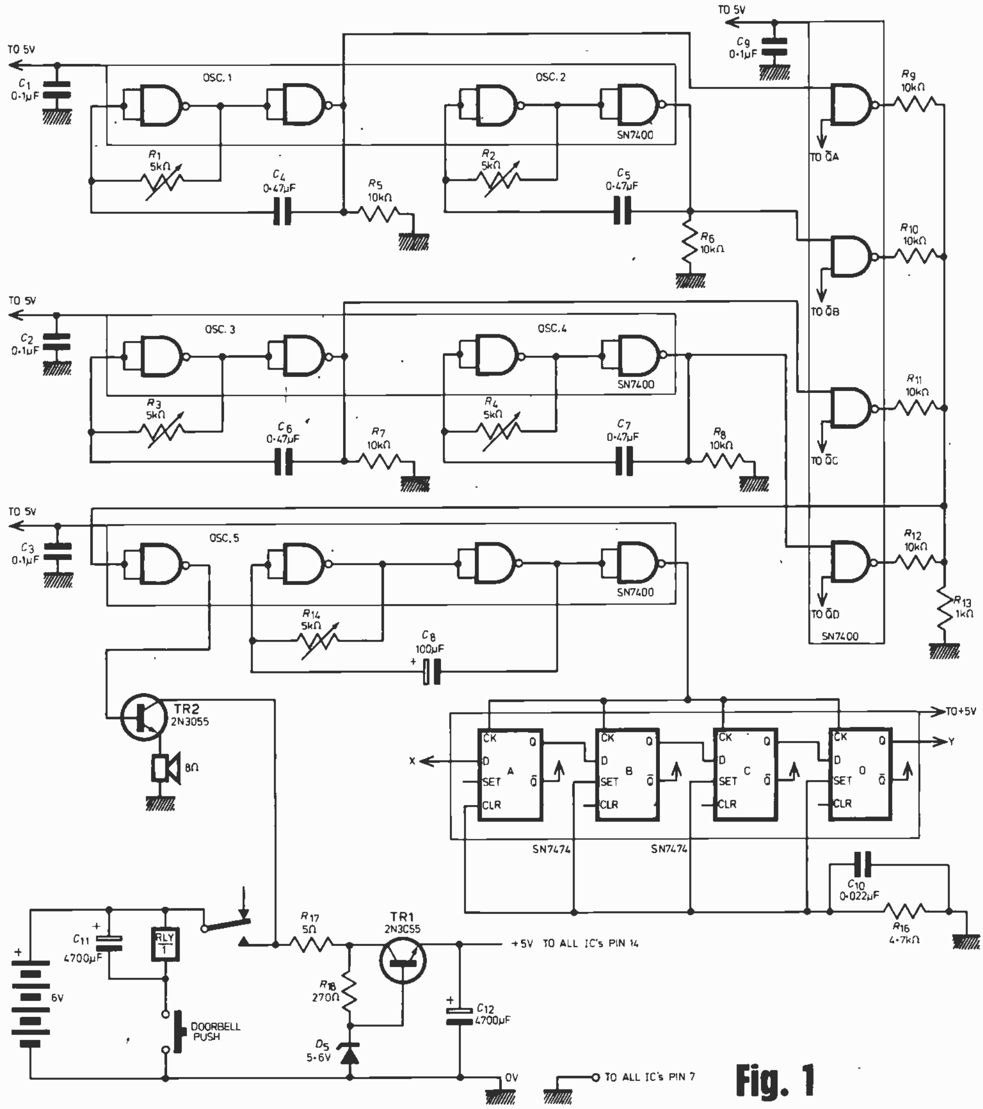

Fig. 1

THE electronic doorbell to be described uses five separate oscillators, one for each note of the tune, and one for the clock generator which governs the speed at which a four-note tune is played. Each oscillator uses two NAND gates, each gate generating the NOT function. These are arranged as shown in Fig. 1.

SN7400 quad dual input NAND gates are employed, and therefore one integrated circuit will form two oscillators. The frequency determining components are chosen to give a wide audio range control by the potentiometers of the note oscillators (1–4), and a rate of 0·5 to 5Hz of the clock oscillator (1).

The oscillators are sequentially switched to the output stage through four NAND gates. This is performed by another SN7400. Each gate is opened by a gating pulse from a four bit shift register.

Each element of the shift register is a D type flip flop. Two SN7474 dual D type flip flops are used for this. The register is programmed on switch on with the binary number 0111 and the 0 is clocked along the shift register. The outputs from the register are taken from the $\overline{Q}$ or inverted outputs thus the binary number presented to the gates is 1000. As the 1 is clocked along, it opens each gate in turn. The four outputs from the gates are then mixed by summing resistors. Fig. 2 shows the shift register.

Programming is performed by taking the set or clear inputs to the flip flops to logic 0. If inputs are floating, they are normally high or at logic 1. At the instant of switch on, C10 passes the switch on pulse and this programs the flip flops.

If X and Y are connected, the 0 clocked along the register will be reinserted at the input and thus the tune will be repeated. If, however, X & Y are left disconnected, the 0 will be lost when it reaches the end of the register. This means that all the gates will be left closed and the tune will only be played once.

The summed outputs from the gates are fed to a buffer which is in fact a spare gate in the SN7400 used for generating clock pulses. This output is connected directly to an emitter follower stage to drive the loudspeaker connected in the emitter of the output transistor.

N. C. Roberts,
Weymouth.

IRREGULAR WAVEFORM PRODUCTION

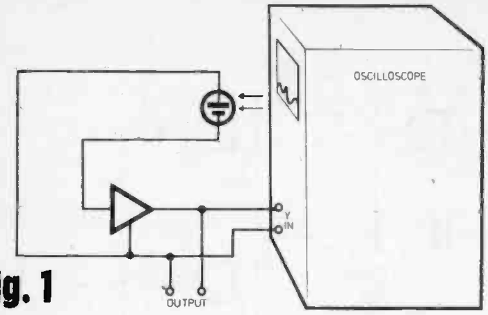

Fig. 1

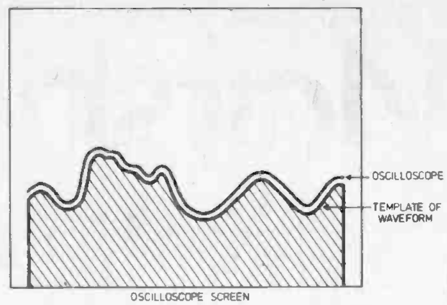

Fig. 2

With the use of an oscilloscope, a photovoltaic cell, an amplifier and a suitable template, any reasonably irregular waveform can be produced. The amplified output of the photocell is connected to the Y input of the oscilloscope with polarity such that an increase in illumination causes the oscilloscope trace to dip (Fig. 1). The photocell is placed facing the oscilloscope screen, whose brightness is turned up fully, so that the light from the spot itself causes the spot to dip. If an opaque template of a waveform is placed on the screen (Fig. 2), the spot will drop until it is partially obscured by the template, as the illumination of the photocell will then fall. Negative feedback causes the trace to follow the outline of the template closely. The amplifier output will therefore be the waveform of the template. If the waveform of a sound is traced from an oscilloscope screen, a template can be cut to reproduce it.

This set-up will work in a dimly lit room. The oscilloscope should have a rapid flyback and short persistence, and, if it has a graticule, this may be removed in order to fix the template closer to the screen to reduce parallax. The circuit for the amplifier will depend on the photocell and oscilloscope used; linearity is not essential if the gain is high enough, but the response must be fast enough for the time base frequency used for very low frequencies, an l.d.r. with a resistor and battery may be used in place of the photocell.

J. Samson,
Bishop's Stortford

SQUARE WAVE GENERATOR

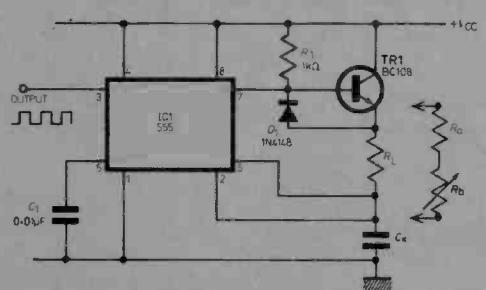

Fig. 1

This circuit basically produces a 1 : 1 mark space square wave from a standard 555 timer. The timing equation is as follows.

f_0 (frequency of oscillation) $= \frac{0{\cdot}722\text{Hz}}{R_L C_X}$ approx. the period

$$\frac{1}{f_0} = = 1{\cdot}386\ R_L\ C_X \text{ sec.}$$

By making the resistor variable (R_b) with current limiting resistor (R_a) in place of R_L a frequency variation of 1,000 : 1 can be obtained with typical values of 1kΩ for R_a, 1mΩ (variable) for R_b. C_X charges via R_L and TR1 which is turned fully on by the pull-up resistor connected to pin 7. When the voltage at pin 6 (threshold) reaches 2/3 V_{cc} the internal discharge circuit is activated and pin 7 (which is the collector of the internal discharge transistor) is driven to earth potential. TR1 is now switched off and C_X now discharges through R_L and D1. This continues until 1/3 V_{cc} is reached across C_X when the whole cycle is repeated.

This circuit with the resistor values given has been used to cover the entire audio range from 20Hz to 20kHz, all with one turn of the knob.

G. Sowersby,
Skipsea,
E. Yorks.

Readout

Sir—Referring to page 336 of Practical Electronics April 1976 I note the comments of *Nexus* concerning socialism, nationalised industry, competitive private enterprise, etc. I regard such comments as politically biased, and if you allow political discussion in your periodical, would offer my own humble opinion.

Was the first human venture into space achieved by competitive private enterprise? Was the first practical (though perhaps deplorable) use of atomic energy so achieved? Were the present availability of electronic components at favourable prices and the controlled quality of the same achieved solely by private enterprise without the support and the custom of national governments? Was the first manned mission to the Moon achieved by competitive private enterprise?

Finally, has not the present state of electronics industries been due to 25 years of major effort and a few billion pounds of taxes paid by World Citizens? *Verbum sapiente satis est!*

M. Knight,
London S.E.18

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2N914	0·22
2N916	0·28
2N918	0·32
2N929	0·25
2N930	0·26
2N1302	0·19
2N1303	0·19
2N1304	0·26
2N1305	0·24
2N1306	0·31
2N1307	0·30
2N1308	0·47
2N1309	0·47
2N1671	1·54
2N1671A	1·67
2N1671B	1·85
2N1711	0·27
2N1907	5·50
2N2102	0·60
2N2147	0·78
2N2148	0·94
2N2160	0·90
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2N2219	0·42
2N2219A	0·52
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2N2221	0·18
2N2221A	0·21
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2N2222A	0·25
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2N2647	0·98
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2N2905	0·47
2N2905A	0·50
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2N2906A	0·42
2N2907	0·22
2N2907A	0·24
2N2924	0·20
2N2925	0·20
2N2926	
Green	0·12
Yellow	0·12
Orange	0·12
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2N3394	0·15
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2N4058	0·18
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2N4060	0·15
2N4061	0·15
2N4062	0·15
2N4126	0·21
2N4289	0·34
2N4919	0·95
2N4920	1·10
2N4921	0·83
2N4922	1·00
2N4923	1·00
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2N5294	0·48
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40410	0·52
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40594	0·74
40595	0·84
40601	0·67
40602	0·61
40603	0·58
40604	0·56
40636	1·10
40669	1·00
40673	0·73
AC126	0·20
AC127	0·40
AC128	0·35
AC151V	0·27
AC152V	0·49
AC153	0·35
AC153K	0·40
AC154	0·25
AC176	0·41
AC176K	0·40
AC187K	0·35
AC188K	0·40
AC187 } AC188 }	PR 0·95
AD142	0·57
AD143	0·68
AD149V	0·74
AD150	1·15
AD161	0·69
AD162	0·69
AD161 } AD162 }	PR 1·56
AF106	0·40
AF109R	0·40
AF114	0·35
AF115	0·35
AF116	0·35
AF117	0·35
AF118	0·35
AF124	0·30
AF125	0·30
AF126	0·28
AF127	0·28
AF139	0·65
AF186	0·46
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BFY51	0·28
BFY52	0·30
BFY53	0·18
BFY90	1·27
BRY39	0·48
BSX20	0·28
BSX21	0·30
BU104	2·00
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C106D	0·65
CA3020A	1·80
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CA3035	1·37
CA3046	0·70
CA3048	2·11
CA3052	1·62
CA3080A	1·08
CA3089E	1·96
CA3090O	4·23
LM301A	0·48
LM308	1·17
LM309K	1·88
LOO5T1	1·50
LM380	0·98
LM381	2·07
LM702C	0·75
LM709	
TO99	0·48
8DIL	0·38
14DIL	0·40
LM710	0·47
LM723C	0·66
LM741	
TO99	0·40
8DIL	0·40
14DIL	0·38
LM747	1·00
LM748	
8DIL	0·44
14DIL	0·73
LM3900	0·61
LM7805	2·50
LM7812	1·99
LM7815	1·99
LM7824	1·99
MC1303	1·50
MC1310	2·50
MC1330P	0·90
MC1351P	0·80
MC1352P	0·80
MC1466	3·50
MC1469	2·75
ME0402	0·20
ME0404	0·13
ME0412	0·18
ME4102	0·11
ME4104	0·11
MJ480	0·95
MJ481	1·20
MJ490	1·05
MJ491	1·45
MJ2955	1·00
MJE340	0·48
MJE2955	1·20
MJE3055	0·75
MJE370	0·65
MJE371	0·75
MJE520	0·60
MJE521	0·70
MP8111	0·32
MP8112	0·40
MP8113	0·47
MPF102	0·39
MPSA05	0·25
MPSA06	0·31
MPSA12	0·35
MPSA55	0·21
MPSA56	0·31
MPSU05	0·65
MPSU06	0·58
MPSU55	0·63
MPSU56	0·80
NE555V	0·70
NE556	1·30
NE560	4·48
NE561	4·48
NE565A	4·48
OC23	1·35
OC28	1·48
OC35	1·16
OC42	0·50
OC45	0·32
OC71	0·17
OC72	0·25
OC81	0·25
OC83	0·24
ORP12	0·60
R53	1·80
SL414A	1·80
SL610C	2·35
SL611C	2·35
SL612C	2·35
SL620C	3·50
SL621C	3·50
SL623	5·75
SL640C	4·00
SL641C	4·00
SN76003N	2·92
SN76013N	1·95
SN76023N	1·60
SN76033N	2·92
ST2	0·20
TAA263	1·20
TAA300	1·84
TAA350	1·96
TAA550	0·32
TAA611C	2·18
TAA621	2·03
TAA661B	1·03
TBA641B	2·25
TBA651	1·69
TBA800	0·89
TBA810	0·98
TBA820	0·80
TBA920	1·79
TIL209	0·35
TIP29A	0·49
TIP29C	0·80
TIP30A	0·58
TIP30C	0·85
TIP31A	0·62
TIP31C	1·00
TIP32A	0·74
TIP32C	1·25
TIP33A	1·01
TIP33C	1·45
TIP34A	1·51
TIP34C	2·60
TIP35A	2·90
TIP36A	3·70
TIP41A	0·79
TIP41C	1·40
TIP42A	0·90
TIP42C	1·60
TIP49C	0·70
TIP2955	0·98
TIP3055	0·50
TIS43	0·28
ZTX300	0·13
ZTX301	0·13
ZTX302	0·20
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ZTX502	0·18
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ZTX531	0·22

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CD4008	0·82	CD4023	0·18	CD4047	0·85
CD4009	0·52	CD4024	0·72	CD4049	0·45
CD4010	0·52	CD4025	0·18	CD4050	0·45
CD4011	0·18	CD4027	0·43	CD4510	1·25
CD4012	0·18	CD4028	0·83	CD4511	1·84
CD4013	0·45	CD4029	1·06	CD4516	1·28
CD4014	0·89	CD4030	0·52	CD4518	1·87
CD4015	0·89	CD4031	1·88	CD4520	1·87
CD4016	0·45	CD4037	0·86		
CD4017	0·88	CD4041	0·70		

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× 200	£1·18	£1·16		

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SN7405	0·19
SN7406	0·36
SN7407	0·36
SN7408	0·19
SN7409	0·16
SN7410	0·16
SN7411	0·20
SN7412	0·22
SN7413	0·28
SN7416	0·28
SN7417	0·28
SN7420	0·16
SN7423	0·23
SN7425	0·23
SN7427	0·23
SN7430	0·15
SN7432	0·22
SN7437	0·28
SN7438	0·28
SN7440	0·16
SN7441AN	0·68
SN7442	0·65
SN7445	0·78
SN7446	0·84
SN7447	0·80
SN7448	0·90
SN7450	0·16
SN7451	0·16
SN7453	0·16
SN7454	0·16
SN7460	0·16
SN7470	0·29
SN7472	0·21
SN7473	0·31
SN7474	0·31
SN7475	0·45
SN7476	0·30
SN7480	0·42
SN7481	1·00
SN7482	0·65
SN7483	0·82
SN7484	0·95
SN7485	1·00
SN7486	0·29
SN7490	0·42
SN7491	0·75
SN7492	0·45
SN7493	0·45
SN7494	0·75
SN7495	0·68
SN7496	0·68
SN74100	1·10
SN74107	0·30
SN74118	0·85
SN74119	1·75
SN74121	0·32
SN74122	0·42
SN74123	0·65
SN74141	0·75
SN74145	0·72
SN74150	1·20
SN74151	0·68
SN74153	0·68
SN74154	1·20
SN74155	0·78
SN74157	0·76
SN74160	0·88
SN74161	0·88
SN74162	0·88
SN74163	0·88
SN74164	1·60
SN74165	1·60
SN74167	3·30
SN74174	0·99
SN74175	0·70
SN74176	1·14
SN74180	1·10
SN74181	1·95
SN74190	1·86
SN74191	1·86
SN74192	1·15
SN74193	1·15
SN74196	1·60
SN74197	1·58
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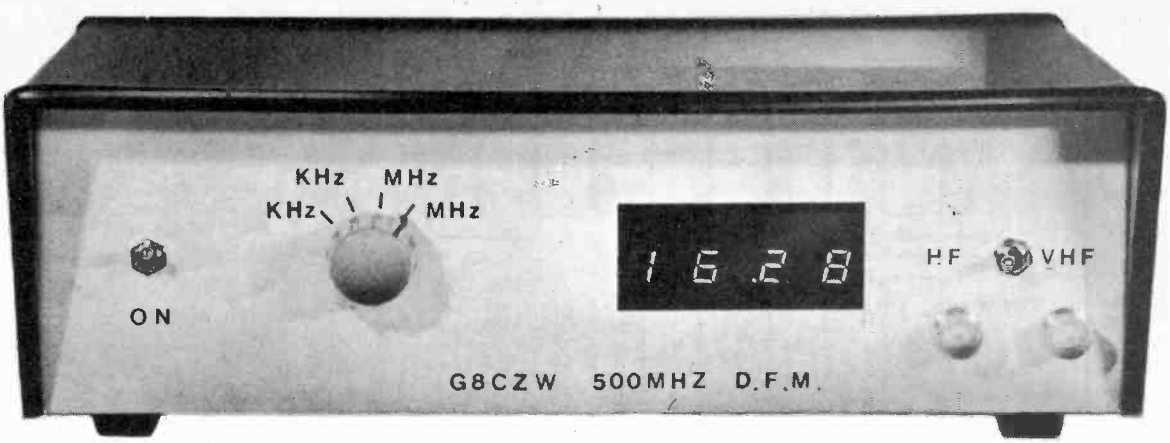


DIGITAL FREQUENCY METER

PART TWO

By A. J. BUXTON

THIS concluding article deals with the construction of the main board, display board and details of the high impedance buffer and a v.h.f. prescaler.

CONSTRUCTION

The layout of the components on the main p.c.b. is shown in Fig. 7. A full size printed circuit master for this board is given in Fig. 8.

The layout of the components on the display board is shown in Fig. 9 and the printed circuit master in Fig. 10.

A ready-made case is used to house the instrument. A rectangular hole is needed in the front panel to show the display. This should be covered with a red filter to make the display more easily read.

Drilling details for the case are given in Fig. 11.

CIRCUIT BOARD ASSEMBLY

When the printed circuit boards have been obtained the components must be soldered in place. Start with the display board. First check that all holes including the 3mm fixing holes have been accurately drilled, then insert and solder the six wire links marked in Fig. 9. Insert and solder the components in the following order: resistors, i.c. sockets, transistors. The transistor leads need to be splayed out slightly; do not bend too close to the plastic.

Cut 15 70mm lengths of sleeved wire and strip 6mm from each end, tinning the bare wire. Insert these wires into the display board pads and solder in place. Check for solder bridges, then proceed to the main board.

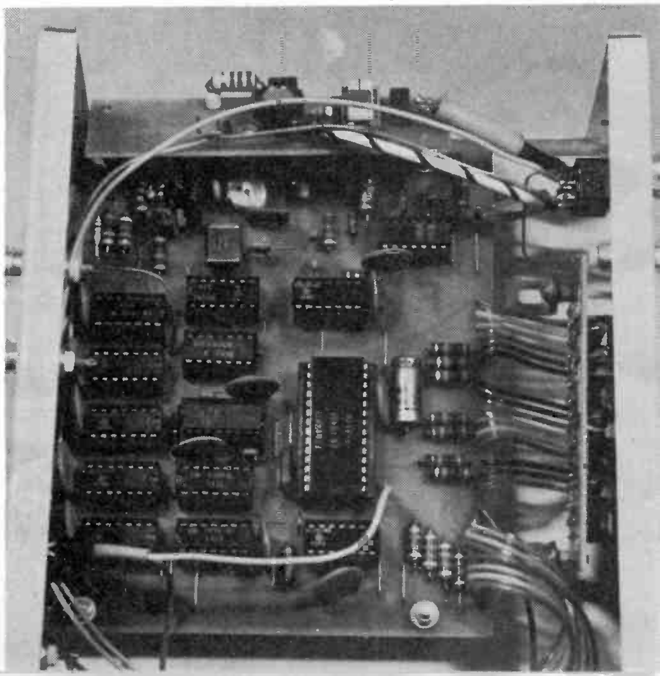
After checking that all holes are present, solder in the 24 links shown on Fig. 7. If i.c. sockets are used, insert and solder these next. The socket for the ZN1040E is 28 pins and can be made either by cutting two 14 pin sockets in half or by using strips of pins.

Insert and solder resistors, capacitors, transistors, diodes and the trimmer capacitor VC1. Insert integrated circuits.

Solder about 20cms of sleeved wire into the −9V and +5V pads (27 and 1) then the same length to pads 20, 21, 17, 18, 19, 22, 23, 24, 25, 26 and 28.

Short out pads 30 and 33 (W and Z) to give IC1 a gain of 100. Solder one end of the 6,800pF capacitor C1 to pad 29.

The main circuit board in position



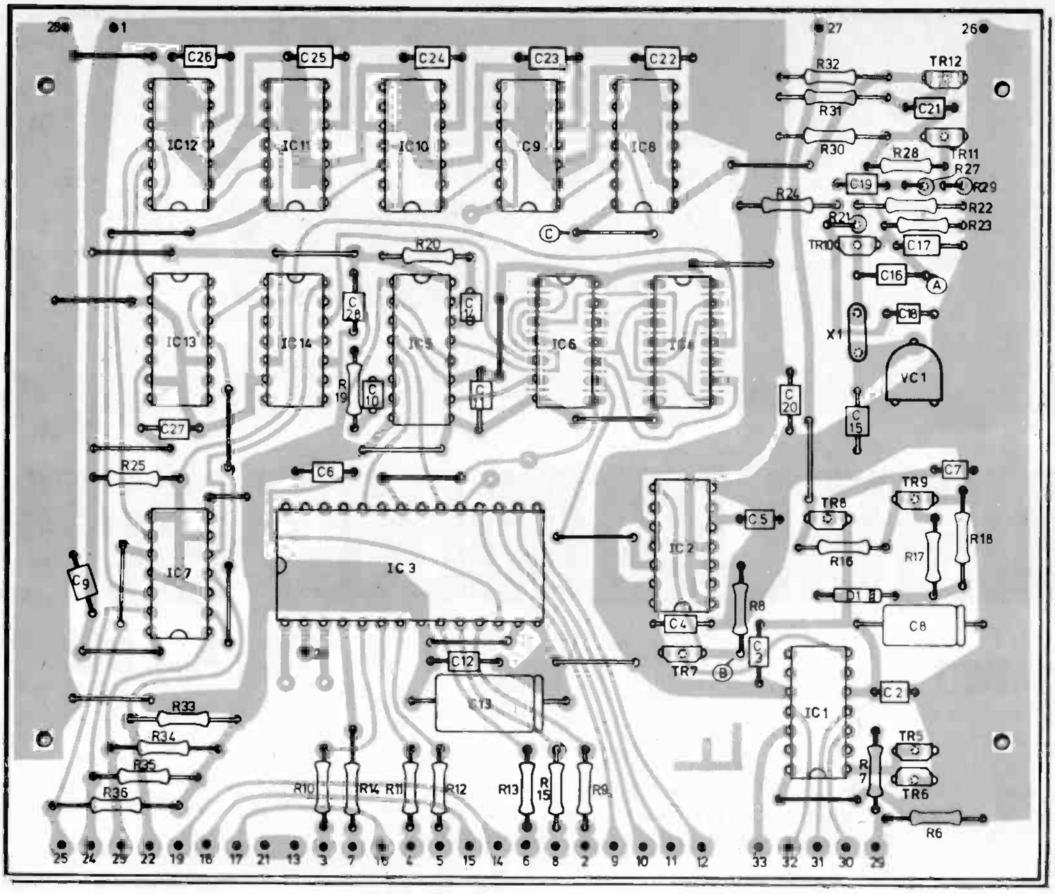


Fig. 7. Layout of the components on the main printed circuit board. Note that if the high impedance buffer is used then C1 and transistors TR5 and TR6 are not required. The three signal test points in Fig. 2 are marked as "A", "B" and "C". I.C. sockets should be used especially for IC3 as replacing a faulty i.c. is difficult

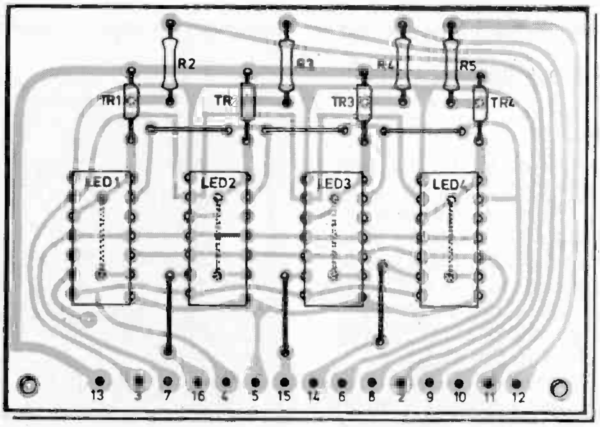


Fig. 9. Layout of the components on the display board. The 15 pads are wired to pads with the corresponding numbers on the main board

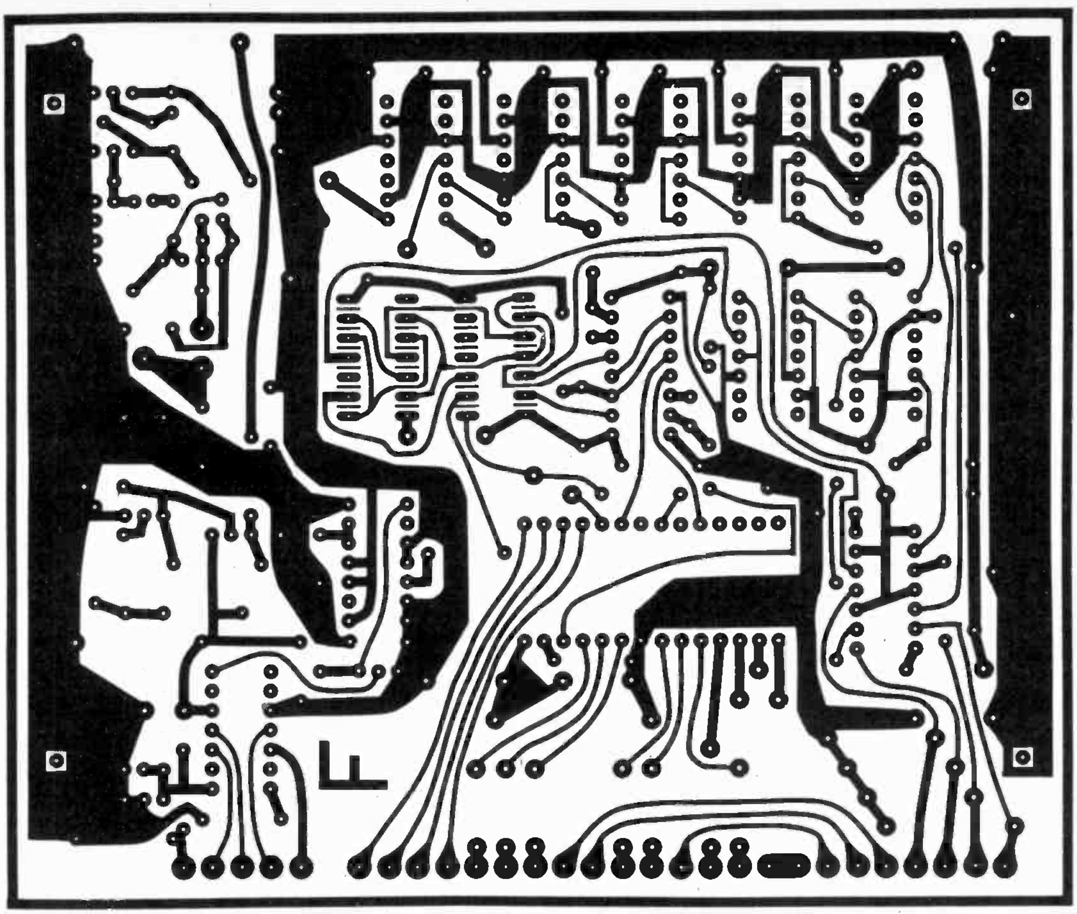


Fig. 8. Full size printed circuit master of the main board as viewed from the copper side

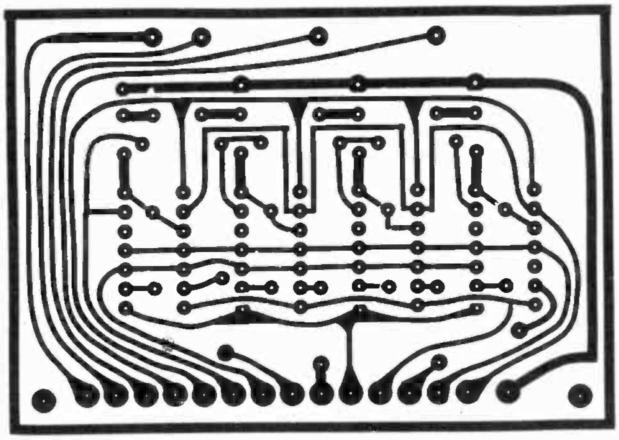


Fig. 10. Full size printed circuit master of the display board

Mount the display board onto its support brackets, check the main board for mistakes, then join the 15 wires from the display board to the main board.

Now insert and solder the crystal X1 leaving about 5mm of lead between can and board.

Glue filter onto inside of case, then mount input socket (SK1), range switch (S1), mains switch (S3), mains lead; fuse (FS1) and lamp test switch (S2).

The mains transformer should have flying leads soldered onto its mains, screen and 0V terminals. Mount the transformer using 4B.A. bolts with a solder tag on each. Take the transformer screen and 0V leads to these tags.

Mount the regulator IC15 using a 4B.A. nut and bolt, then the tag strip. Fig. 12 shows the general layout and interwiring.

Insert four 25mm 6B.A. bolts to hold the main board and fix with nuts. Then screw on another nut on each, leaving about 13mm between it and the case. The display board bolts are then fitted in a similar way, but 13mm bolts are used and 6mm is left between the second nut and the case.

The boards should then both be placed on their bolts and fixed with washers and nuts. The wires from pads 17, 18, 19 and 22, 23, 24, 25 are then soldered to the range switch.

The free end of C1 is soldered to the input socket.

Wire up the power supply using Fig. 12.

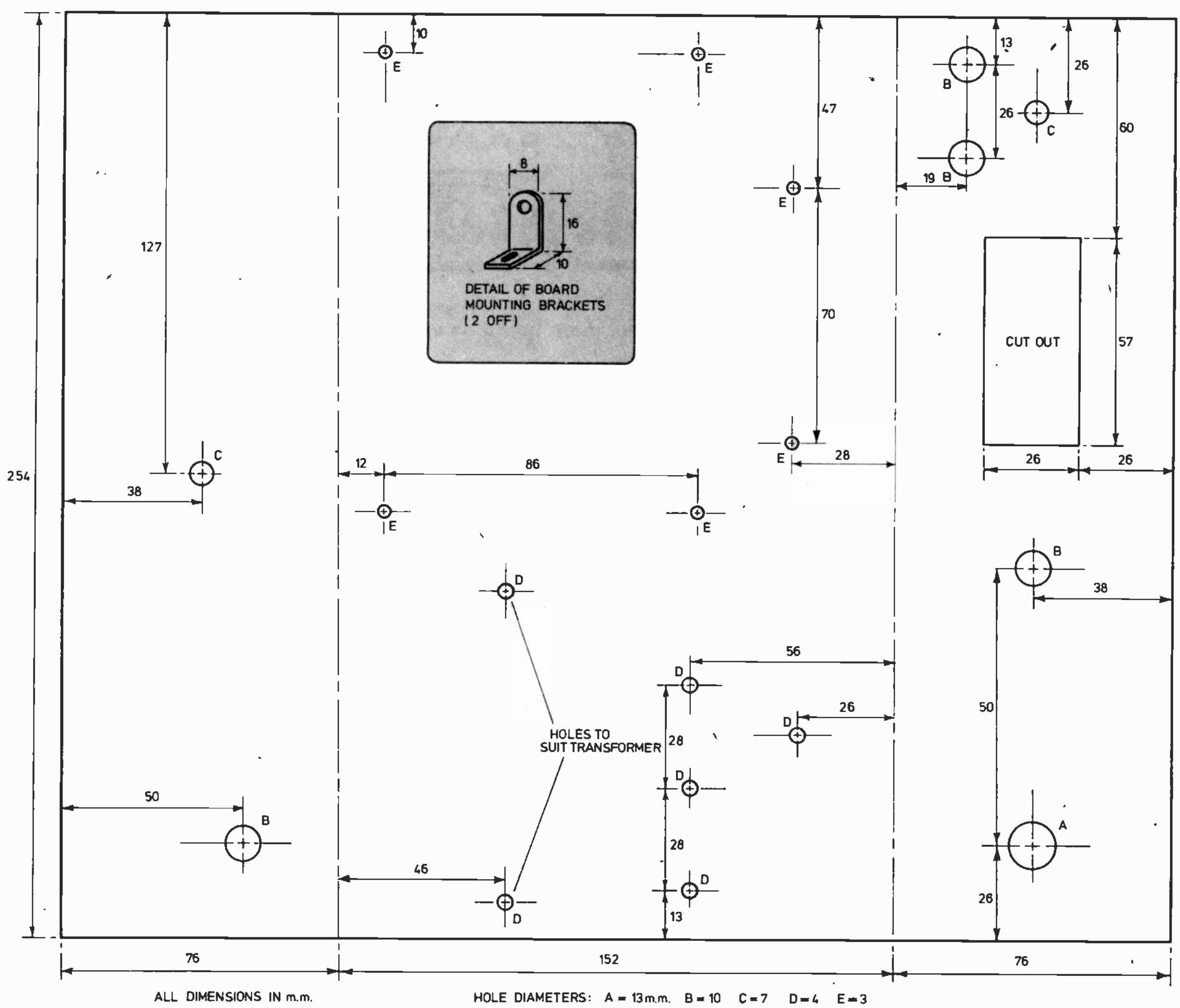
Carefully check for mistakes, then switch the instrument on.

SETTING UP

The following tests should be made to check the correct operation of the instrument.

Measure the voltage on pin 5, IC1 (−5V) and pin 10 (+5V). If an oscilloscope is available the 5MHz

Fig. 11. Drilling details of the metal case. The oblong hole for the display is made by drilling along the perimeter or sawing with an Abrafile



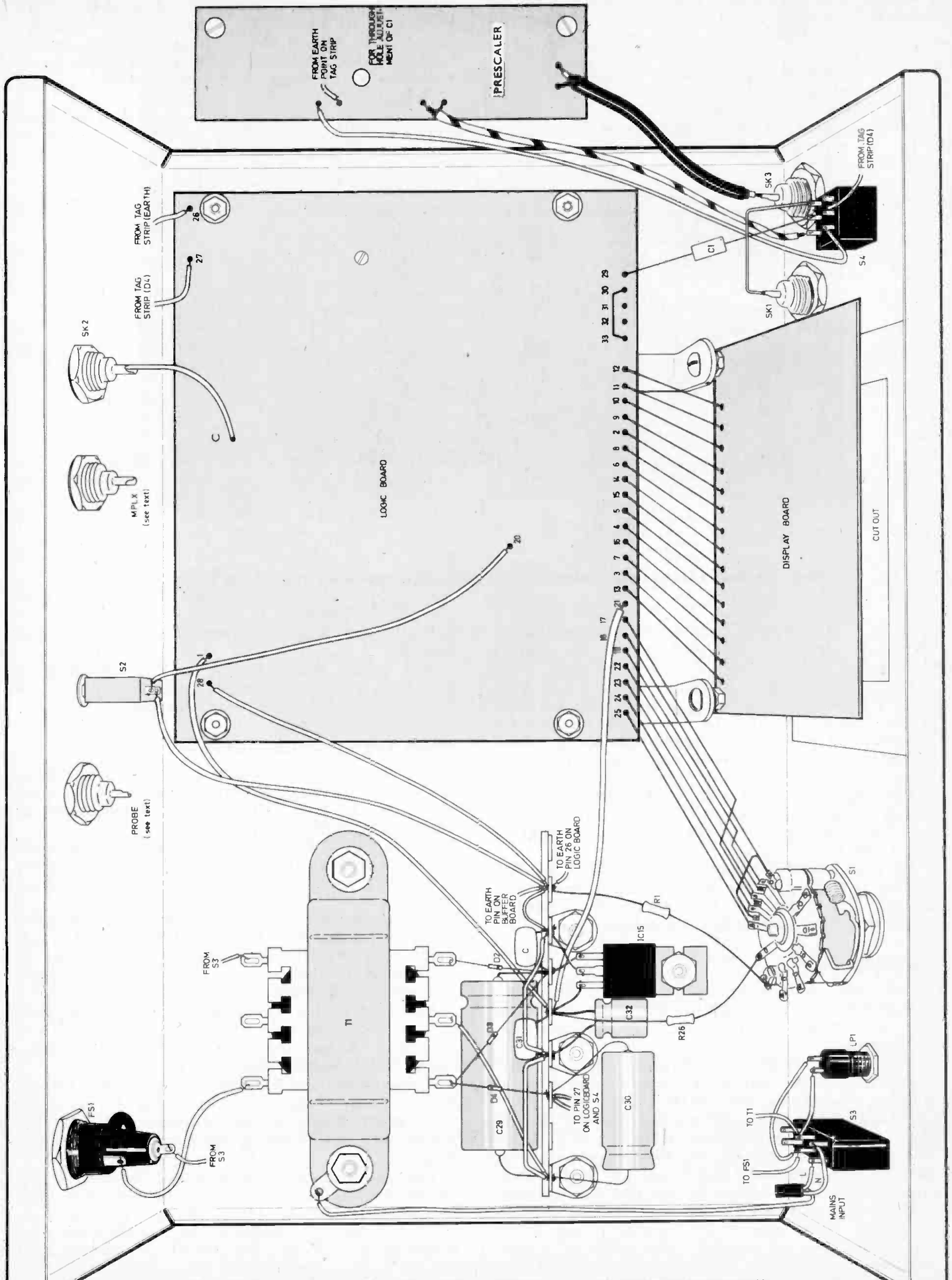
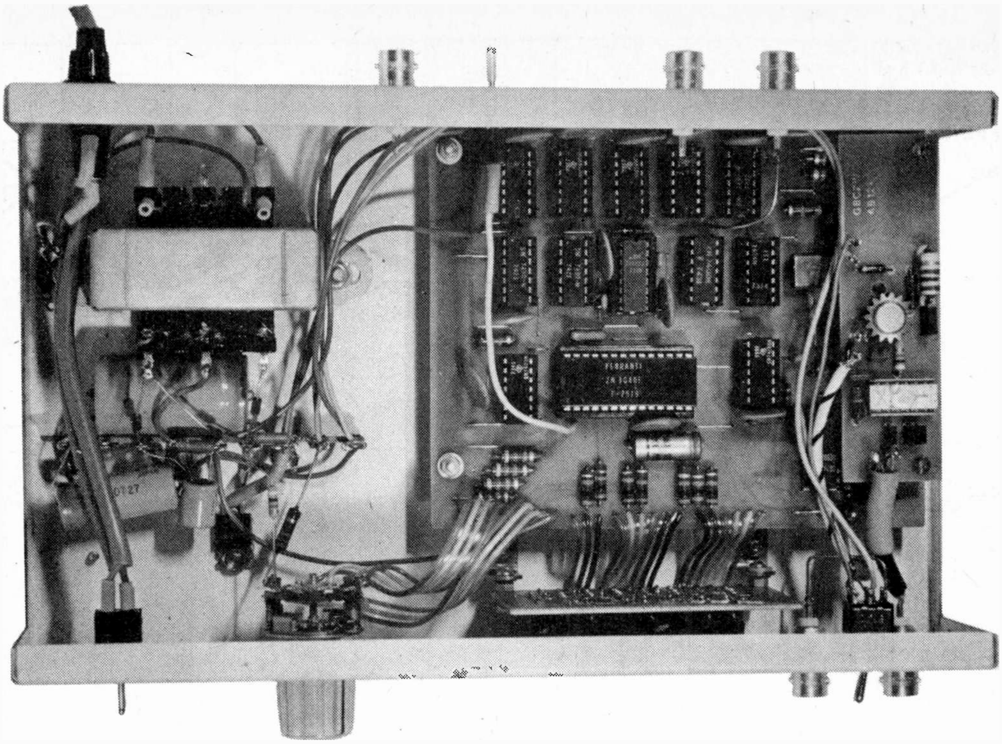


Fig. 12. General layout of the unit and power supply interwiring details



The completed frequency meter with the pre-scaler mounted in position on the right

frequency at point "A" should be checked. Then check the divider chain (IC8 to 14) for correct division.

If an oscilloscope or frequency meter is not available, a multimeter can give an indication of oscillation. Pin 12 of IC8 to 14 has a symmetrical waveform so at high frequencies about 2V or so will be registered. No output will register as either 0V or 4V.

Earthing pin 2 of IC3 with the lamp test switch causes the display to indicate all eights. If not, check that an oscillation of about 2·8kHz is present at pin 12, IC3.

On the lowest frequency range, pin 9 of IC4 should be high for one second and low for one second. The clear and transfer functions need a 'scope or timer to check their operation.

CALIBRATION

The only calibration required in this instrument is the setting of the oscillator frequency at 5MHz. The 3 to 60pF capacitor VC1 is used for this adjustment.

The most convenient calibration signal is that obtained from the long wave Radio 2 transmitter at 200kHz. By taking the 1MHz pulses from point "C" (IC8) through a capacitor and dividing this by five, one can obtain 200kHz from the D.F.M. A 7490 i.c. is quite suitable for this purpose and, in fact, the high impedance buffer board to be described later has provision for an i.c. for just this purpose.

The signal from the D.F.M. at 200kHz is coupled to a long wave receiver by draping a wire from this output over the receiver. The oscillator is then adjusted by means of VC1 until the audible beat frequency is very low. An "S" meter is a useful indicator for this adjustment but ears are nearly as good.

The D.F.M. should be switched on for about an hour before this adjustment is made.

The instrument is now ready for use.

HIGH IMPEDANCE BUFFER

For general purpose use it is often important for the digital frequency meter to have a high input impedance so that it does not load the circuit to which it is connected.

The circuit of Fig. 13 (a) shows suitable buffer for use with this instrument. A field effect transistor (TR15) is used to give the required high input impedance.

The circuit gain is determined by the d.c. coupled amplifier formed by TR17 and TR18, as TR15 has unity gain. With resistor R48 having a value of 1·5 kilohm the gain is about four when the output is loaded by 50 ohms.

The two kilohm potentiometer VR1 is adjusted to give maximum gain. The input transistor TR15 is protected from voltage overload by the two diode-connected transistors TR13 and 14.

Also mounted on the buffer board is the 200kHz divider whose circuit is shown in Fig. 13 (b). Input and output should be via screened leads and the power lines should not be the same as those for the buffer.

The layout of the components on the printed circuit board and the p.c.b. master are shown in Figs. 14 and 15.

The wiring of the buffer board into the main unit is shown in Fig. 16. The board can be mounted on the same bolts holding the right-hand side of the main board, if these are made about 4cms.

COMPONENTS . . .

BUFFER BOARD

Resistors

R37	100kΩ
R38	47kΩ
R39	47kΩ
R40	470kΩ
R41, R42	100Ω (2 off)
R43	180Ω
R44	3·8kΩ
R45	6·3kΩ
R46	330Ω
R47	180Ω
R48	1·5kΩ
R49	470Ω

All ± 5% ¼ or ⅛W

Potentiometer

VR1	2kΩ horizontal skeleton preset

Capacitors

C33	0·047μF
C34	150pF polystyrene
C35–C40	0·01μF disc (6 off)
C41	10μF 63V elect
C42	0·1μF disc

Transistors

TR13, TR14	ZTX314 (2 off)
TR15	E300
TR16	ZTX302
TR17, TR18	ZTX313 (2 off)

Integrated Circuit

IC16	ZN54L90

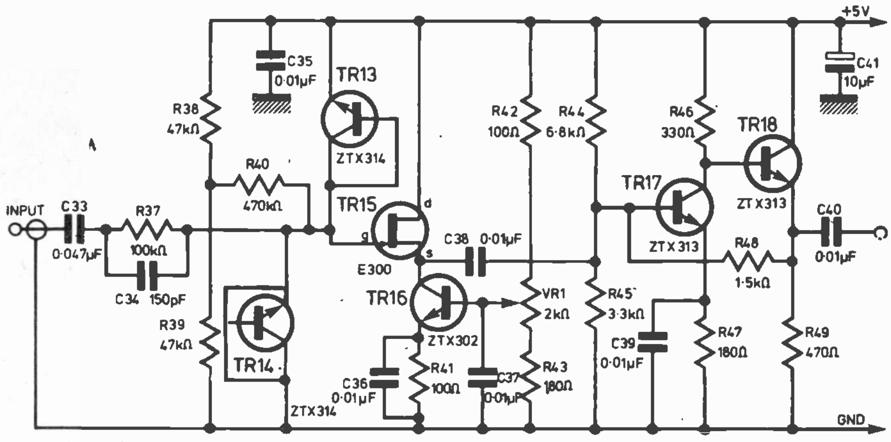


Fig. 13 (a). Circuit diagram of the high impedance buffer

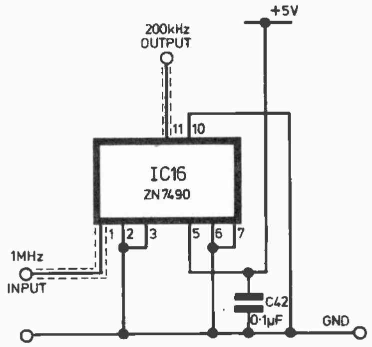


Fig. 13 (b). Circuit diagram of the divider to give the 200kHz calibration signal from the 1MHz available on the main board. Both circuits are mounted on the one board

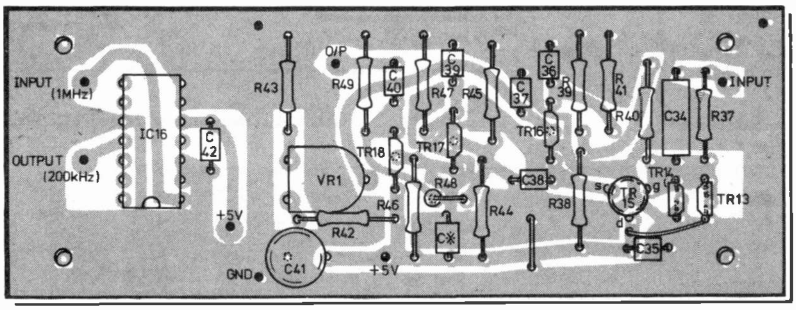


Fig. 14. Layout of the buffer and calibration circuits on the printed circuit board

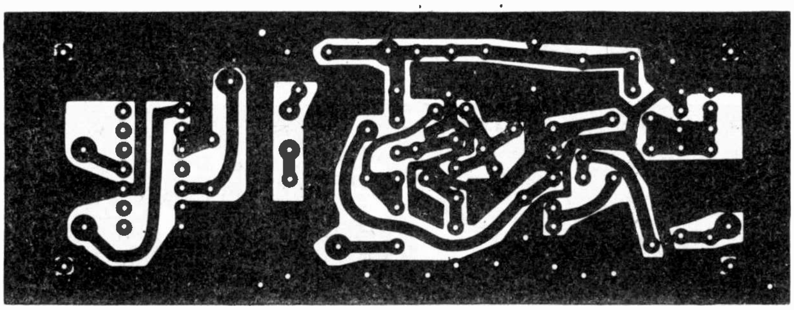


Fig. 15. Full size printed circuit master for the buffer and calibration board

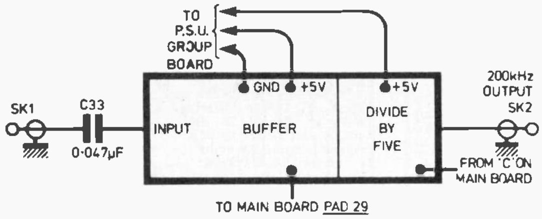
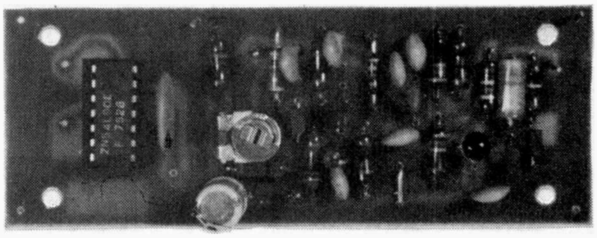


Fig. 16. Connections from the buffer and calibration board to the main unit



The high impedance buffer board

VHF PRESCALER

To enable the frequency meter to read frequencies up to 146MHz a pre-scaler is used. This pre-scaler uses Plessey UHF decade dividers. There are three devices in this family:

SP630B 600MHz
SP631B 500MHz
SP632B 400MHz

The one used depends on one's frequency requirements.

The circuit (Fig. 17) shows the divider and a power supply regulator (TR19). The negative power supply can be taken from the same line that supplies the logic board. The shunt regulator maintains the supply of IC17 at −5·2 volts. It will cater for load current between 0 and 100mA. TR19 may be any silicon *npn* transistor of the 2N3053, 2N1711 type.

The value of R53 will depend on the input voltage V_{in} where

$$R_{53} = \frac{V_{in} - 5.2}{0.1} \text{ ohms}$$

COMPONENTS . . .

VHF PRE-SCALER

Resistors

R50	15kΩ ± 5% ¼W
R51	450Ω ± 5% ¼W
R52	100Ω ± 5% ¼W
R53	100Ω ½W

Capacitors

C43–C47	1,000pF (5 off)
C48	0·1μF

Semiconductors

D5	4·5V 400mW Zener
TR19	2N3053 with heatsink
IC17	SP630

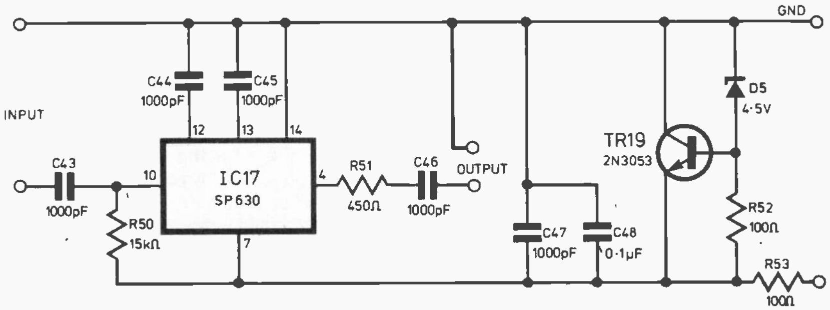


Fig. 17. Circuit diagram of the VHF Prescaler

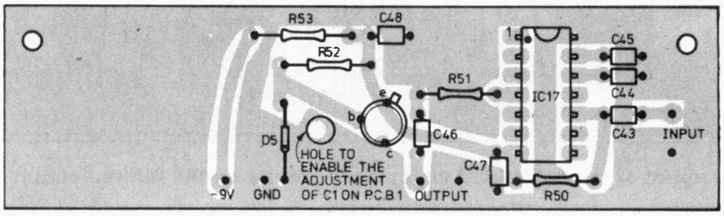


Fig. 18. Layout of the components on the VHF Prescaler board

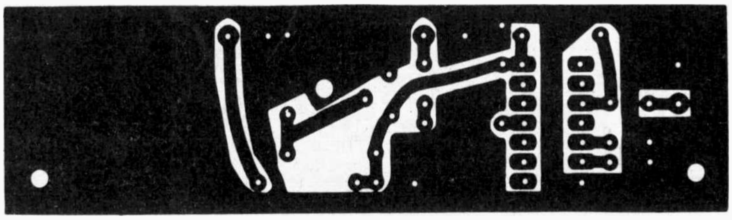


Fig. 19: Full size printed circuit master of the VHF Prescaler board

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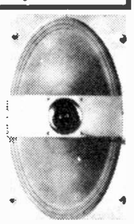

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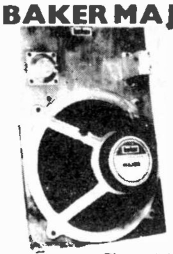

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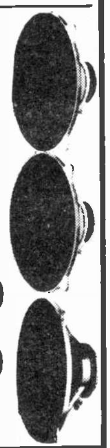

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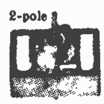

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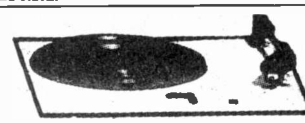

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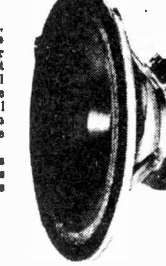

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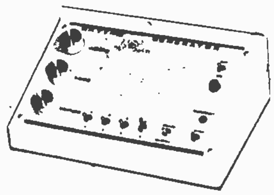

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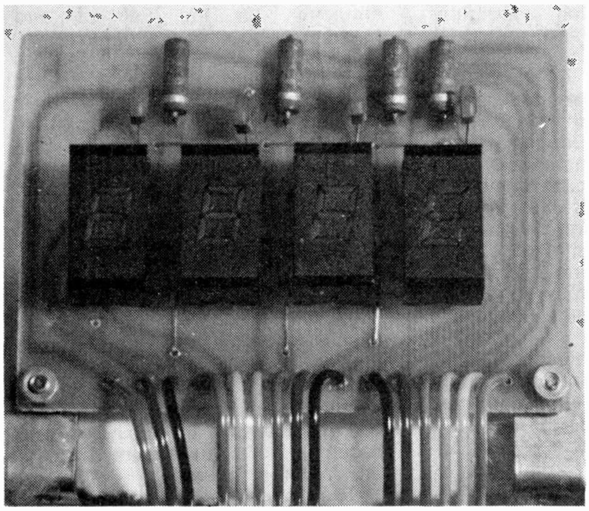

The display board

PRE-SCALER CONSTRUCTION

In this circuit a 100 ohm ½ watt resistor is reasonable. It is advisable to use a socket to mount IC17. The SP632 costs about £16. The price of a socket does not compare to the price of a damaged circuit. The capacitors are all disc ceramic. All component leads should be kept short. Component layout is shown in Fig. 18 and p.c.b. master in Fig. 19.

The board is mounted on the oscillator side of the logic board. Two 13mm pillars are used to secure the logic board and the pre-scaler board mounts on top of these. The hole next to the 4·5V Zener is to adjust the oscillator trimmer capacitor VC1. The drawing (Fig. 12) shows how the prescaler is connected in circuit.

Test the power supply regulator before inserting IC17. Check that the voltage between pin 14 and pin 7 is about −5·2 volts. Plug a 68 ohm resistor between pin 7 and pin 14, check the voltage is still about −5·2 volts.

The input and output impedance is 50 ohms. The minimum drive voltage depends on frequency. The characteristics sheet should be consulted.

Note: The maximum peak input voltage must not exceed 5·2 volts.

APPLICATIONS

The digital frequency meter can be used to measure the frequency of any signal source. This ranges from transmitters, receiver oscillators, signal generators to function generator and pulse generator pulse repetition rates.

When using the 50 ohm input, care must be taken not to load the signal source in such a way that its frequency is changed. If the source is loaded then the D.F.M. may have to be left in circuit as the source is used.

The buffer amplifier will reduce the effect of this loading. When using large signal sources, a resistor in series with the D.F.M. input will further reduce the loading.

The buffer described has an input protection which starts to limit at an input voltage of 4·7V peak to peak. Before limiting the shunt capacitance is 5pF and after limiting 150pF. The limiting can be counteracted by using a variable resistor across the input to the D.F.M. (Fig. 20).

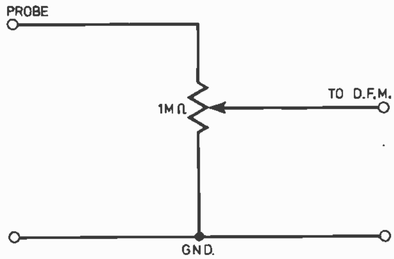

Fig. 20. A potentiometer across the input of the Digital Frequency Meter reduces the loading effects

High power transmitter frequencies can be measured by looping a piece of wire around the feeder. The D.F.M. input is connected to its ends.

If one wishes to measure, say, 35·01853MHz, one would measure the first four digits, then overrange the meter to read the following digits.

Range 1 35·01

Range 2 5·018

Range 3 018·5

Range 4 18·53

The D.F.M. can resolve down to 10Hz using this procedure. ★

INDUSTRY NOTEBOOK

By Nexus

TOP OF THE POPS

Looking through back numbers of P.E., I find that in October 1974 I was commending the work of Godfrey Hounsfield, the bachelor boffin of EMI's Central Research Laboratories, who master-minded the EMI-Scanner brain X-ray equipment. At that time it had already clocked up £14 million of orders and was clearly going to be one of Britain's commercial as well as technical triumphs, which makes a change from the usual routine of British inventions being left for other nations to exploit.

What Hounsfield and his small team have now done for EMI emerged with startling clarity in the company's latest half-year results. The Scanner is generating profits on a scale unmatched since the days and following years when EMI had signed up the Liverpool Sound of the Beatles after John, Paul, George and Ringo had been rejected by Decca.

The EMI Group sales for the last half-year were £313 million, up 30 per cent, and profits (pre-tax) were £29.5 million, an increase of 81 per cent. But if we look closer at the figures we find that electronics as a separate activity in itself, had a 44 per cent increase in sales to £88 million and now, wait for it, profits had shot up to £10.6 million, an increase of 178 percent. Nice going in tough times!

But, said John Read, EMI Chairman, this is not a Scanner bonanza. Other sectors, too, had made big contributions and he cited defence electronics, industrial electronics and EMI's stake in TV transmission and studio equipment where the company had done particularly well in the Australian re-equipment programme in the switch-over to colour TV.

I didn't find Read's argument carrying much conviction. Profit on defence equipment is tightly controlled and TV and industrial electronics are, to say the least, highly competitive, which means that profit margins are necessarily restricted if you are to stay in business. The EMI-Scanner, however, was unique, technically and commercially, and could command in sales price what the market could afford. Although I disagree with John Read's comment, I don't argue with his reasons for making it which seem to have been intended to discourage potential competitors.

Total Scanner sales are now over £80 million and still rising fast. But note that the Scanner *was* unique. This is no longer the case with competitive models now appearing and there could be as many as 15 other manufacturers bringing similar equipment to the market in the next year or so. But, with a substantial lead in hand, EMI is still hopeful of remaining among the market leaders and a 20 per cent market share in 1980 could still represent sales of £100 million a year.

SALARIES

Last month I wrote at some length on the present salary structure for qualified engineers. My assessment was based on situations vacant notices in the national and technical press. Since then an authoritative survey has been published by the IEE as a result of a canvass among the membership. It more than confirmed my own general impression.

In the Associate Membership grade the greatest number is employed in non-managerial R & D where the median salary taking in all age groups is £3,700 although if those working in private industry are taken separately the median drops to £3,500 and the figure for the lower quartile (i.e., the figure below which 25 per cent of the sample falls) is £3,000. Non-managerial R & D is the most poorly paid.

Engineers working as salesmen or on maintenance and servicing earn more than the man in the laboratory. Fellows and Members, by definition, are people of greater maturity and experience and in general management in private industry enjoy a median income of £7,610 although a quarter get over £10,000.

It seems then, that the engineer whose main interest is income should switch as soon as possible to selling and marketing, and get a foothold on the managerial ladder.

What, to me, was a surprising finding in the survey is that engineers whose salaries are determined by collective bargaining do less well than those whose salary is adjusted periodically by the employer. Of the Fellows and Members about one in nine enjoy, if that is the word, collective bargaining and get £1,000 a year less for it than the eight of their colleagues. Twenty-five per cent of Associate Members are in a collective bargaining situation and they run behind to the extent of £500.

MARINE RADAR

With shipbuilding in the doldrums at home one might expect marine radar to be taking a few knocks. Not so. Market leader Decca Radar took orders for nearly 200 installations in a single week recently, worth more than £700,000 and all from overseas.

The largest single order was from Yugoslavia for 93 sets, of which 67 are for fitting in a fleet of push-tugs under construction for Iraq. The second largest order came from Brazil, 35 sets for bulk carriers now being built as part of Brazil's maritime expansion programme. Another 37 sets were ordered by various navies, including those of Sweden and Chile.

Kelvin Hughes also appears to be doing very well in the world market and especially so with the KH Situation Display, a TV-type radar presentation which won the Queen's Award for Technological Innovation last year. KH engineers have been busy on further developments of the Situation Display and a new model, with improved definition, has just been released.

BELL CENTENARY

The 100th anniversary of the birth of the telephone provided the occasion for all manner of people to sound off about the virtues of instant person-to-person communication. Sir William Ryland, chairman of the Post Office and target of much impolite criticism over the past year, was well to the fore.

In an anniversary message to all his telecommunications staff he spoke of great achievement and said it was time the British people gave credit where it is due. He pointed out that the BPO installs 1,200 telephones an hour and invests at the rate of £1,700 a minute day and night.

But he didn't reveal how many people were asking for disconnection since the call charges went up, or that 9,000 workers are being made redundant in the manufacturing industry following cut-backs in orders. Sir William, however, remains optimistic that the BPO will make £80 million profit this year. I hope he is right. Last year the loss was £194·6 million.

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PATENTS REVIEW...

AID FOR THE HANDICAPPED

Devices whereby a severely handicapped or paralysed person can control domestic equipment, such as a radio or television, are already known. These usually rely on a pressure-sensitive switch into which the patient blows. In BP 1 418 006, Signale und Automatik, of Bern, Switzerland, suggest an even more sensitive control switch.

It is suggested that even the most seriously handicapped persons can often still control tongue movement. Accordingly, a mouthpiece, generally similar to a microphone, carries two separate pairs of contacts, each embedded in insulating material.

These contacts, Fig. 1, are so spaced that the patient can bridge them easily with the tongue. One pair of contacts, *a*, *b*, is linked via cables to an excitation circuit, Fig. 2a. Terminal *a* connects to the collector of TR1, and terminal *b* to its base, with the emitter earthed. Transistor TR1 collector controls relay RLA via thyristor CSR1.

Contacts c, *d*, are linked to a de-excitation circuit Fig. 1b. Terminal c is connected to TR2 collector and terminal *d* is connected to its base, with the emitter earthed. Transistor TR2 collector controls relay RLB via thyristor CSR2. When closed, RLA1 connects the anode of CSR2 to earth.

To switch on load circuit *U*, the patient bridges contacts *a*, *b*, with his tongue. This makes TR1 conductive, switches on CSR1 and energises RLA relay. Contact RLA2 closes to route power permanently to the circuit *U* and contact RLA1 closes to prepare Fig. 1b for de-excitation.

De-excitation is achieved by the patient bridging contacts c, *d*, to make TR2 conduct, switch CSR2 on and energise RLB.

Contact RLB1 is opened to switch off thyristor CSR1 and de-energise the relay RLA. Contacts RLA1 and 2 thus open, to isolate the load *U* and the relay RLB. Contact RLB1 now closes again to bring the device back to its rest state.

BP 1 418 006

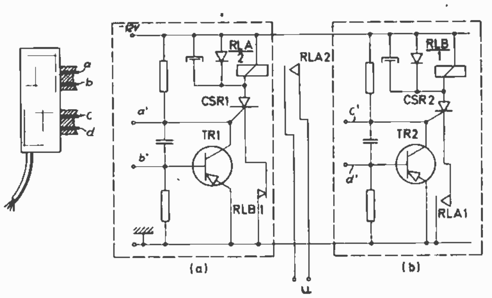

Fig. 1

ELECTRIC FENCE

Farmers have for many years kept sheep and cattle within their fields by surrounding the area with a high voltage, low current wire. After a few shocks, the animals learn to keep clear of the wire, and the power need seldom be turned on. In BP 1 417 086, Richard Peck, of Pennsylvania, USA, describes a sophisticated version of the system, for use with domestic pets, for instance to prevent them from straying out of a house garden.

As shown in Fig. 1, a loop of wire defines the area in which the animal is to be confined. This loop can be buried under the ground.

BP 1 417 086

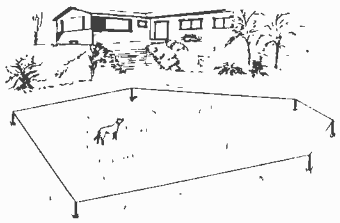

Fig. 1

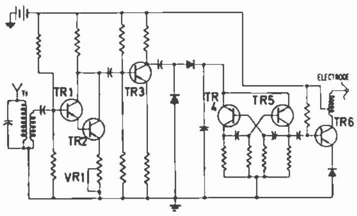

Fig. 2

The wire radiates, for instance at 560kHz, and the animal carries a small, battery-powered receiver on its collar.

The radiated signals are received at an aerial, Fig. 2, filtered and amplified by a Darlington pair TR1, TR2. Potentiometer VR1 serves as an adjustable feedback path for circuit stability and gain control. The output signal of the Darlington is fed via power amplifier TR3 to the rectifier pair and the following storage capacitor.

An astable multivibrator, TR4, TR5, is powered by the capacitor to produce a square wave signal which is amplified at TR6 and fed to induction coil. This produces a high voltage shock signal at the electrode which is in contact with the animal's skin. Alternatively the coil can power a loudspeaker close to the animal's ears. As soon as the animal strays too close to the wire, the multi-vibrator triggers a warning shock or sound in the animal's ear.

As an alternative arrangement, a transmitting aerial is located centrally within the confined area, and the circuit modified to trigger a shock when the animal moves too far from the aerial.

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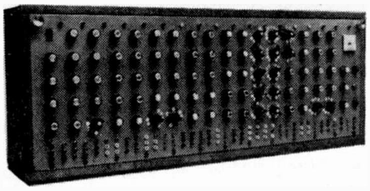

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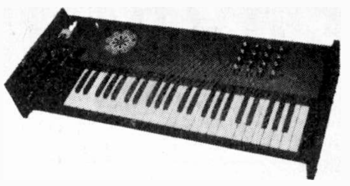

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P.E. MINIMIX 6

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Stereo main PCB	£2·80
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VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)
An independently designed VCF that can be used with the P.E. Synthesiser.

Component set	£3·41
Printed circuit board	£1·25

ENVELOPE SHAPER AND V.C.A.

The ADSR Envelope Shaper published in P.E. April 1976 and having its own voltage controlled amplifier and full manual control of its Attack, Release and Sustain functions.
Component set incl. PCB £5·43

AUTO WAH-WAH

Component Set and P.C.B. £2·99.

RHYTHM GENERATOR

(P.E. Mar. Apr. 74)
Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and soft cymbal), and with variable time signatures and rhythm rates. Really fascinating and useful.

Tempo, Timing and Logic circuits	£12·59
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A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)	£2·50

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB)	£3·75

ENVELOPE SHAPER
The ADSR Envelope Shaper published in P.E. October 1975 and having manual control of its Attack, Release and Sustain functions.

Component set incl. PCB	£4·16

WIND AND RAIN UNIT
A manually controlled unit for producing the above-named sounds.

Component set incl. PCB	£2·83

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Multi-function circuits that, with the use of other external equipment, can serve as lie detector, alphaphone, cardiophone, etc.

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Component set and PCB £3·71

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Type PC7 £5·50

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PCB for above components	£1·60
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(P.E. NOVEMBER, 1975)

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(P.E. MARCH, 1976)

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BC109	13p	OC28	60p	2N3819	35p
BC147	12p	OC71	14p	2N3823E	39p
BC148	12p	OC72	14p	2N4060	12p
BC149	12p	OC84	25p	2N4871	36p
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BC187	25p	ZTX531	23p		
BC204	14p	2N706	13p		
BC209C	14p	2N914	22p		
BC212L	15p	2N1304	22p		
BC213	15p	2N2905	27p		
BC478	29p	2N2907	22p		
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5·6V 1 3W	20p
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6·8V 400mW	15p
9·1V 400mW	15p
10V 400mW	15p
11V 1W	25p
12V 400mW	15p
12V 1W	25p
15V 400mW	15p
15V 1W	25p
18V 400mW	15p
18V 1W	25p
20V 400mW	15p
20V 1W	25p
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6·8/40	6p	220/16	7p	4700/40	93p
10/25	6p	220/25	15p		
10/63	6p	220/40	17p		
15/40	6p	220/63	21p		
22/10	6p	330/10	6p		
22/25	6p	470/6·3	7p		
33/6·3	6p	470/10	15p		
33/16	6p	470/25	18p		
33/40	6p	470/40	20p		
33/50	6p	680/6·3	10p		
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47/25	6p	1000/10	14p		
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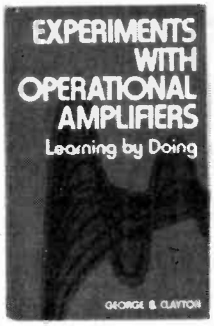

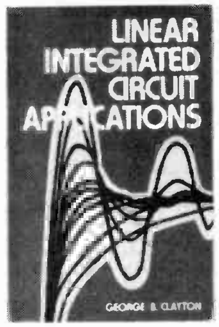

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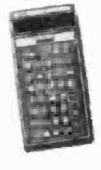

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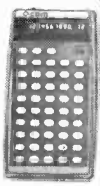

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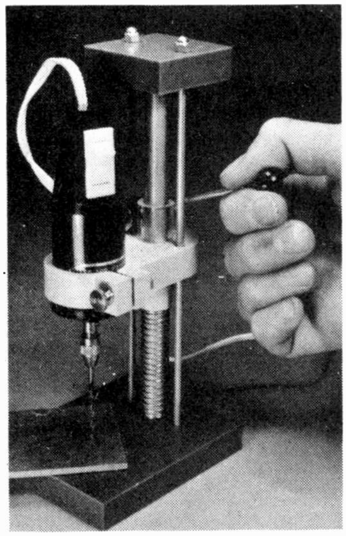

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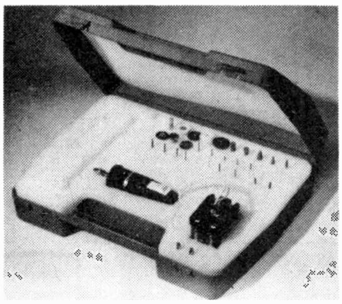

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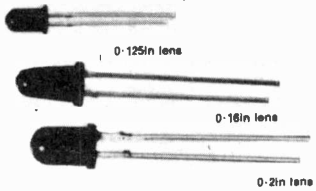

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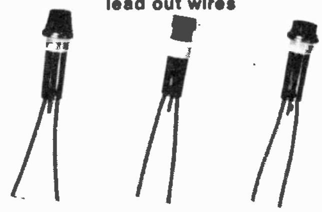

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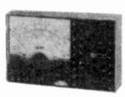

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108	8	4	5·09	85
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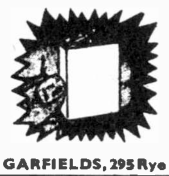

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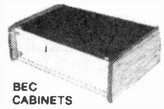

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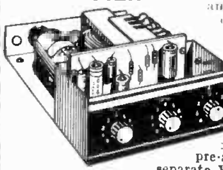
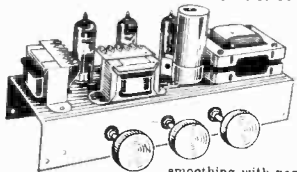
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. 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 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £13·75. P. & P. 85p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. 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 300m/v 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 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £12·40. P. & P. 95p.

ALL PURPOSE 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 on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2¼". Ready built and tested. **Price £5·75. P. & P. 85p.**

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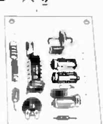
STEREO-DECODER SIZE 2" × 3" × ½"



Ready built. Pre-aligned and tested. Sens. 20-560mV for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £5·62 plus 20p P. & P. Stereo beacon light if required 40p extra.

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 wide × 3in deep × 6in high. Ready built and tested. PRICE £6·20. P. & P. 90p.
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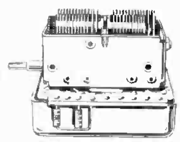
Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¾" × 1¼" × ¾". 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 12p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7·8V + earth. Supplied pre-aligned, with full circuit diagram. Connection details supplied. Beautifully made with precision-geared FM and 323 Pf + 323 Pf AM Tuning Gang only £3·15 + P. & P. 35p.

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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 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, 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 specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12-30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12-15,000 Hz. 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"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£13·50	P. & P. 55p
(Magnetic input components 33p extra)		
POWER PACK KIT	£4·85	P. & P. 85p
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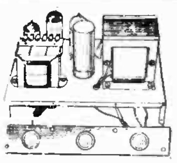
Full after sales service
Also available ready built and tested £29·25. P. & P. £1·00.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, 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 7½"w. × 4"d. × 4¾"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 £7·80. P. & P. 85p.
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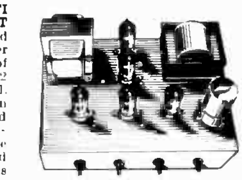
10/14 WATT HI-FI AMPLIFIER KIT



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 base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £11·25. P. & P. £1·25. Also available ready built and tested £15·20. P. & P. £1·20.

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