

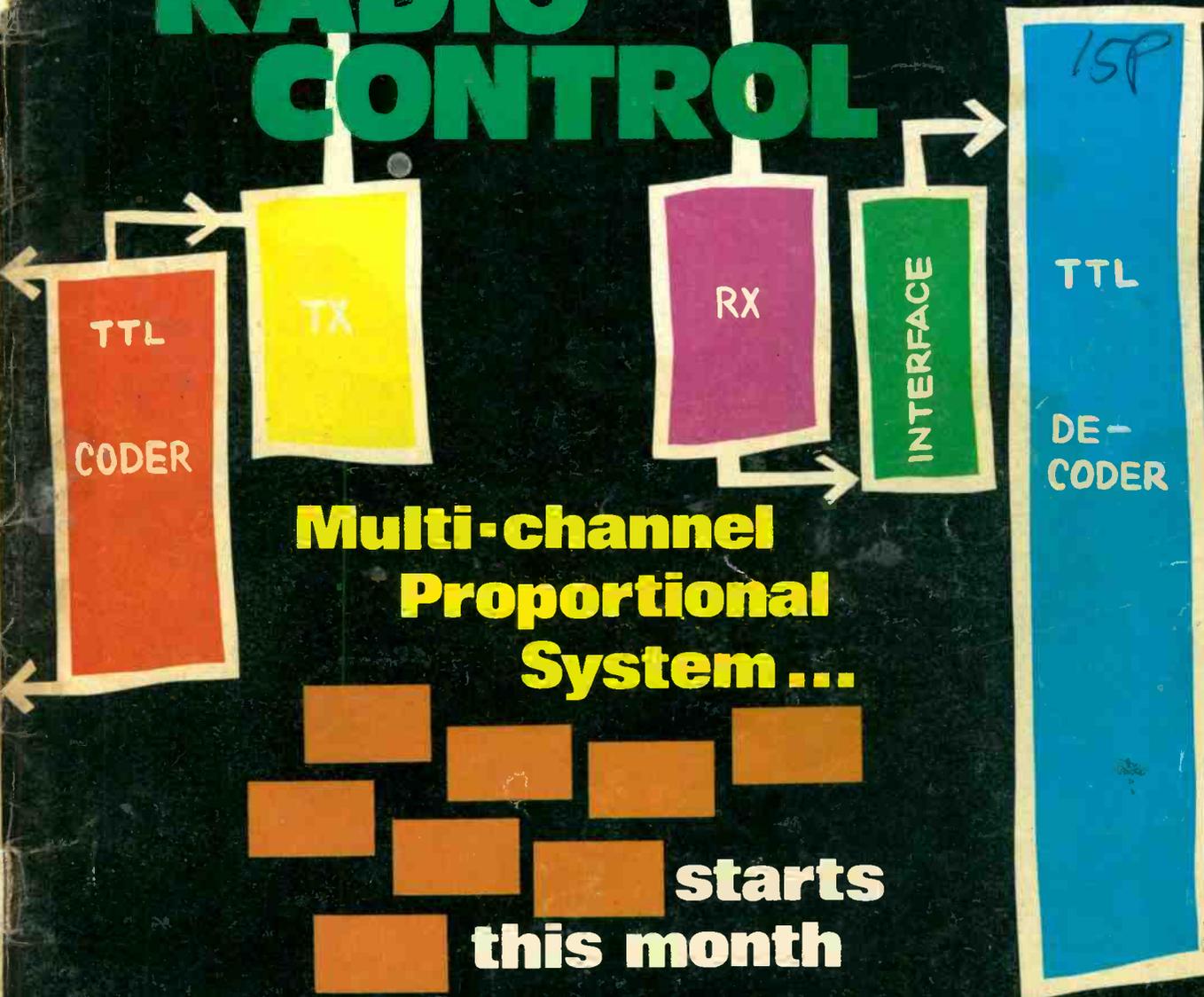
PRACTICAL

ELECTRONICS

JUNE 1976

35p

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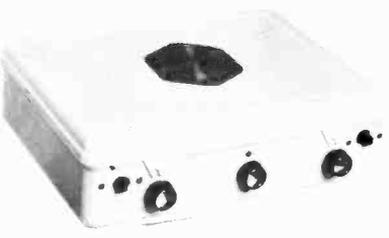


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- 2 Volume Controls
- Ready Wound MW/LW/SW Coils
- 5 Transistor Push Pull Amplifier
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- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- 10 Transistors
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- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
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Uses a retractable chrome plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc.

All parts including case and plans

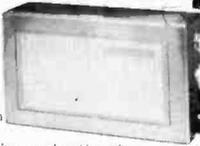
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POCKET FIVE

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Total Building costs £4.30 P. & P. + Ins. 50p



E.V.6. Case and looks as above. 6 Transistors 3 diodes. Powered by 9V battery. Ferrite rod aerial, 3in. loudspeaker, etc. MW/LV coverage. Push/Pull output.

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Total Building costs £4.95 P.P. & P. + Ins. 55p

E.V.7. Case and looks as above, 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band SW1, SW2, SW3, powered by 9V battery. Push pull output. Telescopic aerial for short waves. 3in. Loudspeaker.

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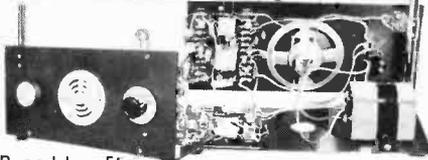
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ELECTRONIC CONSTRUCTION KITS

E.C.K. 2 Self Contained Multi-Band V.H.F. Receiver Kit.

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Complete kit of parts **£7.15 P.P. and Ins. 55p**



Including Construction Plans

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Complete kit of parts **£6.55 P.P. and Ins. 55p**



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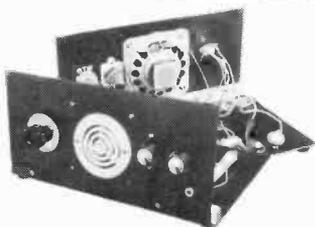
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- ★ 4 Transistor Push/Pull Amplifier

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Complete kit of parts including construction plans **£6.55 P. & P. + Ins. 55p**



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WITH VHF INCLUDING AIRCRAFT

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PRACTICAL ELECTRONICS

VOLUME 12 No. 6 JUNE 1976

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15-240 WATTS!

HY5 Preamplifier

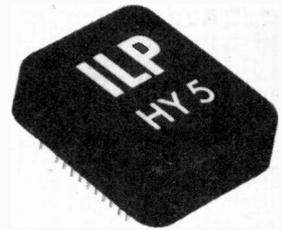
The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack; multi-function equalisation; low noise; low distortion; high overload; two simply combined for stereo.

APPLICATIONS: hi-fi; mixers; disco; guitar and organ; public address.

SPECIFICATION: Inputs—magnetic pick-up 3mV; ceramic pick-up 30mV; tuner 100mV; microphone 10mV; auxiliary 3-100mV; input impedance 47k Ω at 1kHz. Outputs—tape 100mV; main output 500mV R.M.S. Active Tone Controls—treble \pm 12dB at 10kHz; bass \pm 12dB at 100Hz. Distortion—0.1% at 1kHz; signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage— \pm 18-50V.

Price \pounds 4.75 + \pounds 1.19 VAT. P. & P. free



HY30 15W into 8 Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit; low distortion; short, open and thermal protection; easy to build.

APPLICATIONS: updating audio equipment; guitar practice amplifier; test amplifier; audio oscillator.

SPECIFICATION: Output Power—15W R.M.S. into 8 Ω . Distortion—0.1% at 15W. Input Sensitivity—500mV. Frequency Response—10Hz-16kHz - 3dB.

Price \pounds 4.75 + \pounds 1.19 VAT. P. & P. free

AVAILABLE
JUNE 1976

HY50 25W into 8 Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: low distortion; integral heatsink; only five connections; 7 amp output transistors; no external components.

APPLICATIONS: medium power hi-fi systems; low power disco; guitar amplifier.

SPECIFICATION: Input Sensitivity—500mV. Output Power—25W R.M.S. into 8 Ω . Load Impedance—4-16 Ω . Distortion—0.04% at 25W at 1kHz. Signal/Noise Ratio—75dB. Frequency Response—10Hz-45kHz - 3dB. Supply Voltage— \pm 25V. Size—105 x 50 x 25mm.

Price \pounds 6.20 + \pounds 1.55 VAT. P. & P. free



HY120 60W into 8 Ω

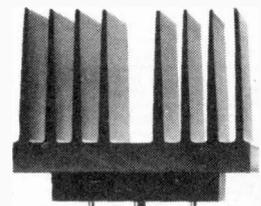
The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: very low distortion; integral heatsink; load line protection; thermal protection; five connections; no external components.

APPLICATIONS: hi-fi; high quality disco; public address; monitor amplifier; guitar and organ.

SPECIFICATION: Input Sensitivity—500mV. Output Power—60W R.M.S. into 8 Ω . Load Impedance—4-16 Ω . Distortion—0.04% at 60W at 1kHz. Signal/Noise Ratio—90dB. Frequency Response—10Hz-45kHz - 3dB. Supply Voltage— \pm 35V. Size—114 x 50 x 85mm

Price \pounds 14.40 + \pounds 1.16 VAT. P. & P. free



HY200 120W into 8 Ω

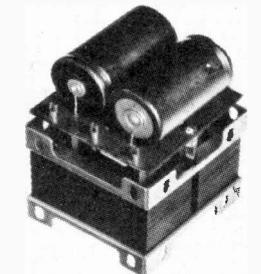
The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

FEATURES: thermal shutdown; very low distortion; load line protection; integral heatsink; no external components.

APPLICATIONS: hi-fi; disco; monitor; power slave; industrial; public address

SPECIFICATION: Input Sensitivity—500mV. Output Power—120W R.M.S. into 8 Ω . Load Impedance—4-16 Ω . Distortion—0.05% at 100W at 1kHz. Signal/Noise Ratio—96dB. Frequency Response—10Hz-45kHz - 3dB. Supply Voltage— \pm 45V. Size—114 x 100 x 85mm

Price \pounds 21.20 + \pounds 1.70 VAT. P. & P. free



HY400 240W into 4 Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4 Ω ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: thermal shutdown; very low distortion; load line protection; no external components.

APPLICATIONS: public address; disco; power slave; industrial.

SPECIFICATION: Output Power—240W R.M.S. into 4 Ω . Load Impedance—4-16 Ω . Distortion—0.1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz-45kHz - 3dB. Supply Voltage— \pm 45V. Input Sensitivity—500mV. Size—114 x 100 x 85mm.

Price \pounds 29.25 + \pounds 2.34 VAT. P. & P. free

POWER SUPPLIES: PSU36—suitable for two HY30s \pounds 4.75 + \pounds 1.19 VAT. P. & P. free. PSU50—suitable for two HY50s \pounds 6.25 + \pounds 1.56 VAT. P. & P. free. PSU70—suitable for two HY120s \pounds 12.50 + \pounds 1.00 VAT. P. & P. free. PSU90—suitable for one HY200 \pounds 11.50 + 92p VAT. P. & P. free. PSU180—suitable for two HY200s or one HY400 \pounds 21 + \pounds 1.68 VAT. P. & P. free.

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC117K	*0.39	AF179	*0.51	BC169C	0.10	BC440	*0.37	BF117	*0.46	OC75	*0.18	2N706A	*0.09	2N2846	*0.34	2N3703	*0.09	2N3704	*0.14	2N3704	*0.08
AC126	*0.14	AF180	*0.51	BC170	0.09	BD115	*0.03	BF119	*0.71	BSX20	*0.16	OC77	*0.26	2N708	*0.11	2N2904A	*0.18	2N3705	*0.08	2N3706	*0.08
AC127	*0.11	AF181	*0.51	BC171	0.09	BD116	*0.07	BF152	0.56	BSY25	*0.16	OC81	*0.16	2N914	*0.15	2N2905	*0.18	2N3706	*0.08	2N3707	*0.08
AC128	*0.11	AF186	*0.51	BC172	0.09	BD121	*0.07	BF153	0.48	BSY26	*0.16	OC81D	*0.16	2N918	*0.18	2N2905A	*0.18	2N3707	*0.08	2N3708	*0.08
AC128K	*0.26	AF239	*0.38	BC173	0.09	BD123	*0.07	BF154	0.48	BSY27	*0.16	OC82	*0.16	2N1131	*0.18	2N2906	*0.12	2N3708	*0.08	2N3709	*0.08
AC141	*0.10	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	2N3710	*0.09
AC141K	*0.20	AL103	*0.75	BC175	*0.22	BD125	*0.36	BF156	*0.48	BSY29	*0.16	OC83	*0.26	2N1302	*0.15	2N2907	*0.15	2N3710	*0.09	2N3711	*0.09
AC142	*0.10	BC107	*0.08	BC177	*0.18	BD132	*0.40	BF157	*0.56	BSY38	*0.19	OC139	*0.20	2N1303	*0.15	2N2907A	*0.18	2N3711	*0.09	2N3712	*0.09
AC142K	*0.26	BC108	*0.08	BC178	*0.18	BD133	*0.41	BF158	0.56	BSY39	*0.19	OC140	*0.23	2N1304	*0.18	2N2923	0.15	2N3819	*0.14	2N3820	*0.40
AC153K	*0.24	BC109	*0.08	BC179	*0.16	BD135	0.41	BF159	0.51	BSY40	*0.29	OC169	*0.26	2N1305	*0.18	2N2924	0.15	2N3820	*0.40	2N3821	*0.16
AC178	*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	2N3903	0.12
AC176K	*0.26	BC114	0.16	BC181	0.25	BD137	0.48	BF176	0.38	BSY95	*0.13	OC200	*0.26	2N1307	*0.21	2N2926G	0.09	2N3903	0.12	2N4290	0.18
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	2N4291	0.18
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	2N4292	0.18
AC181	*0.20	BC117	0.19	BC183	0.09	BD140	0.41	BF181	*0.31	MJE521	*0.56	OC202	*0.29	2N1613	*0.18	2N2926R	0.07	2N3906	0.14	2N4293	0.18
AC181K	*0.30	BC118	0.09	BC183L	0.09	BD155	*0.81	BF194	0.10	MJE2955	*0.88	OC203	*0.26	2N1711	*0.18	2N2926S	0.07	2N4287	0.18	2N4288	0.18
AC187	*0.17	BC119	*0.31	BC184	0.09	BD175	*0.81	BF195	0.10	MJE3055	*0.57	OC204	*0.26	2N1711	*0.18	2N2926T	0.07	2N4287	0.18	2N4288	0.18
AC187K	*0.23	BC120	*0.81	BC184L	0.09	BD176	*0.81	BF196	0.92	MJE3440	*0.51	OC205	*0.26	2N1711	*0.18	2N2926U	0.07	2N4287	0.18	2N4288	0.18
AC188	*0.19	BC137	0.18	BC186	*0.29	BD177	*0.87	BF197	0.12	MPF132	*0.28	OC206	*0.26	2N2218	*0.18	2N3055	*0.40	2N4290	0.18	2N4291	0.18
AC188K	*0.23	BC139	*0.41	BC187	*0.29	BD178	*0.87	BF198	0.12	MPF104	*0.28	ORP12/		2N2218A	*0.18	2N3402	*0.21	2N4290	0.18	2N4291	0.18
AD140	*0.49	BC140	*0.31	BC207	0.11	BD179	*0.71	BF199	0.12	MPF105	*0.28	NSL4931	*0.46	2N2219	*0.18	2N3403	*0.21	2N4292	0.18	2N4293	0.18
AD142	*0.55	BC141	*0.31	BC208	0.11	BD180	*0.71	BF257	*0.28	OC19	*0.36	ORP60	*0.41	2N2219A	*0.18	2N3404	*0.21	2N4293	0.18	2N4294	0.18
AD143	*0.49	BC142	*0.31	BC209	0.12	BD185	*0.87	BF258	*0.36	OC20	*0.80	ORP61	*0.41	2N2220	*0.22	2N3405	*0.43	2N4294	0.18	2N4295	0.18
AD149	*0.45	BC143	*0.31	BC212	0.10	BD186	*0.87	BF259	*0.46	OC22	*0.47	TIP29	*0.48	2N2221	*0.18	2N3614	*0.09	2N4547	*0.28	2N4548	*0.28
AD150	*0.85	BC145	0.48	BC212L	0.10	BD187	*0.71	BF262	0.56	OC23	*0.48	TIP30	*0.45	2N2222	*0.18	2N3615	*0.16	2N4549	*0.28	2N4550	*0.28
AD161	*0.32	BC147	0.09	BC213	0.10	BD188	*0.71	BF263	0.56	OC24	*0.57	TIP31A	*0.52	2N2365	*0.18	2N3616	*0.16	2N4550	*0.28	2N4551	*0.28
AD162	*0.36	BC148	0.09	BC213L	0.10	BD189	*0.71	BF270	*0.36	OC25	*0.39	TIP32A	*0.60	2N2369	*0.12	2N3646	0.09	40361	*0.30	40362	*0.35
AD161A		BC149	0.09	BC214	0.10	BD190	*0.77	BF271	*0.31	OC26	*0.38	TIP41A	*0.65	2N2369A	0.17	2N3732	0.09	40361	*0.30	40362	*0.35
AD162(MP)		BC150	0.10	BC214L	0.10	BD195	*0.87	BF272	*0.81	OC28	*0.60	TIP42A	*0.72								
AF114	*0.22	BC152	0.20	BC225	0.28	BD196	*0.87	BF273	0.38	OC29	*0.60	TIS43	*0.25								
AF115	*0.22	BC153	0.20	BC251	0.10	BD197	*0.92	BF274	0.38	OC35	*0.45	UT46	*0.20								
AF116	*0.22	BC154	0.20	BC301	*0.28	BD199	*0.98	BF284	*0.19	OC41	*0.20	ZTX108	0.07								
AF117	*0.22	BC157	0.11	BC302	*0.25	BD200	*0.98	BF285	*0.25	OC42	*0.25	ZTX109	0.07								
AF118	*0.32	BC158	0.11	BC303	*0.31	BD205	*0.81	BF286	*0.22	OC44	*0.16	ZTX300	0.07								
AF124	*0.28	BC159	0.11	BC304	*0.37	BD206	*0.81	BF287	*0.22	OC45	*0.13	ZTX500	0.09								
AF125	*0.26	BC160	*0.11	BC327	0.36	BD207	*0.81	BF288	*0.22	OC70	*0.10	ZN696	*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	*0.11	BC168	0.10	BC338	0.12	BF115	*0.15	BFY52	*0.13	OC74	*0.15	2N699	*0.36								

VAT CHAT
Please add 8% to prices marked *
Remainder add 12 1/2%. Do not add VAT to prices marked †.

SUPER UNTESTED PAKS

Pak No.	Description	Price
U 1	120 Glass Sub-min. General purpose Germ. diodes	0.60
U 4	30 Germanium transistors like OC81, AC128	0.60
U 5	60 200mW sub-min. silicon diodes	0.60
U 11	20 PNP Sil. planar trans. TO-5 like 2N132, 2N2904	0.60
U 15	20 NPN Sil. planar trans. TO-5 like 2N696, 2N697	0.60
U 19	20 Silicon NPN transistors like BC108	0.60
U 26	30 Fast switching silicon diodes like IN914 Micro-Min.	0.60
U 29	10 1 Amp SCR's TO-5 can. up to 600 CR5/25-60	£1.20
U 32	25 Zener diodes 400mW D-7 case 36 volts mixed	0.60
U 36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	0.60
U 45	7 3A SCR. TO66 up to 600 PIV	£1.20
U 46	20 Unijunction transistors similar to TIS43	0.60
U 48	9 NPN Sil. power transistors like 2N3055	£1.20

Code No. 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	*0.05	BY127	*0.16	OA79	*0.07	OA202	*0.07
BA154	*0.12	BY128	*0.16	OA81	*0.07	1N914	0.06
BA158	*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	0.8A	1A	3A	5A	5A	7A	10A	16A	30A
	TO18	TO92	TO5	TO66	TO66	TO64	TO48	TO48	TO48	TO48
10	*0.13	*0.15	—	—	—	—	—	—	—	—
20	*0.15	*0.13	—	—	—	—	—	—	—	—
30	*0.19	*0.22	—	—	—	—	—	—	—	—
50	*0.22	*0.20	*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 15)	3 Amp (SO 10)	10 Amp (TO 48)	30 Amp (TO 48)
50	0.05*	0.06*	IN4001	0.05*	0.07*	0.14*	0.19*
100	0.05*	0.07*	IN4002	0.06*	0.09*	0.16*	0.21*
200	0.06*	0.09*	IN4003	0.07*	0.12*	0.20*	0.23*
400	0.07*	0.14*	IN4004	0.08*	0.14*	0.28*	0.35*
600	0.08*	0.16*	IN4005	0.09*	0.18*	0.33*	0.42*
800	0.11*	0.18*	IN4006	0.10*	0.18*	0.35*	0.44*
1000	0.13*	0.28*	IN4007	0.11*	0.23*	0.44*	0.60*
1200	—	0.32*	—	—	0.28*	0.54*	0.69*

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300mW 400 PIV (min) SUB-MIN FULLY TESTED
Ideal for Organ builders
30 for *50p, 100 for *£1.50, 500 for *£5, 1,000 for *£9.

TRIACS

	Case TO5	100V	200V	400V
2 Amp	TO5	*0.31	*0.51	*0.71
6 Amp	TO66	*0.51	*0.61	*0.77
10 Amp	TO48	*0.77	*0.92	*1.12

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COMPONENTS

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BA1	5 1/2" x 2 1/2"	1 1/2"	1 1/2"	*0.45
BA2	4" x 4"	1 1/2"	1 1/2"	*0.45
BA3	4" x 2 1/2"	1 1/2"	1 1/2"	*0.45
BA4	5 1/2" x 4"	1 1/2"	1 1/2"	*0.54
BA5	4" x 2 1/2"	1 1/2"	1 1/2"	*0.45
BA6	3" x 5"	2 1/2"	1 1/2"	*0.39
BA7	3" x 5"	2 1/2"	1 1/2"	*0.79
BA8	8" x 6"	2 1/2"	1 1/2"	*1.02
BA9	6" x 4"	2 1/2"	1 1/2"	*0.65

(Each complete with 1/2" deep lid and screws). PLEASE ADD 20p POSTAGE AND PACKING FOR EACH BOX.

COMPONENTS

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These Paks contain a range of Carbon Resistors, assorted into the following groups:

R1	50 Mixed 100Ω-820kΩ	1W.	0.60
R2	50 Mixed 1kΩ-8.2kΩ	1W.	0.60
R3	50 Mixed 10kΩ-82kΩ	1W.	0.60
R4	50 Mixed 100kΩ-820kΩ	1W.	0.60
R5	30 Mixed 100Ω-820kΩ	1/2W.	0.60
R6	30 Mixed 1kΩ-8.2kΩ	1/2W.	0.60
R7	30 Mixed 10kΩ-82kΩ	1/2W.	0.60
R8	30 Mixed 100kΩ-820kΩ	1/2W.	0.60

THESE ARE UNREPEATABLE PRICES

REPANCO CHOKES & COILS

RF Chokes	CH1	2.5mH	0.27
	CH3	7.5mH	0.29
	CH5	1.5mH	0.26
	CH2	5.0mH	0.28
	CH4	10mH	0.31
COILS DRX1	Crystal set	0.29	DRR2
Dual range			0.42

CARBON POTENTIOMETERS

Log and Lin	4.7k, 10k, 22k, 47k, 100k, 220k, 470k, 1M, 2M.	
VC1	Single Less Switch	0.20
VC2	Single D.P. Switch	0.40
VC3	Tandem Less Switch	0.60
VC4	1K Less Switch	0.20
VC5	100K Log anti-Log	0.60

HORIZONTAL CARBON PRESETS

0.1 Watt	100, 220, 470, 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M	4.7M.
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REPANCO TRANSFORMERS

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MT/50 1	1 £4.00 0.48
MT/50 2	2 £5.00 0.60

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NORMAN 1/2" Cores and Formers	0.07
3/4" Cores and Formers	0.09

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VBI containing approx. 50 sq.in. various sizes all 0.1 matrix	*0.60
VB2 containing approx. 50 sq.in. various sizes all 0.15 matrix	*0.60

CABLES

CP1	Single lapped screen	Per Metre	*0.08
CP2	Twin Common Screen		*0.11
CP3	Stereo Screened		*0.12
CP4	Four Core Common Screen		*0.21
CP5	Four Core Individually screened		*0.28
CP6	Microphone Fully Braided Cable		*0.11
CP7	Three Core Mains Cable		*0.11
CP8	Twin Oval Mains Cable		*0.08
CP9	Speaker Cable		*0.06
CP10	Low Loss Co-Axial		*0.14

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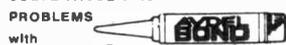
COMPONENT PAKS

Pak No.	Qty.	Description	Price
C1	200	Resistors, mixed values approx. count by weight	0.60
C2	150	Capacitors, mixed values approx. count by weight	0.60
C4	75	1/2 width Resistors, mixed preferred values	0.60
C5	5	Pieces assorted Ferrite Rods	0.60
C7	1	Pak Wire 50 metres assorted colours	*0.60
C8	10	Reed Switches	*0.60
C9	3	Micro Switches	*0.60
C10	15	Assorted Pots and Pre-salts	0.60
C12	30	Paper Condensers preferred types, mixed values	0.60
C13	20	Electrolytics Trans. types	0.60
C14	1	Pak assorted Hardware—Nuts, Bolts, Grommets, etc.	*0.60
C16	20	Assorted Tag Strips and Panels	0.60
C19	2	Relays 6-24V Operating 0.60 Sheets Copper Laminate approx. 200 sq.in.	*0.60

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S222	5 pin DIN plug to 5 pin DIN socket length 1.5m	89p
S237	5 pin DIN plug to 5 pin DIN plug mirror image length 1.5m	£1.20
S238	2 pin DIN plug to 2 pin DIN socket length 5m	68p
S270	2 pin DIN plug to 2 pin DIN socket length 10m	89p
S271	5 pin DIN plug to 2 photo plugs connected to pins 3 and 5 length 1.5m	70p
S275	5 pin DIN plug to 2 phono sockets connected to pins 3 and 5 length 23cm	68p
S318	5 pin DIN socket to 2 phono plugs connected to pins 3 and 5 length 23cm	68p
S404	Coiled stereo headphones extension cord extends to 7m	£1.40
S217	3 pin DIN plug to 3 pin DIN plug length 1.5m	80p
S219	5 pin DIN plug to 5 pin DIN plug length 1.5m	80p
S474	3.5mm Jack to 3.5mm Jack length 1.5m	68p
S600	5 pin DIN plug to 3.5mm Jack connected to pins 3 and 5 length 1.5m	80p
S700	5 pin DIN plug to 3.5 Jack connected to pins 1 and 4 length 1.5m	80p

SWITCHES		
DP/DT Toggle		0.28
SP/ST Toggle		0.22

VAT

P&P

Postage and Packing add 25p unless otherwise shown. Add extra for airmail. Minimum order £1.00.

BIB ACCESSORIES

REF 200	2 Hi-Fi Cable and Flex Tidy Kit	*34p
REF 201	Tape Head Cleaning Kit 72p	
REF 202	Hi-Fi Cleaner	*30p
Model 9	Wire Stripper	*£1.00
REF 23	1/2" Tape Editing Kit	*£1.80
REF 24	1/2" Cassette Ed ng Kit	*£1.84
REF 29A	Salvage Cassette	*44p
REF 32A	Stylus Balance	£1.28
REF 33	Splicing Tape	*38p
REF 36A	Record and Stylus Cleaning Kit	*35p
REF 41	8 Track Cartridge Head Cleaner	*85p
Model 42	Groov-Kleen	*£1.84
REF 42/S	Roller and Brush for REF 42 and 2000	*24p
REF 43	Record Care Kit	*£2.76
REF 45	Auto Changer Groov-Kleen	*98p
REF 46	Spirit Level	*72p
REF 48	Record Dust-Off	*26p
REF 52A	Cassette Tray	54p
REF 53	Hi-Fi Stereo Test Cassette	*£2.40
REF 56	Hi-Fi Hints and Tips Book	*48p
Model 60S	Groov-Kleen	*£1.72
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
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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

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SK2. Soldering Kit	*£3.90

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102 for model CCN240	*42p
104 for model CCN240	*42p
106 for model CCN240	*42p
1100 for model CCN240	*42p
1101 for model CCN240	*42p
1102 for model CCN240	*42p
1021 for model G240	*42p
1021 for model G240	*42p
1022 for model G240	*42p
50 for model X25	*44p
51 for model X25	*44p
52 for model X25	*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

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PLUGS	Price
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PS2 DIN 3 Pin	0.10
PS3 DIN 3 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 1/2" Plastic	0.14
PS12 Jack 1/2" Screened	0.20
PS13 Jack Stereo Screened	0.33
PS14 Phono	0.09
PS15 Car Aerial	0.14
PS16 Co-Axial	0.14

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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 1/2" Plastic	0.28
PS28 Jack 1/2" 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 1/2" Switched	0.19
PS42 Jack Stereo Switched	0.28
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BV4	9" x 5 1/2" x 2 1/2"			£1.39

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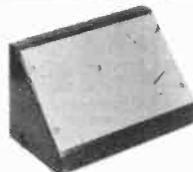
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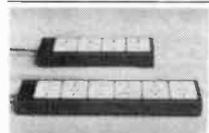
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Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated.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



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ACY17	22p
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ACY20	19p
ACY21	28p
ACY39	27p
AD181	40p
AD182	40p
m/pr:	80p
AF117	20p
AFY19	32p
AF239	44p
ASY26	29p
ASY27	33p
ASZ23	27p
BC107	10p
BC108	10p
BC109	10p
BC116A	15p
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BC126	20p
BC139	24p
BC140	21p
BC143	22p
BC147	12p
BC148	11p
BC149	13p
BC157	12p
BC158	11p
BC159	13p
BC161	22p
BC171	13p
BC172	14p
BC182	11p
BC183	12p
BC184	13p
BC206	9p
BC212	12p
BC213	13p
BC214	14p
BC267	13p
BC297	16p
BC328	13p
BC347	13p
BC348	10p
BC461	28p
BC548	11p
BCY43	22p
BCY70	15p
BCY71	15p

All types: 25+ less 15%, 100+ less 25%

RECTIFIERS

1N4001 8p; 1N4002 7p; 1N4003 8p; 1N4004 9p; 1N4005 10p; 1N4006 11p; 1N4007 12p; 1N4148 4p; BY127 17p; OA5 60p; OA10 40p; 100V3A 15p; 400V3A 20p; 1300V1A 16p.

TRANSISTOR PACKS

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.

SCR's

2N1595 30p; 2N2323A 34p; 500V5A (TO66 case) 80p; 600V 1A 75p.

RESISTORS

Mullard CR25 ½W 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 16p; 15W wirewound 12p. 1% and better. S.A.E. for list

ZENERS

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

See Practical Wireless for details of packs of components, surplus goods, etc. All prices quoted include VAT at new rate. Add 15p postage on orders under £2. SAE with enquiries or for List please. Send 10p for Multimeter catalogue—free on request on orders over £3. Official Orders accepted from Schools, etc. Export/Wholesale enquiries welcome. Surplus components always wanted.

IC's

723 TO99 60p; 741C 6 pin DIL 30p; 748C 14 pin DIL 40p; 555 55p; LM301A 50p; SL521B E5-62; SN76013ND E1-12; TAD100 E1-17; TCA270Q E3-60; ZN414 E1-35

ELECTROLYTIC CAPACITORS

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	6p	470µF	63V	16p
22µF	25V	6p	1000µF	10V	11p
47µF	25V	6p	1000µF	16V	15p
47µF	40V	7p	1000µF	25V	16p
47µF	63V	7p	1000µF	50V	32p
100µF	10V	6p	1000µF	63V	40p
100µF	25V	7p	2200µF	10V	16p
100µF	40V	8p	2200µF	16V	22p
200µF	10V	6p	2200µF	25V	27p
200µF	50V	9p	2200µF	40V	46p
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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Case type:
1410, 205 x 140 x 40mm £2-90
1411, 205 x 140 x 75mm £3-25
1412, 205 x 140 x 110mm £4-20
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Supplied complete with base and PK screws. Big reduction for quantity.
AB7 133 x 70 x 38mm 80p
AB8 102 x 102 x 38mm 80p
AB9 102 x 70 x 38mm 55p
AB10 102 x 133 x 38mm 80p
AB11 102 x 64 x 51mm 55p
AB12 76 x 51 x 25mm 48p
AB13 152 x 102 x 51mm 80p
AB14 178 x 127 x 64mm £1-06
AB15 203 x 152 x 76mm £1-42
AB16 254 x 178 x 76mm £1-70
AB17 254 x 114 x 76mm £1-22
AB19 305 x 203 x 76mm £2-10

BATTERY HOLDERS

For 4 x HP7 2 by 2 or side by side. Both types 16p. For 4 x 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.

OPTO DEVICES

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50V ceramic plate capacitors, 5%: 10 of each value 22pF to 1,000pF, total 210 caps., £2-70.
CR25 carbon film ½W resistors, 5%: 10 of each value 10 ohms to 1MΩ, total 610 resistors, £6.
Electrolytics, wire ended 25V working, 10 each of: 1.2-2, 4.7-10, 22, 47 and 100µF. 70 capacitors for £3-20.
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MINIATURE OEAC NI-CADMIUM

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TTL

7400	E0-11	74151	E0-13	74155	75
7401	11	7453	13	74156	71
7402	11	7454	14	74157	71
7403	11	7460	11	74161	95
7404	13	7464	21	74163	10
7405	13	7465	21	74164	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		

LOW POWER TTL

74100	E0-16	74151	E0-16	75190	E0-93
74102	16	74155	18	74191	80
74103	16	74171	18	74193	89
74104	18	74172	27	74195	89
74106	18	74173	38	74198	1-53
74110	16	74174	38	74164	1-53
74120	16	74178	44	74165	1-53
74130	16	74185	85		
74142	89	74186	38		

LOW POWER SCHOTTKY

74LS00	E-23	74LS32	25	74LS95	1-20
74LS02	23	74LS40	30	74LS107	35
74LS04	23	74LS42	80	74LS164	1-20
74LS08	25	74LS74	40	74LS193	1-30
74LS10	23	74LS90	80	74LS197	1-20
74LS20	23	74LS93	80		

SCHOTTKY

74500	23	74508	30	74522	23
74502	30	74510	23	74532	35
74503	23	74520	23	74574	23
74504	30				

HIGH SPEED TTL

74H00	E0-16	74H22	E0-18	74H61	E0-25
74H01	16	74H30	18	74H62	20
74H04	16	74H40	16	74H74	32
74H08	16	74H50	16	74H103	35
74H10	16	74H52	18	74H102	35
74H11	16	74H53	20	74H103	40
74H20	16	74H55	20	74H106	40
74H21	16	74H60	21	74H108	40

8000 SERIES

8091	E0-33	8214	E0-93	8811	E0-38
8092	33	8220	93	8812	60
8095	76	8230	1-42	8822	1-42
8121	49	8520	71	8830	1-42
8123	98	8511	91	8831	1-42
8130	1-20	8552	1-37	8836	27
8200	1-42	8554	1-37	8880	73
8210	1-92	8810	44		

9000 SERIES

9002	E0-21	9109	E0-49	9601	E0-54
9101	63	9312	49	9602	49

DTL

930	10	937	10	949	10
932	10	944	10	962	10
936	10	946	10	963	10

Zener Diodes, Diodes & Rectifiers

IN 486B	Diode	250V	E0-15	10/E-90
IN 715A	Zener	11V	-15	10/-90
IN 756A	Zener	3.6V	-15	10/-90
IN 756A	Zener	8.2V	-15	10/-90
IN 756A	Zener	8.2V	-15	10/-90
IN 904	Sw. Diode	30V	-7	10/-50
IN 914	Sw. Diode	100V	-7	10/-50
IN 967B	Zener	18V	-15	10/-90
IN 2990A	Zener	33V	-75	10/S-
	(Stud Mt.)			
IN 3064	Sw. Diode	75V	-12	10/-80
IN 3600	Sw. Diode	50V	-12	10/-80
IN 3604	Sw. Diode	75V	-12	10/-80
IN 4148	Sw. Diode	75V	-7	10/-50
IN 4858	Zener	120V	-15	10/-90
IN 5230A	Zener	4.7V	-15	10/-90
IN 5242B	Zener	12V	-15	10/-90

MISC. DEVICES

ULN2288	FM gain block	34dB mDIP	-90
ULN2299	FM gain block	48dB mDIP	-90
2513	64 x 8 x 5 character generator		6-
CA3046	Transistor array	14 pin DIP	-50

CMOS

4000A	E	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	E0-21	74C74	E0-63	74C162	E1-70
74C02	30	74C76	93	74C163	1-78
74C04	41	74C107	82	74C164	1-92
74C08	41	74C151	1-59	74C173	1-59
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		

TANALUM CAPACITORS

.1 mfd	35V	12p	6.8 mfd	6V	15p
.33 mfd	35V	12p	6.8 mfd	50V	18p
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

MV10B	Red TO 18	E0-14
MV50	Axial leads	8
MV50Z0	lumbo Vis. Red (Red Dome)	18
	lumbo Vis. Red (Clear Dome)	18
ME4	Infra red diff. 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	5" high solid seg.	3-81
MAN7	Red 7 seg. .270"	74
MAN8	Yellow 7 seg. .270"	2-17
MAN66	5" high spaced seg.	2-55
MCT2	Opto-iso transistor	38

MULTIPLE DISPLAYS

NSN33	3 digit .12" red led 12 pin ITC I/O skt.	E-90
HP45582	5 digit .11 led magn. lens com. cath.	1-80
7405		
HP5082	4 digit .11 led magn. lens com. 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	E1-20
MM5016	500/512 bit dynamic mDIP	1-10
SLS-4025	QUAD 25 bit 2504 1024 bit multiplexed dynamic shift register	4-95

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INCLUDES:
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All necessary transistors, resistors & capacitors
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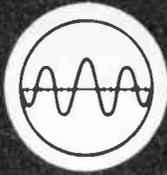
Data included with order on request. Add 20p ea. if item is priced below 50p. Add 40p ea. if item is not ordered.

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300	Pos V Reg (super 723) TO-5	£43
301	Hi Peril 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	Micro Pwr Op Amp mDIP TO-5	60
309K	SV 1A regulator TO-3	91
310	V follower Op Amp mDIP	65
311	Hi Peril V Comp mDIP TO-5	58
319	Hi Speed Volt Comp DIP	74
320	Neg Reg 5.2, 12 TO-3	74
320T	Neg Reg 5, 12, 15 TO-220	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	ACC/Squelch AMPL DIP	80
372	AF-Inf Strip detector DIP	44
373	AM/FM/558 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	Pre V Reg DIP	44
555	Timer mDIP	54
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	38
723	V Reg DIP	38
733	Diff. video AMPL TO-5	-55
739	Dual Hi Peril Op Amp DIP	65
741	Comp Op Amp mDIP TO-5	25
747	Hi Peril Op Amp DIP or TO-5	44
748	Freq Adj 741 mDIP	27
1304	FM Multis Stereo Demod DIP	65
1307	FM Multis Stereo Demod DIP	45
1456	Int. compensated Op Amp mDIP	-79
1458	Dual Comp Op Amp mDIP	38
1800	Stereo Multiplexer DIP	1-50
1800	Quad Amplifier DIP	1-07
LH2111	Dual LM 211 V Comp DIP	33
3900	Quad Amplifier DIP	1-07
7524	Dual core memory sense Amp	1-94
7525	Dual core memory sense Amp	-80
8038	Voltage contr. osc. DIP	3-20
8864	9 DIG Led Cath Dvr DIP	1-37
75150	Dual Line Driver DIP	1-10
75451	Dual Peripheral Driver mDIP	21
75452	Dual Peripheral Driver mDIP	21
75453	(351) Dual Periph Driver mDIP	21
75481	Quad Seg Driver for LED DIP	50
75492	Hex Digit driver DIP	55

MEMORIES

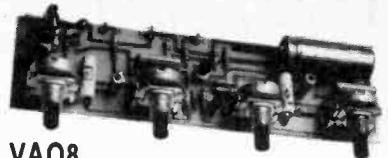
1101	256 bit RAM MOS	96
1103	1024 bit RAM MOS	2-72
2102-2		



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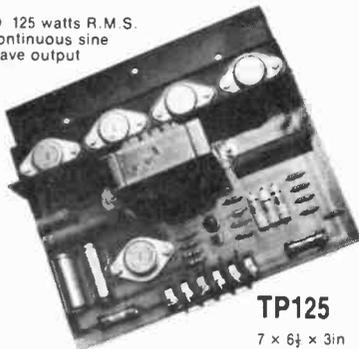


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- 125 watts R.M.S. continuous sine wave output



TP125

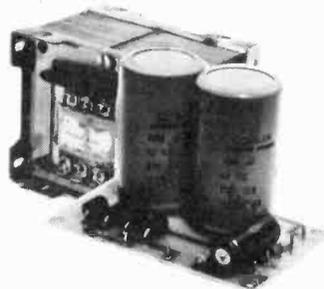
7 × 6½ × 3 in

£19.50

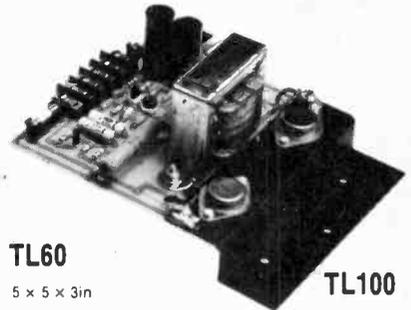
- 4 R.C.A. 150 watt 15 amp output transistors

- 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
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PS 60 = 38 volts for TL60 £11.50
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PSU 2 for supplying disco mixer £5.50



TL60

5 × 5 × 3 in

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

£13.50

TL100

5 × 5 × 3 in

- 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.

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Cookies Disco Centre, 132 West Street (Tel. Crewe 4739)

Leighton Electronics Centre, 59 North Street (Tel. Leighton Buzzard 2316)

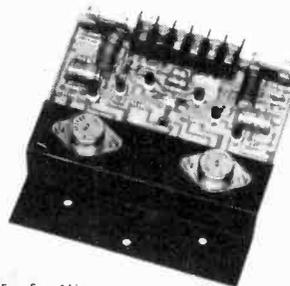
A1 Music Centre, 88 Oxford Street, Manchester (Tel. 061-236 0340)

Damon Electronics, 99 Carrington Street (Tel. Nottingham 53880)

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5 × 5 × 1½ in

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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



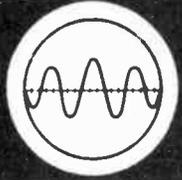
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BLUE AMBER**

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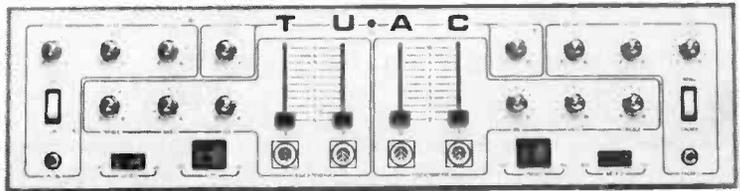
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Size: 25in long x 6in high x 3in deep



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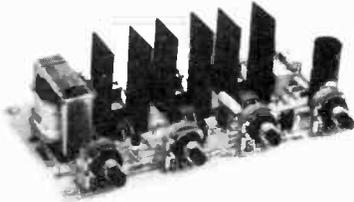
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▲ All Lo-Line Amplifiers are 25in long x 11in high x 6in deep ▼

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

3 CHANNEL LIGHT MODULATOR

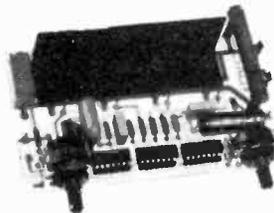
- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control
- 12 easy connections



£15.50 (Single Channel Version 1500 Watts £7.25)

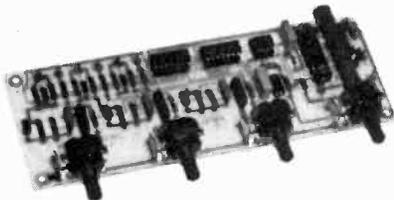
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER—4LSMI

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- Full logic integrated circuitry with optical isolation for amplifier protection
- Full wave control
- 13 easy connections



Patents applied for **£17.25**

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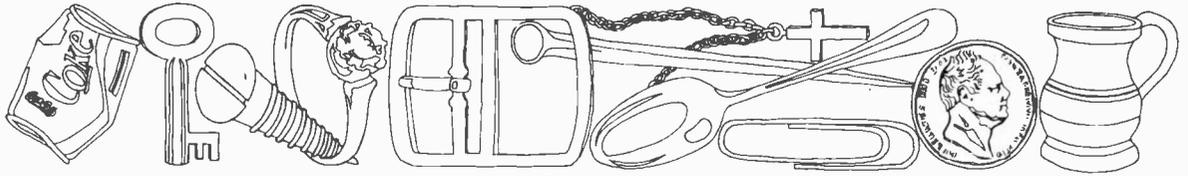
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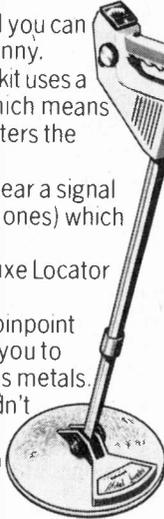
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ORION stereo amplifier

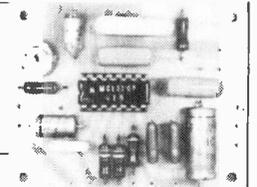
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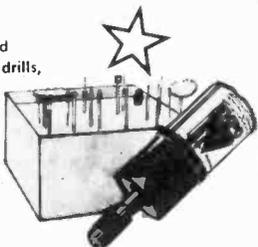
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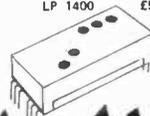
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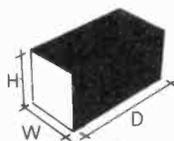
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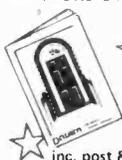
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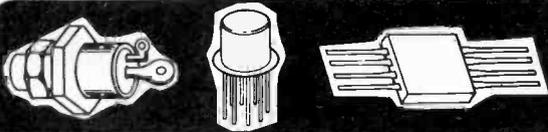
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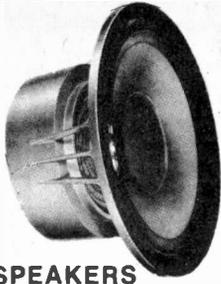
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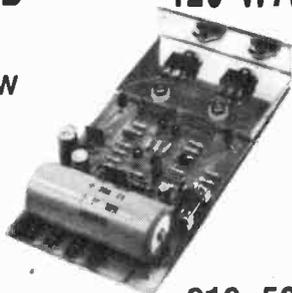
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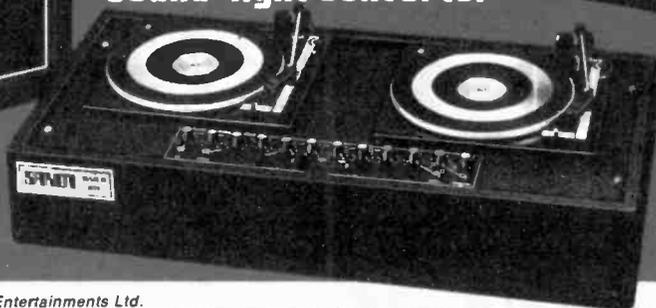
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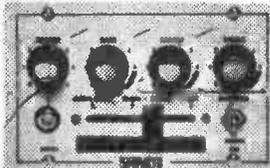
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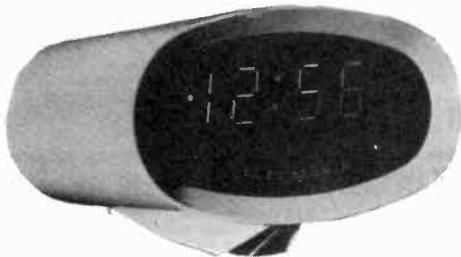
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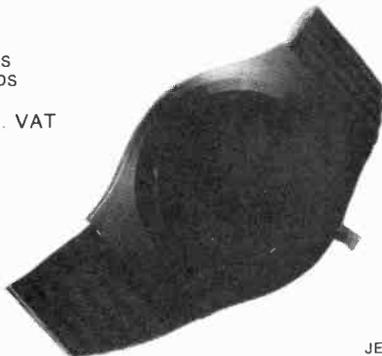
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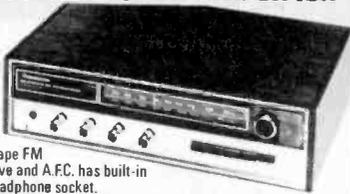
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RTVC

ELIZABETHAN STEREO TUNER AMPLIFIER

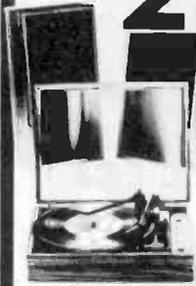
This compact Tuner Amplifier gives you full medium wave and V.H.F. coverage and FM stereo. With inputs for your turntable and tape recorder. It has rotary tuning, Volume, Balance, Bass and Treble controls and push button selection switches for Phono/tape FM Stereo, FM mono, Medium wave and A.F.C. has 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 15 1/2" 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

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 output. 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 15 1/2" x 12" x 6".

Extras if required. Optional Diamond Stylus £1.60.
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance **£5.80.**

COMPLETE ONLY
£23.20 + p&p £4.00

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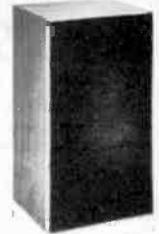
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These superb simulated teak-finished speaker kits have been specially designed by RT-VC for the cost-conscious hi-fi enthusiast who wants top quality speakers but doesn't want to spend the earth. Built to EMI's exacting specification, these new RT-VC speaker kits (350 type kit) incorporate 13" x 8" woofer, 3" 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 9 1/2" 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 acoustic efficiency for the low powered amplifier. The professional finish can be obtained with the minimum of tools, the infinite baffle type enclosures come ready mitted 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 2 1/2" magnet size 2 1/2" approx. **£6.00** + p&p £1.70
PAIR INCLUSIVE



EMI 350 KIT

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Complete with crossover Components and circuit diagram

System consists of a 13" x 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

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WATTS RMS

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 PU - 3 millivolts at 47 K ohms (R.I.A.A.); 2. Crystal/ceramic PU - 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: 15 1/2" x 3" x 10". MP60 type deck with magnetic cartridge, de luxe plinth and cover. Two Duo Type 11a matched speakers - Enclosure size approx. 19 1/2" x 10 1/2" x 7 1/2" in simulated teak. Drive unit 13" x 8" with 3" tweeter. 15 watts handling. 30 watts peak.

SYSTEM 2 £85.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)

Two Duo Type 11a matched speakers - Enclosure size approx. 27" x 13" x 11 1/2". Finished in teak simulate. Drive units 13" x 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 11a 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 11a speakers £46.00 + £7.50 p & p.

MP60 type deck with Mag. cartridge de luxe plinth and cover £22.00 + £3.30 p & p.

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20x20 SYSTEM

Complete System with these speakers **£69.00** + £6.50 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 4 1/2in 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

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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 input mike — 65dB 10KΩ. DIN — 47dB 100KΩ. Track system 2 channel stereo record play-back. Tape speed: 4.8CM/SEC. Frequency response 50-12,000Hz signal to noise ratio — 42dB. Recording system AC Bias. Erasing system AC erase. Bias frequency 57KHz. Size of mechanism 8" x 5" x 3 1/2" 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: 12 1/2" x 6" x 3 1/2"

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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

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.

PORTABLE DISCO CONSOLE*



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% (Gaugmont 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 — 17 1/2" x 13 1/2" x 8 1/2" (app.)
Unit Open — 35 1/2" x 13 1/2" x 4 1/2" (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.

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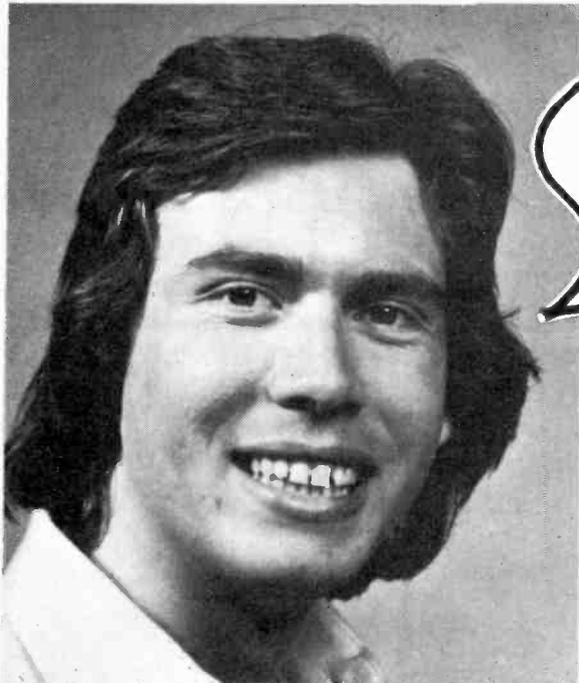
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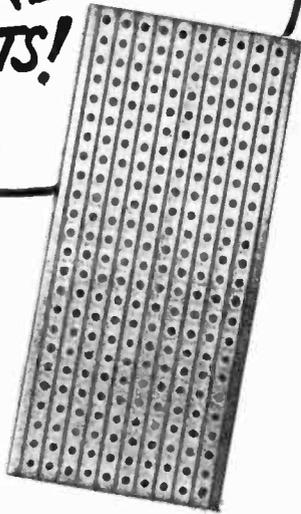
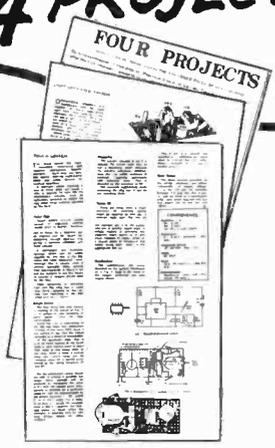


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As you know, I'm fairly well in with the Managing Director of Home Radio Components Ltd. He was deep in thought when I called on him the other day. "Cooking up something new?" I said. "Yes," he replied, "I'm thinking of giving a piece of Vero Board 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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RIISING 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.

F.E.B.

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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.

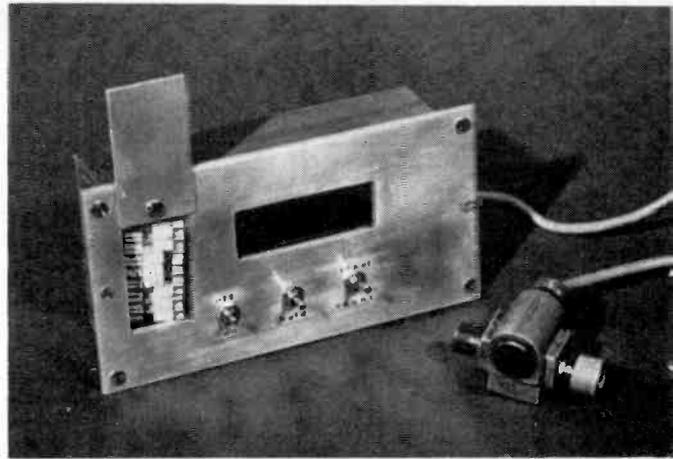
(e) Cost: The cost should be kept to a minimum.

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.



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

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



MILOMETER

By P. LEAH

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 $2 \div 176 = 1.1$ 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.

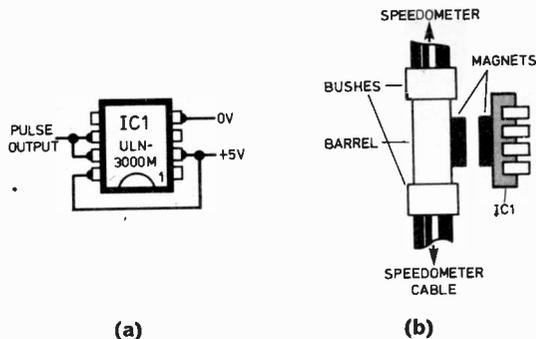


Fig. 1. Details of the pulse sender unit. (a) shows the pin connections to the ULN-3000M Hall-effect i.c. and (b) shows the method of mounting in the T-piece

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 0V. 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 $1k\Omega$ 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 on the reset switch (S4) 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 polarity PRESET pulse.

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.

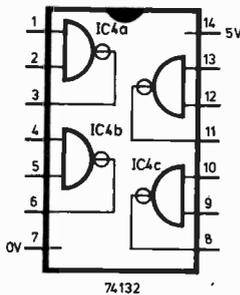


Fig. 2. Circuit diagram of the pulse counting section of the Digital Milometer. The internal configuration of IC4 is shown above. Wiring of the component boards should be ascertained from the Figs. 2, 3 and 4

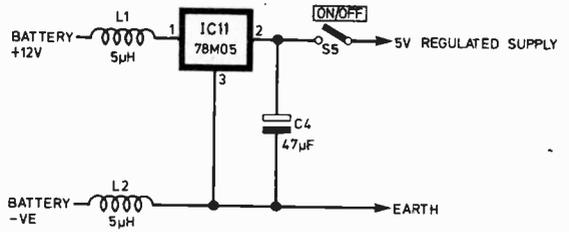
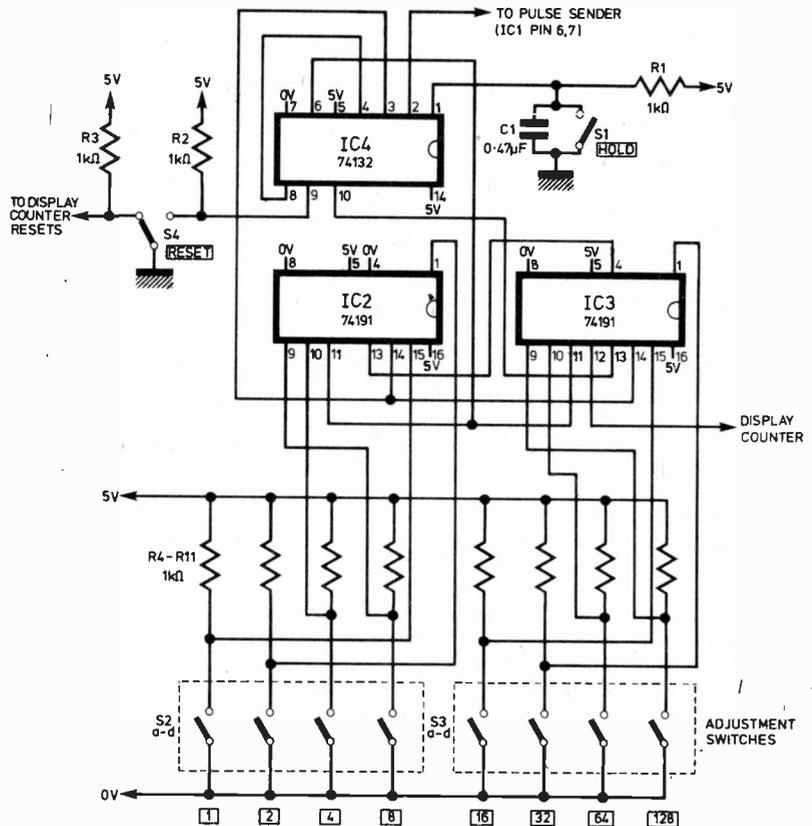


Fig. 4. Circuit diagram of the 5V regulator section. The chokes suppress transients in the leads

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.

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.

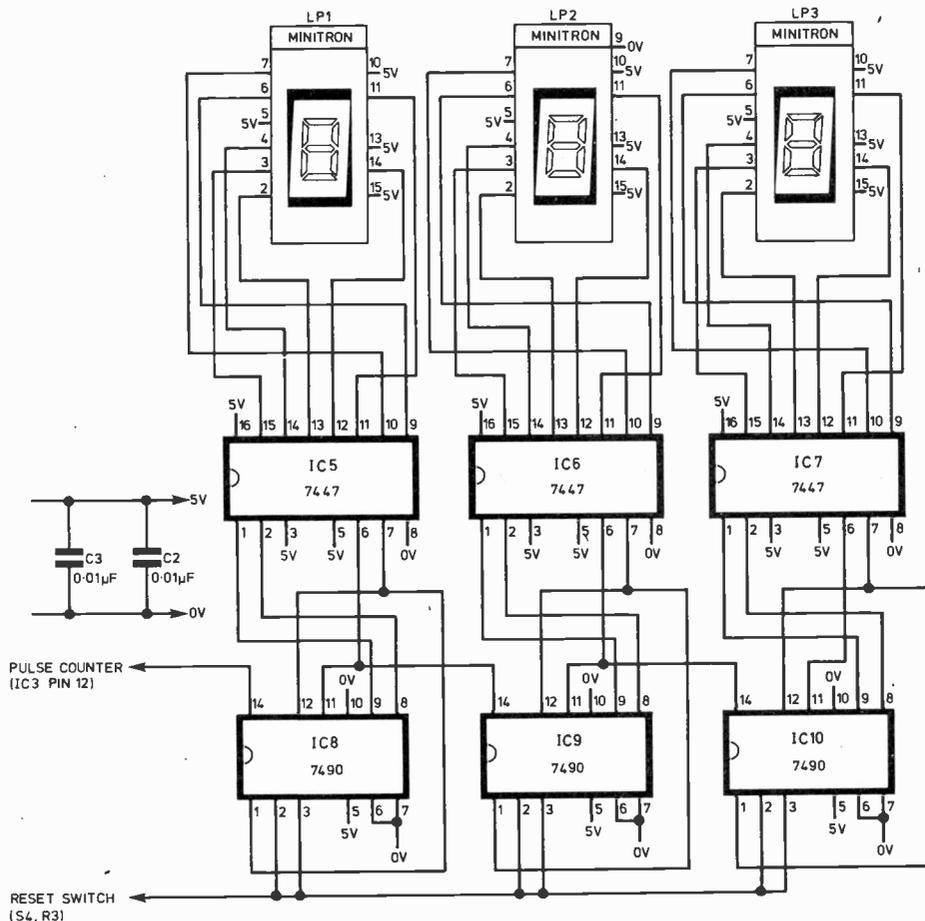
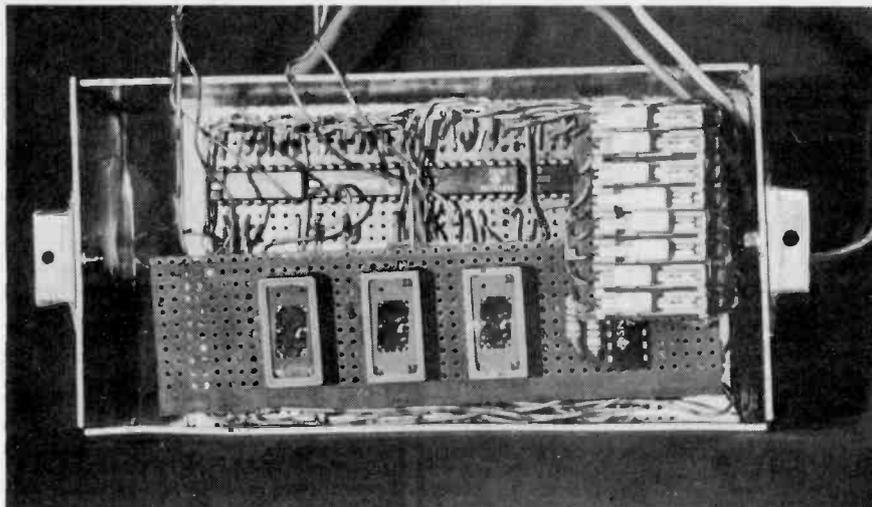


Fig. 3. Circuit diagram of the display counter, decoder and display section of the Milimeter



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.

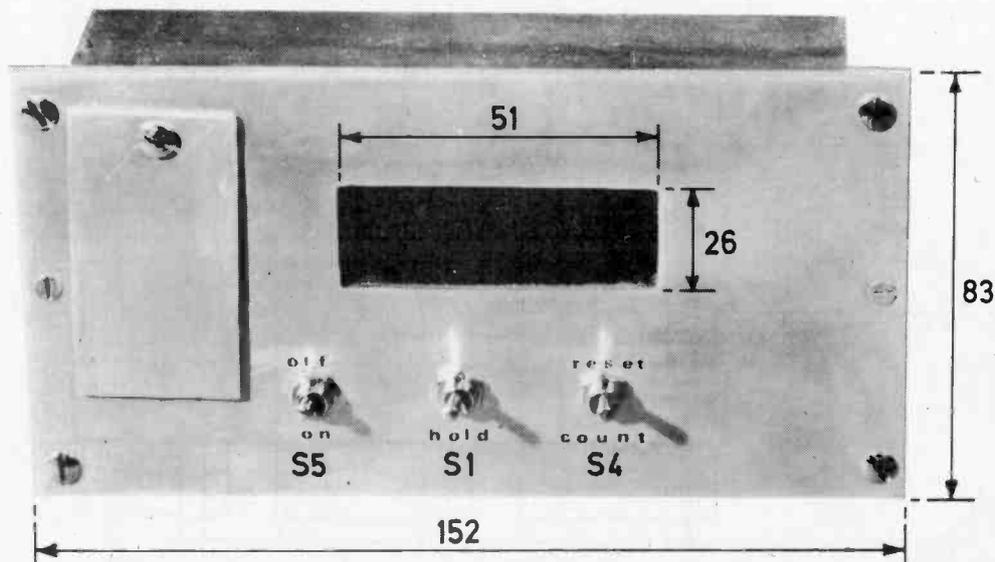
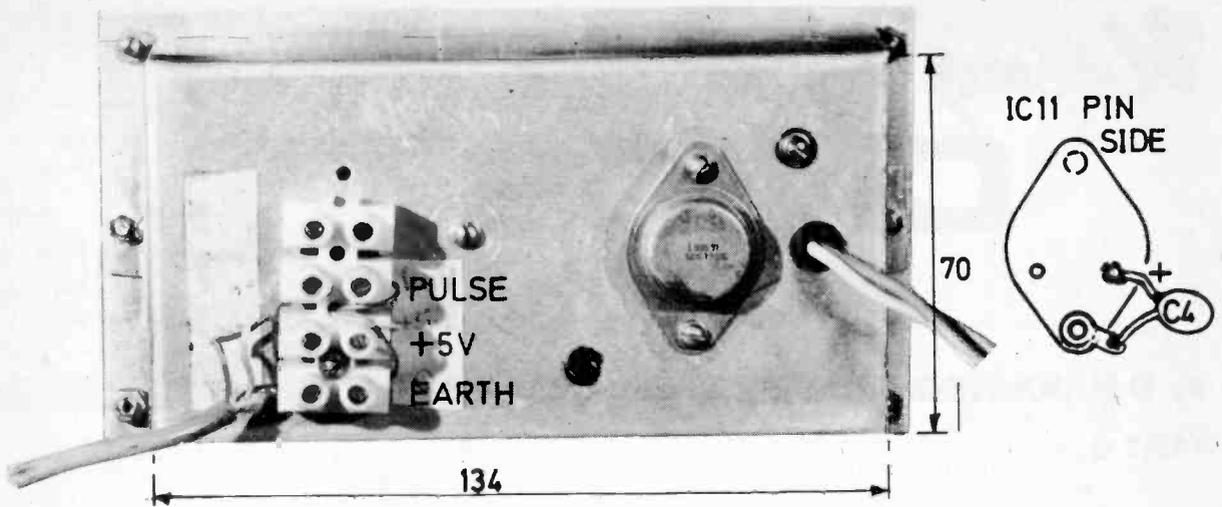


Fig. 5. Front panel details and overall measurements. The dual-in-line switches cutout measures 32 x 45mm



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 a 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. ★

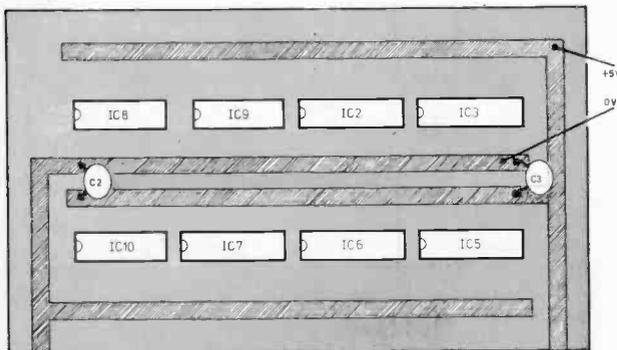


Fig. 6. Layout of the components on the dual-in-line board



Using CMOS digital I.C.s

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

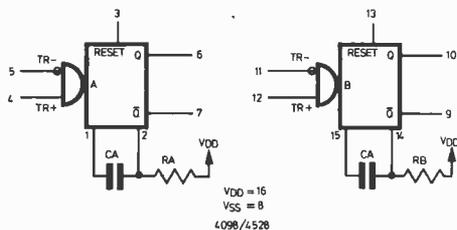
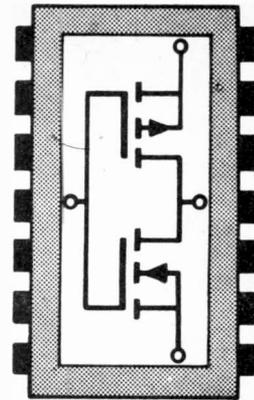


Fig. 6.1. Pin connections for the 4098 or 4528 dual retriggerable monostable. R_A and R_B can be between 5kΩ and 10MΩ. C_A and C_B can be any value, and the period is given approximately by T=RC seconds



can be avoided by using the 4538, which incorporates linear circuitry to achieve a more accurately specified period.

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,

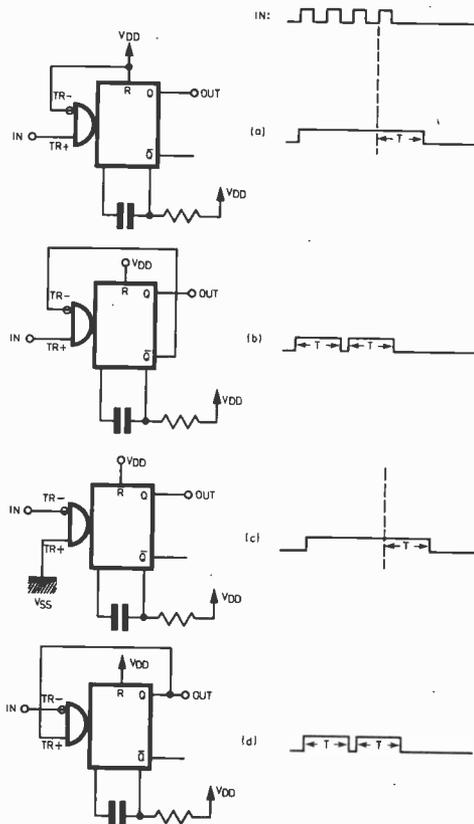


Fig. 6.2. The four possible modes of operation of the 4098/4528 monostable, and the four outputs obtained with the input shown

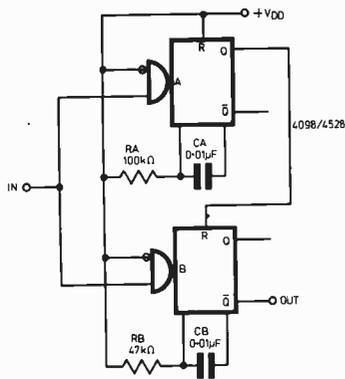


Fig. 6.3. Digital bandpass filter constructed from a single 4098/4528 package. If the input pulse interval lies between the periods of the monostables, the output follows the input. Otherwise the output is permanently held either high or low. With the values given only frequencies lying between 1kHz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

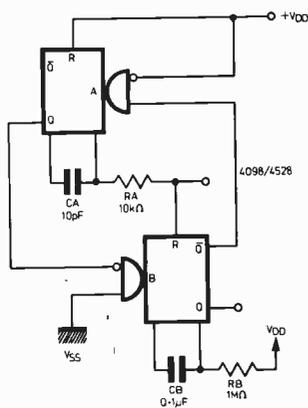


Fig. 6.4. Multivibrator using two monostables. With the values given the "on" and "off" times are about 0.1 secs and 0.1 μsecs respectively

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 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

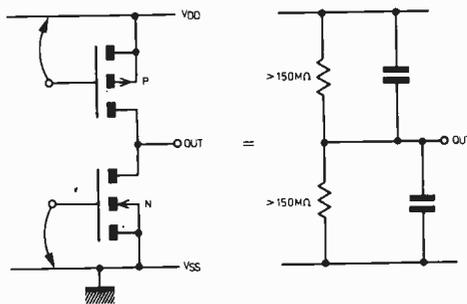


Fig. 6.5. Complementary pair with both devices biased "off" forms a disabled output which is floating with respect to the supply rails

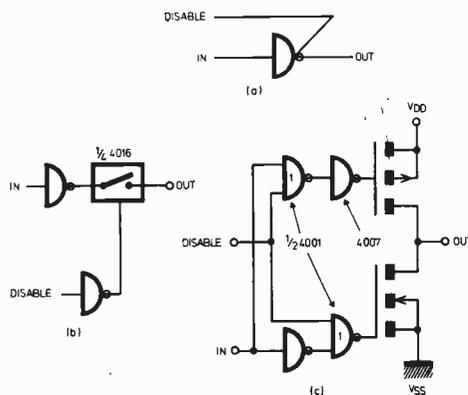


Fig. 6.6. (a) Symbol for an inverter with a three-state output. (b) Three-state output using a bilateral switch. The extra inverter is to make the disable input active when "high". (c) Three-state output using the connections to the gates of the individual MOSFETs, made available in the 4007

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 : 10⁷.

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.

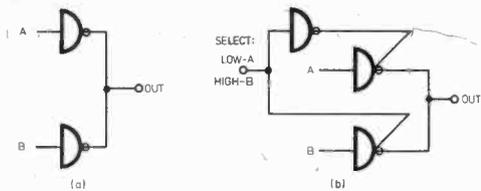


Fig. 6.7. (a) Inadvisable commoning of normal gate outputs. (b) Common bussing of two three-state outputs, where all but one are disabled at any time

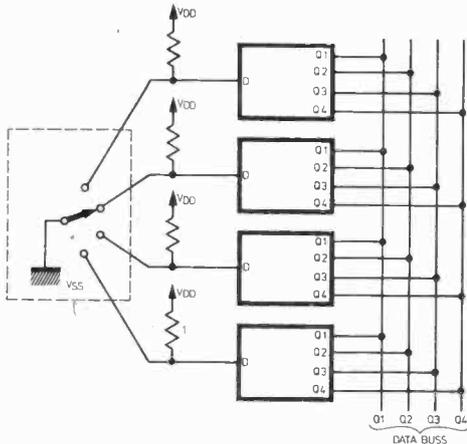


Fig. 6.8. Common bussing illustrated with hypothetical devices (such as the 4043) where only one set of outputs needs to be accessed at any time

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 bresight 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.

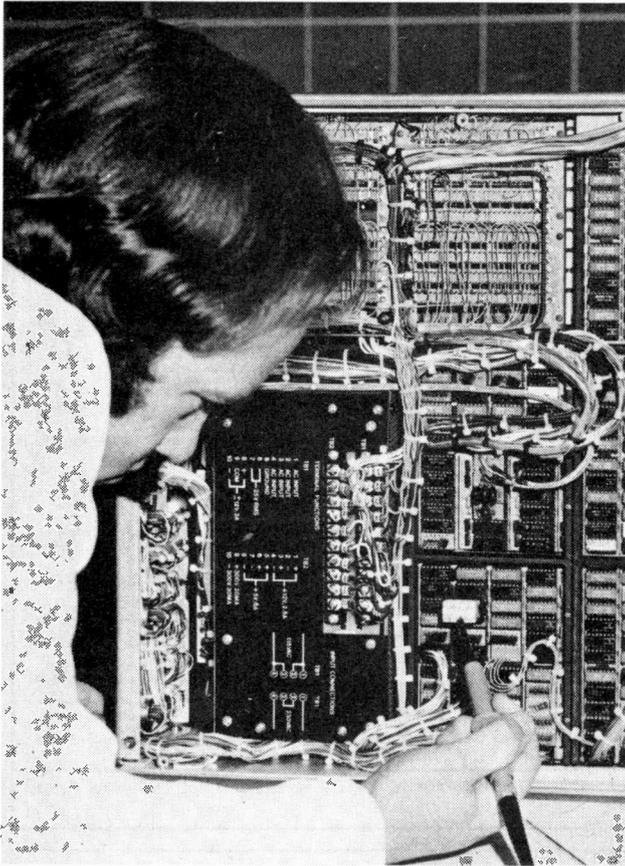
Design objective of the Night Attack non-imaging Maverick system is to provide a first pass multiple launch capability at AAA standoff ranges against such tactical sea/land targets as tanks, trucks, and patrol boats. Test results to date have validated that capability.

New Electronic Exchange in Service

THE first of a new generation of electronic telephone exchanges forming the next phase in a major Post Office programme to modernise the nation's telephone service, has been successfully brought into operation.

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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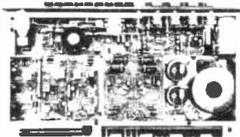
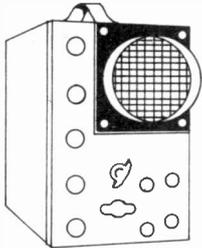
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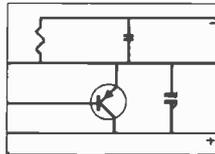
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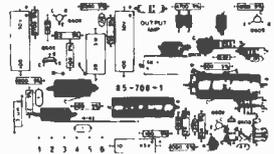
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SMALL MAINS SUPPRESSORS (small chokes, ideal for radio Hi-Fi inputs, etc.) approx. 1in x 1 1/2in, 3 for 50p.

PERSPEX TUNER PANELS (for FM Band 2 tuners) marked 88-108 MHz and Channels 0-70, clear numbers, rest blacked out, smart modern appearance, size approx 8 1/2in x 1 1/2in, 2 for 35p. Multiturn Pots, 10 turn, 1in spindle (ex-equip), following values available: 2kohm, 5kohm, 10kohm, £1 each.

Lead suppressors (10kohm) for mobile plug leads, 4 for 50p.

1mA Meters, 2 in square, plastic fronts (these have a paper scale stuck over original markings) 0-1mA, which is easily peeled off and an internal 18K resistor which is easily removed, £1.75 each or 2 for £3.

TS Midget 3 pole 4 way, rotary switches, 40p each.

HIGH QUALITY SPEAKERS, 8in x 6in elliptical, only 2in deep, inverse magnet, 4ohms, rated up to 10W, £1.50 each or 2 for £2.75 (city discount available + 12 1/2% VAT).

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TV Plugs (metal type), 5 for 50p.

TV Sockets (metal type), 4 for 50p.

TV Line Connectors (back-to-back sockets), 4 for 50p. Please add 12 1/2% VAT.

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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 $\pm 5^\circ$. 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 Centre 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 200kHz, and the response is virtually flat over the audio frequency spectrum. The input impedance is $1\text{M}\Omega$, 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 sine wave is fed into the input. The fast leading edge of the waveform overcomes the forward threshold voltage of the diodes

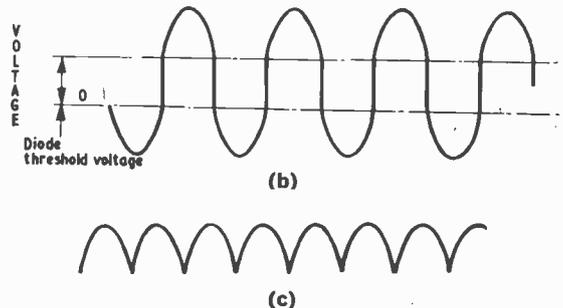
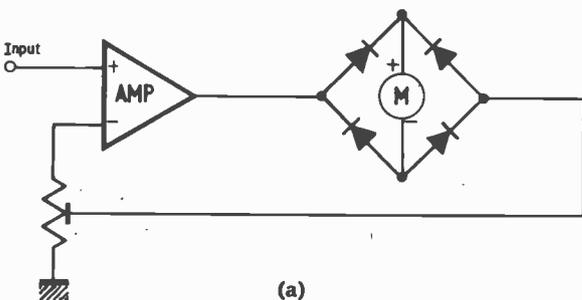


Fig. 1. (a) Overcoming diode forward voltage drop by placing them in the feedback loop of an amplifier. (b) The output waveform produced by the amplifier with a sine wave input. (c) Current waveform through meter

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.

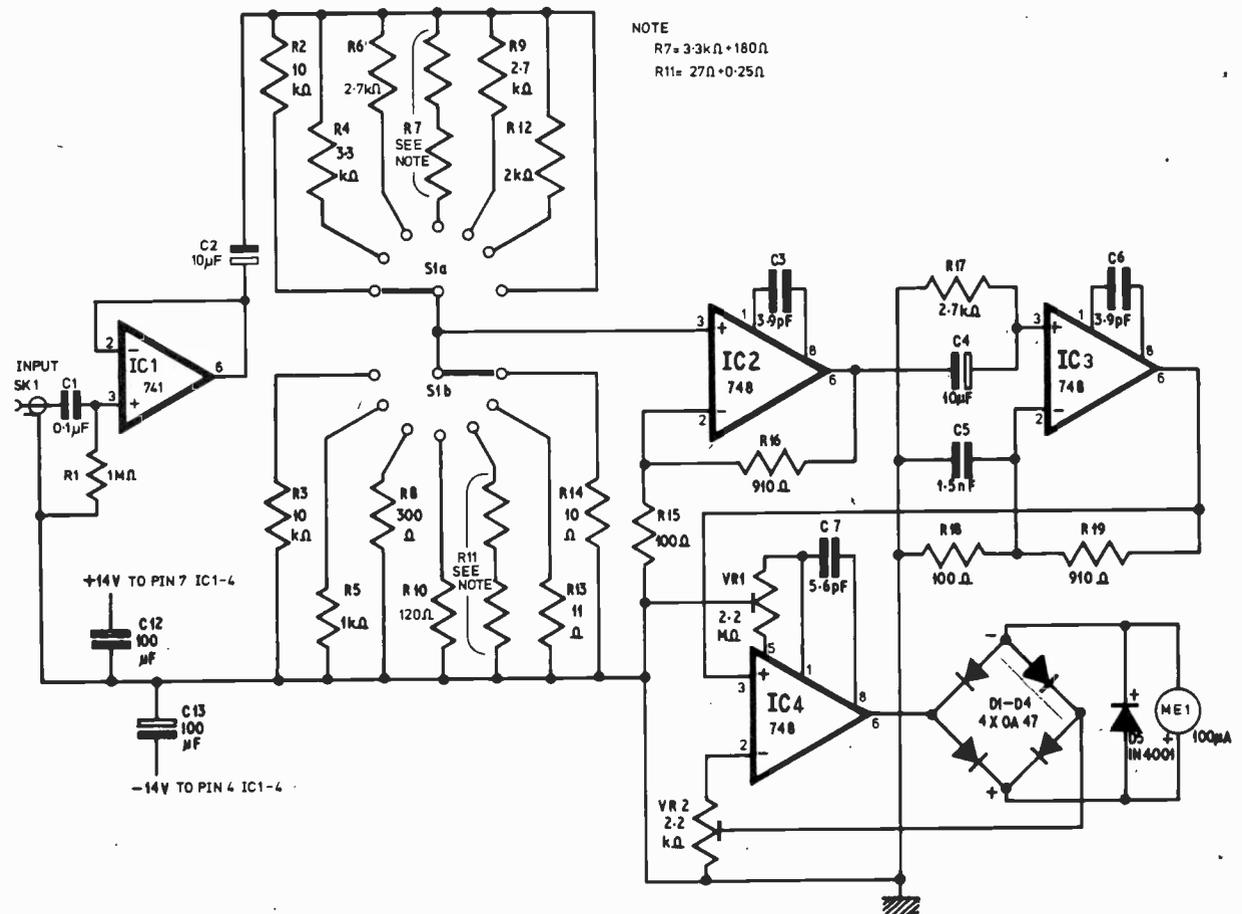
ATTENUATOR

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



NOTE
 R7 = 3.3kΩ + 180Ω
 R11 = 27Ω + 0.25Ω

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 100 μ A 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	1M Ω	R12	2k Ω 1%
R2	10k Ω 1%	R13	11 Ω 1%
R3	10k Ω 1%	R14	10 Ω 1%
R4	3.3k Ω 1%	R15	100 Ω
R5	1k Ω 1%	R16	910 Ω
R7	{ 180 Ω 1%	R17	2.7k Ω
	{ 3.3k Ω 1%	R18	100 Ω
R8	300 Ω 1%	R19	910 Ω
R9	2.7k Ω 1%	R20	2.7k Ω
R10	180 Ω 1%	R21	2.7k Ω
R11	27 Ω + 0.25 Ω 1%		

All resistors $\frac{1}{4}$ W 5% unless otherwise stated

Potentiometers

VR1	2.2M Ω
VR2	2.2k Ω

Capacitors

C1	100nF plastic
C2	10 μ F 10V elect.
C3	3.9pF ceramic
C4	10 μ F 10V elect.
C5	1.5nF disc ceramic
C6	3.9pF ceramic
C7	5.6pF ceramic
C8	400 μ F 25V elect.
C9	400 μ F 25V elect.
C10	100 μ F 16V elect.
C11	100 μ F 16V elect.
C12	100 μ F 16V elect.
C13	100 μ F 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 x 215 x 85mm metal
100 μ A 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.

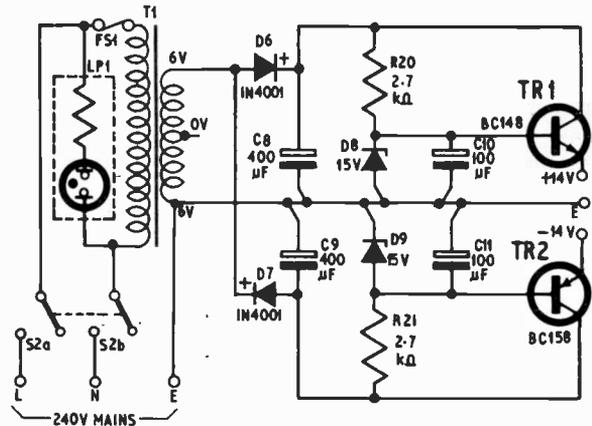


Fig. 3. Power supply circuit

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 ± 14 V to the main circuit.

COMPONENTS

Any 100 μ A 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 100 μ A 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.



Stirling Sound Products

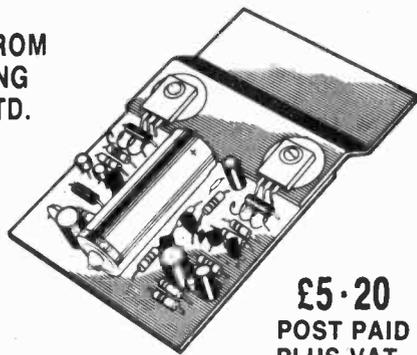
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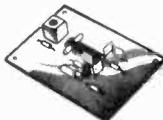
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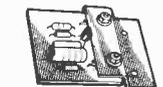
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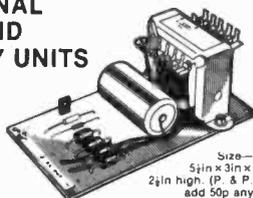
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1N266	0-50	ASY29	0-45	BYZ13	0-42	OAZ209	0-40	ZTX107	0-12
1N645	0-16	ASY36	0-25	BYZ15	1-25	OAZ210	0-40	ZTX300	0-13
1N725A	0-20	ASY50	0-20	BYZ16	0-20	OAZ211	0-40	ZTX304	0-24
1N914	0-06	ASY51	0-40	BZY88	0-10	OAZ222	0-45	ZTX500	0-13
1N4007	0-12	ASY53	0-20	C111	0-55	OAZ223	0-45	ZTX503	0-18
18113	0-25	ASY62	0-25	CRS1/05	0-45	OAZ224	0-45	ZTX631	0-25
18202	0-23	ASY66	0-33	CRS1/40	0-65	OAZ241	0-25		
2G371	0-75	ASZ21	1-00	CS4B	1-90	OAZ242	0-15		
2G381	0-22	ASZ23	0-75	CS10B	3-50	OAZ244	0-25		
2G414	0-30	AU104	1-00	DD000	0-15	OAZ246	0-15	7400	0-16
2G417	0-25	AUY10	1-50	DD003	0-15	OAZ290	0-88	7401	0-18
2N404	0-22	BC107	0-14	DD006	0-25	OC16	1-00	7402	0-16
2N697	0-16	BC108	0-13	DD007	0-40	OC16T	1-00	7403	0-16
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2N705	0-12	BC113	0-15	GD3	0-33	OC24	1-10	7405	0-22
2N706A	0-12	BC115	0-20	GD4	0-10	OC25	0-40	7407	0-42
2N708	0-15	BC116	0-20	GD5	0-33	OC26	0-40	7408	0-28
2N709	0-40	BC118A	0-23	GD8	0-25	OC28	0-75	7409	0-28
2N1091	0-55	BC119	0-20	GD12	0-10	OC29	0-65	7410	0-16
2N1131	0-25	BC122	0-20	GET102	0-50	OC30	0-40	7411	0-16
2N1132	0-24	BC125	0-68	GET103	0-40	OC33	0-75	7412	0-80
2N1302	0-18	BC126	0-65	GET113	0-35	OC36	0-60	7413	0-86
2N1303	0-18	BC129	0-18	GET114	0-30	OC41	0-35	7416	0-88
2N1304	0-28	BC140	0-55	GET115	0-90	OC42	0-40	7417	0-86
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2N1306	0-28	BC149	0-10	GET120	0-50	OC44	0-20	7422	0-25
2N1307	0-28	BC157	0-14	GET872	0-30	OC44M	0-17	7423	0-30
2N1308	0-28	BC158	0-12	GET880	0-60	OC45	0-40	7425	0-87
2N2148	0-60	BC160	0-63	GET881	0-25	OC45M	0-18	7427	0-87
2N2160	0-78	BC169	0-14	GET882	0-35	OC57	0-60	7428	0-40
2N2218	0-23	BCY31	0-45	GET885	0-40	OC58	0-60	7432	0-87
2N2219	0-25	BCY32	0-85	GEX44	0-08	OC59	0-60	7433	0-30
2N2369A	0-16	BCY33	0-38	GEX45/1	0-25	OC66	0-50	7437	0-87
2N2444	1-99	BCY34	0-45	GEX941	0-45	OC71	2-25	7440	0-22
2N2613	0-75	BCY36	1-00	GJ4M	0-50	OC72	0-25	7441AN	0-82
2N2646	0-50	BCY39	1-50	GJ5M	0-25	OC73	0-50	7442	0-79
2N2904	0-20	BCY40	0-80	GJ7M	0-25	OC74	0-30	7450	0-18
2N2906	0-20	BCY42	0-18	HG1005	0-50	OC75	0-30	7451	0-16
2N2907	0-23	BCY70	0-18	HG1009	0-20	OC76	0-30	7453	0-16
2N2924	0-13	BCY71	0-22	MAT100	0-20	OC77	0-50	7454	0-18
2N2925	0-15	BCZ10	0-80	MAT101	0-25	OC78	0-25	7460	0-16
2N2926	0-12	BD121	1-00	MAT120	0-20	OC79	0-30	7470	0-88
2N3054	0-48	BD123	1-00	MAT121	0-25	OC81	0-29	7472	0-88
2N3055	0-65	BD124	0-65	MJE340	0-47	OC81M	0-20	7473	0-42
2N3702	0-11	BFY11	0-10	MJE250	0-63	OC82	0-25	7474	0-48
2N3705	0-15	BF115	0-20	MJE2955	1-27	OC81DM	0-18	7475	0-69
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2N3083	0-33	BF197	0-15	NKT212	0-25	OC140	1-14	7493	0-70
2N3091	0-59	BF861	0-25	NKT214	0-24	OC141	0-80	7494	0-80
28304	1-15	BF898	0-25	NKT216	0-40	OC169	0-20	7495	0-80
28501	0-75	BFX19	0-28	NKT217	0-45	OC170	0-30	7496	0-85
28703	1-00	BFX13	0-28	NKT218	0-45	OC171	0-30	7497	1-87
40250	0-84	BFX29	0-28	NKT219	0-38	OC200	1-00	74100	0-89
40251	0-81	BFX30	0-28	NKT220	0-30	OC201	1-50	74101	0-87
AA1129	0-50	BFX35	0-98	NKT224	0-25	OC202	1-50	74107	0-46
AAZ12	0-75	BFX63	0-50	NKT251	0-24	OC203	1-25	74110	0-58
AAZ13	0-12	BFX68	0-25	NKT271	0-20	OC204	1-50	74111	0-86
AAZ17	0-13	BFX84	0-25	NKT272	0-20	OC205	1-75	74118	0-90
AC107	0-51	BFX85	0-28	NKT373	0-20	OC206	1-10	74119	1-68
AC126	0-25	BFX86	0-25	NKT375	0-20	OC207	1-00	74121	0-50
AC127	0-25	BFX87	0-25	NKT378	0-25	OC208	1-00	74122	0-70
AC128	0-25	BFX88	0-24	NKT277	0-20	OC460	0-20	74123	1-00
AC187	0-21	BFY10	0-50	NKT278	0-25	OC470	0-30	74141	0-80
AC188	0-20	BFY11	0-50	NKT301	1-00	OC71	1-20	74145	1-26
ACY17	0-75	BFY17	0-40	NKT304	1-00	ORP12	0-60	74151	1-00
ACY18	0-35	BFY18	0-45	NKT403	1-00	ORP60	0-65	74154	2-00
ACY19	0-35	BFY19	0-45	NKT494	1-00	ORP61	0-48	74155	1-00
ACY20	0-35	BFY24	1-00	NKT678	0-30	SX68	0-20	74156	1-00
ACY21	0-35	BFY24	1-00	NKT713	0-30	SX691	0-45	74157	0-95
ACY22	0-35	BFY30	0-21	NKT773	0-25	SX635	0-55	74170	2-52
ACY27	0-25	BFY51	0-20	OA5	0-72	SX640	0-75	74174	1-57
ACY28	0-25	BFY52	0-20	OA6	0-12	SX641	0-75	74175	1-28
ACY29	0-25	BFY53	0-17	OA7	0-08	SX642	0-60	74176	1-28
ACY38	0-78	BFY64	0-30	OA71	0-20	SX645	0-85	74190	2-00
ACY40	0-22	BFY90	0-81	OA73	0-15	TIC44	0-29	74191	2-00
ACY44	0-22	BR100	0-40	OA74	0-15	V15/30P	0-75	74192	2-00
AD140	0-50	BSX27	0-50	OA79	0-10	V30/201P	0-75	74193	2-00
AD149	0-75	BSX60	0-98	OA81	0-18	V60/201P	0-75	74194	1-20
AD161	0-44	BSX76	0-18	OA85	0-15	V60/201P	0-75	74195	1-10
AD162	0-44	BSY26	0-17	OA86	0-15	XA101	0-10	74196	1-20
AF106	0-30	BSY27	0-20	OA90	0-07	XA102	0-18	74198	2-77
AF114	0-25	BSY31	0-10	OA91	0-07	XA151	0-15	74199	2-52
AF115	0-25	BSY95A	0-12	OA95	0-07	XA152	0-15		
AF116	0-25	BSY95	0-12	OA200	0-08	XA161	0-25		
AF117	0-24	BT102/300R	0-75	OA202	0-08	XA162	0-25		
AF118	0-57			OA210	0-20	XB101	0-43		
AF119	0-20	BTY42	0-92	OA211	0-35	XB102	0-30		
AF124	0-30	BTY79/100R	0-75	OA2200	0-50	XB103	0-35		
AF126	0-30	HTV79/400R	0-75	OAZ201	0-45	XB110	0-30		
AF127	0-30			OAZ202	0-45	XB113	0-30		
AF139	0-41	BY100	0-27	OAZ203	0-45	XB121	0-43		
AF178	0-55	BY126	0-14	OAZ204	0-45				
AF179	0-65	BY127	0-12						
AF180	0-55	BY182	0-85						

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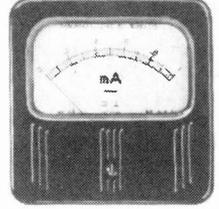
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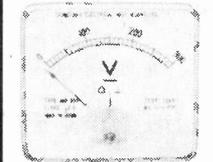
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100-0-100µA	30A d.c.	300V a.c.*
500-0-500µA	50A d.c.	1A a.c.*
1mA	5V d.c.	5A a.c.*
1-0-1mA	10V d.c.	10A a.c.*
5mA	15V d.c.	20A a.c.*
10mA	20V d.c.	30A a.c.*
50mA	50V d.c.	50A a.c.*
100mA	150V d.c.	500mA a.c.
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200µA	100mA	300V d.c.
500µA	500mA	15V d.c.
100-0-100µA	1A d.c.	300V a.c.
500-0-500µA	5A d.c.	1A a.c.*
1mA	15A d.c.	5A a.c.*
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METER CIRCUIT BOARD

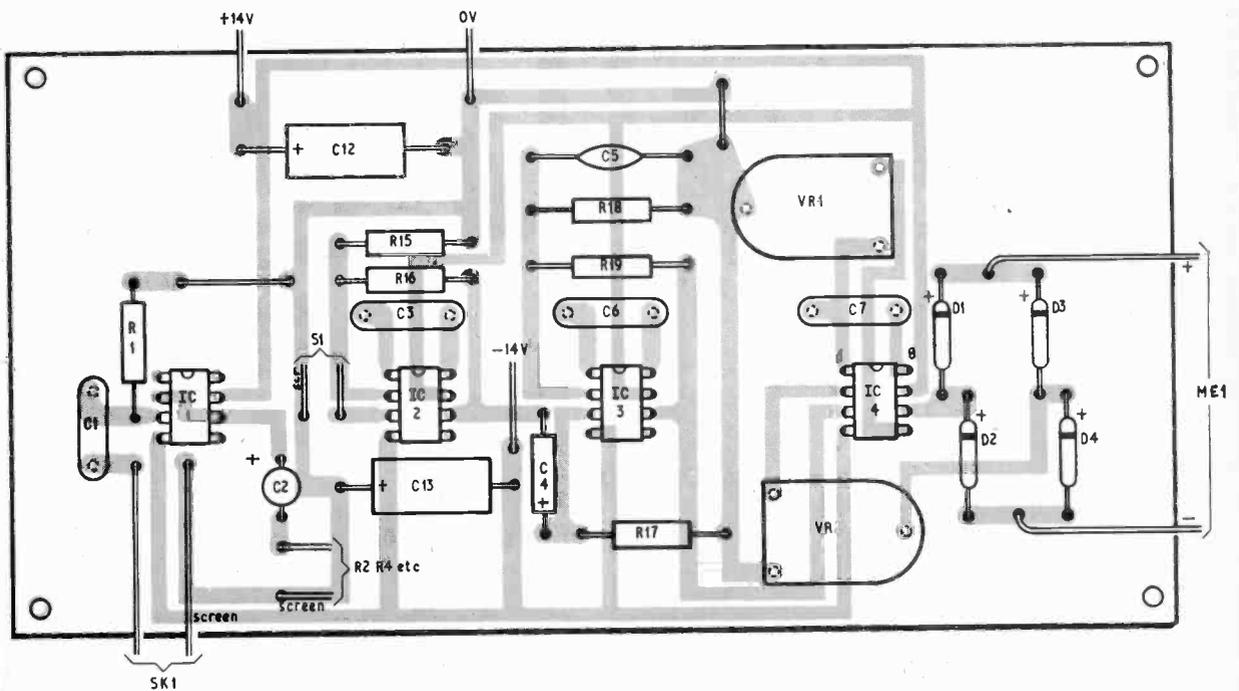
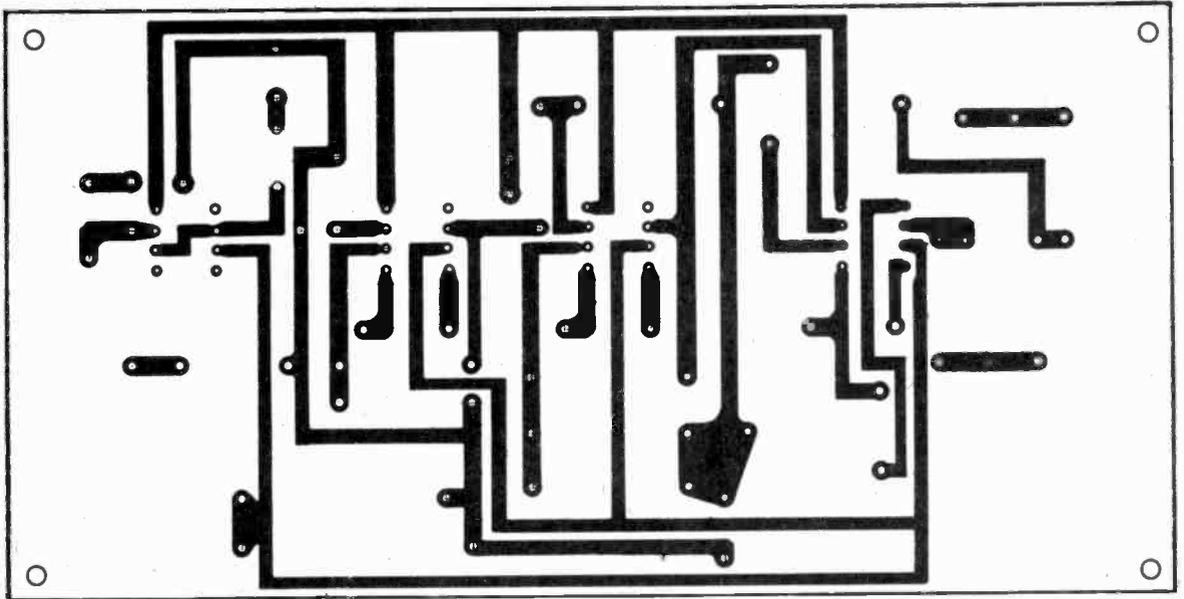
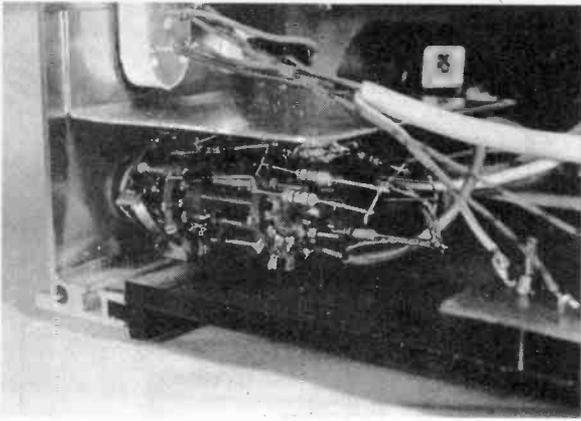


Fig. 4. Component layout and p.c.b. master for main board



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

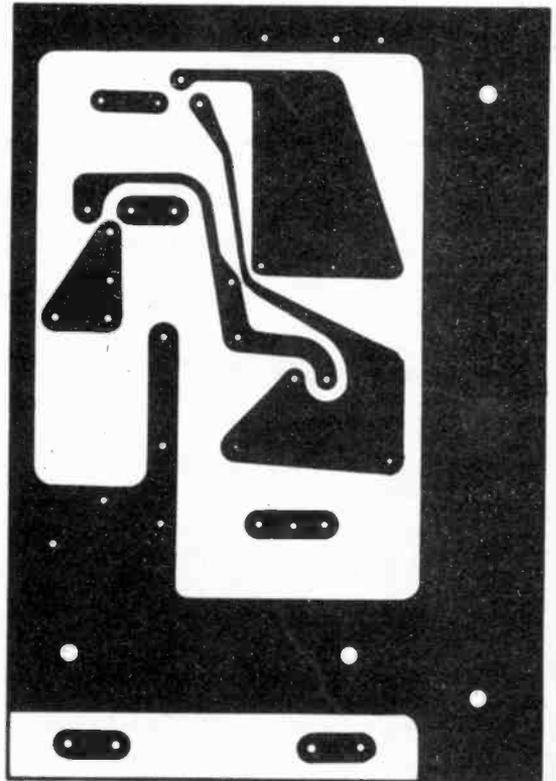
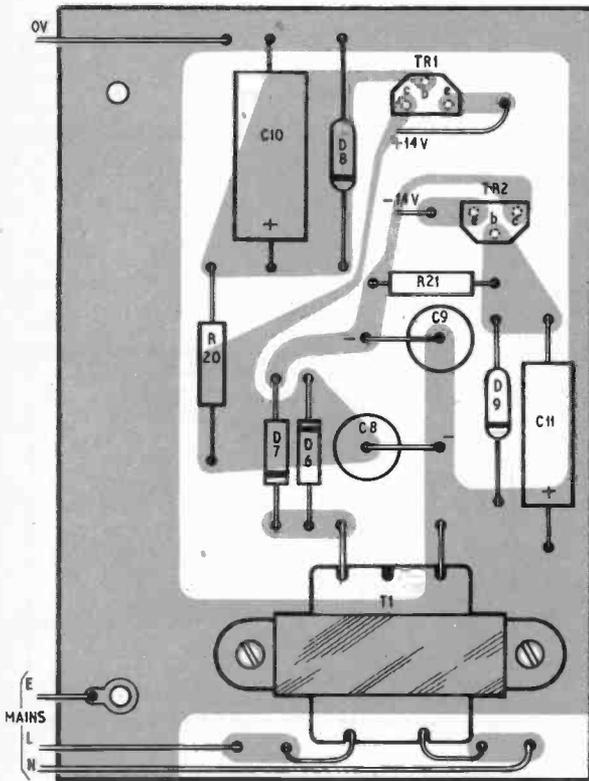
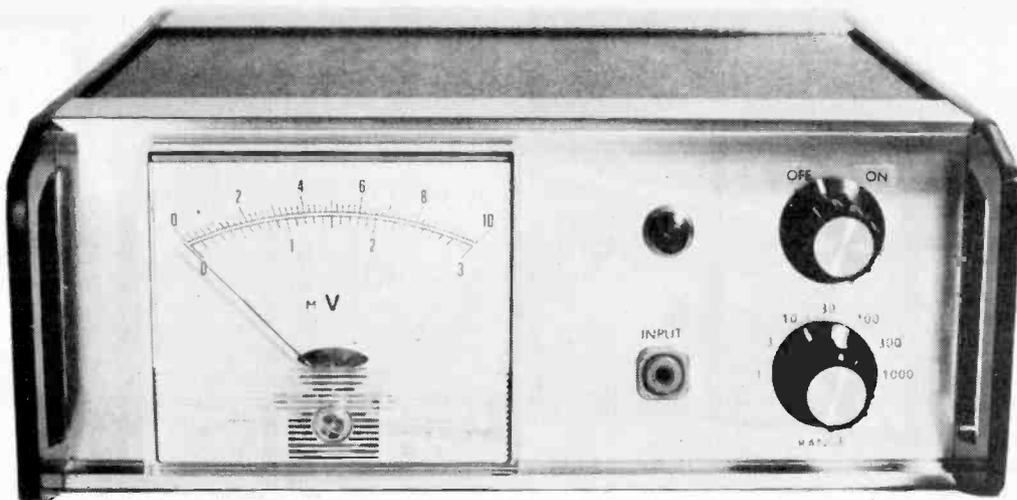


Fig. 5. Details of power supply p.c.b.



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.

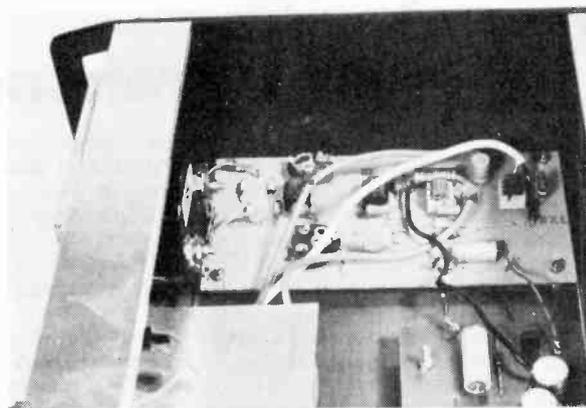
CALIBRATION

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



Interior of the unit showing position and interwiring of boards

accuracy it is advisable to measure the output rather than rely upon the calibration of the generator.

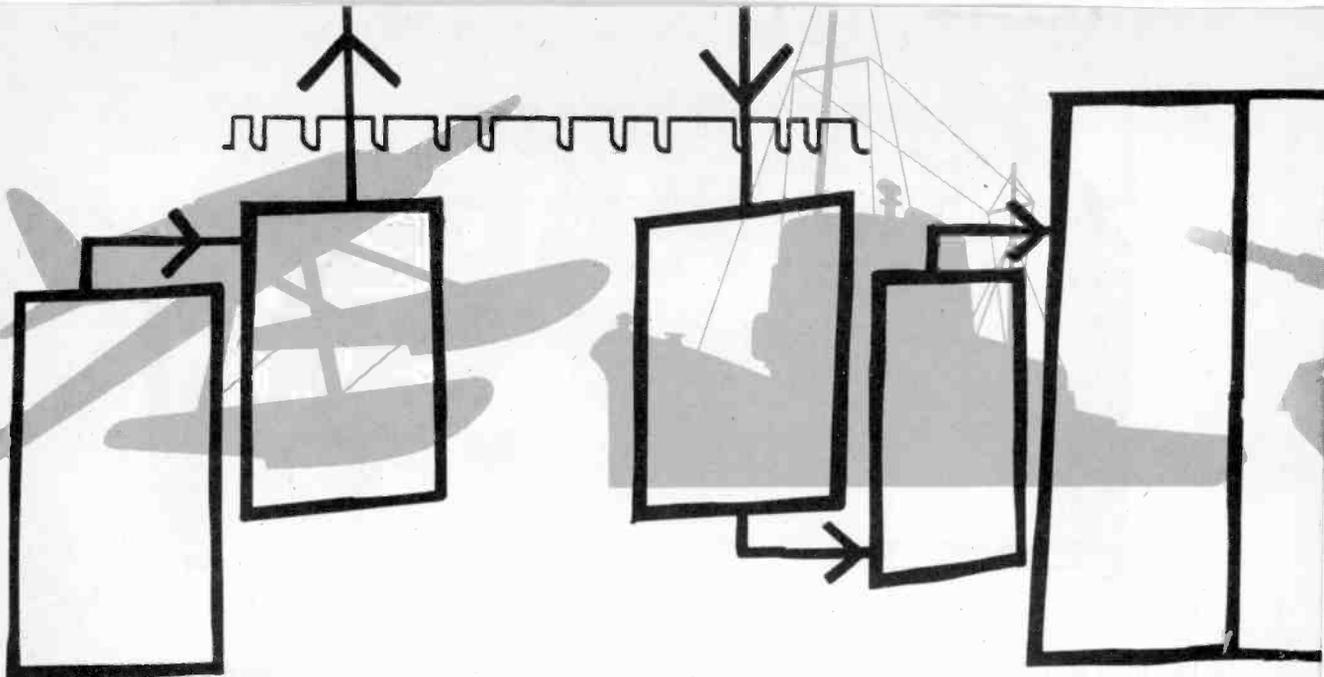
For the average constructor the most practical method of calibrating the millivoltmeter is probably to use an ordinary multimeter set to a low a.c. volts range to enable the generator's output level to be accurately measured and set at 1V r.m.s. The millivoltmeter can then be measured on the 1V range.

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 $1M\Omega$ 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 $10M\Omega$).

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

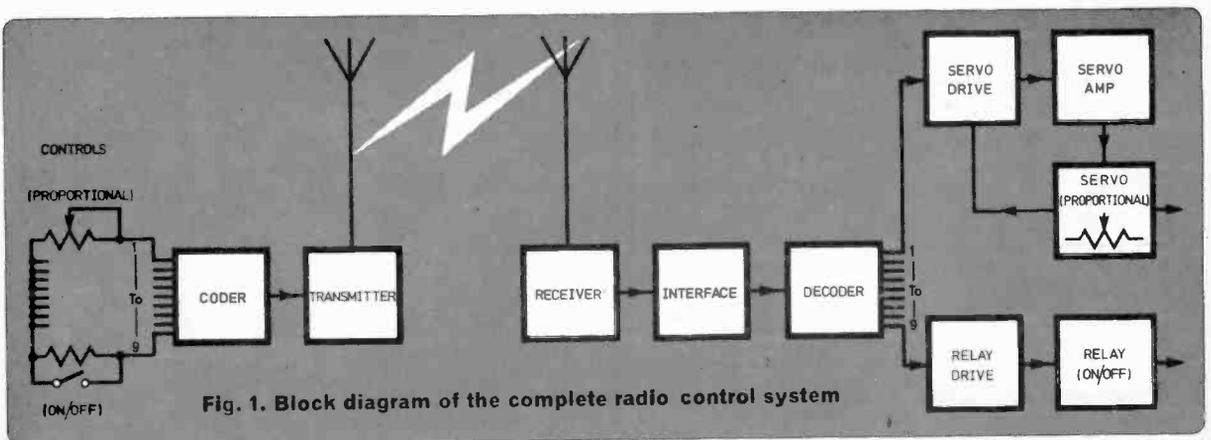


Fig. 1. Block diagram of the complete radio control system

CODER

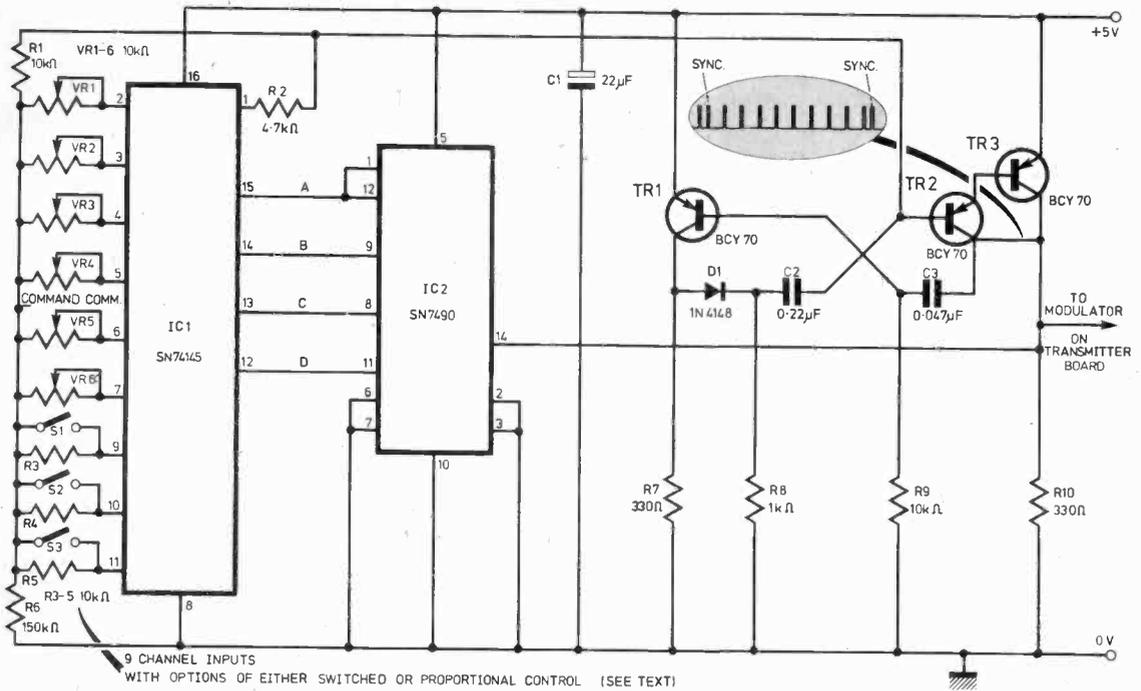


Fig. 2. Circuit diagram of the Coder

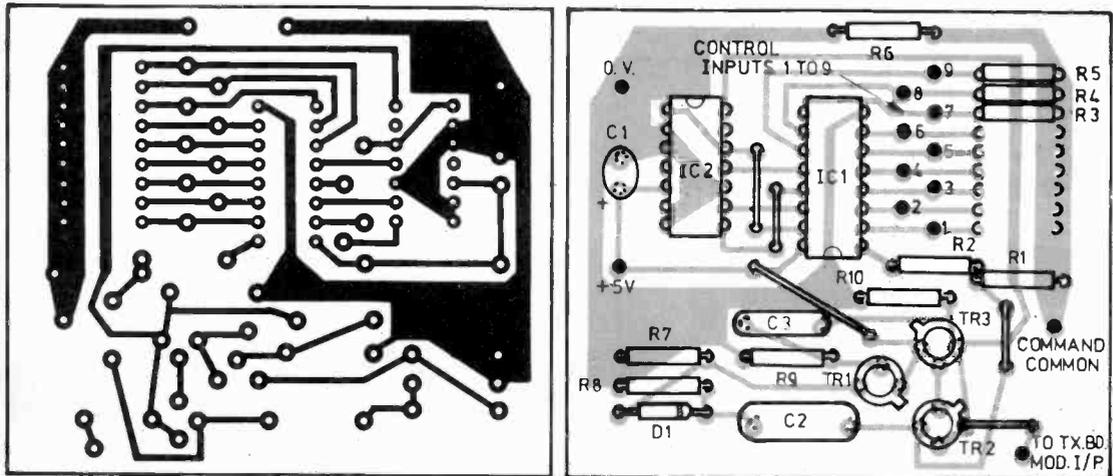


Fig. 3. Printed circuit master and component layout details for the Coder (full size)

TRANSMITTER

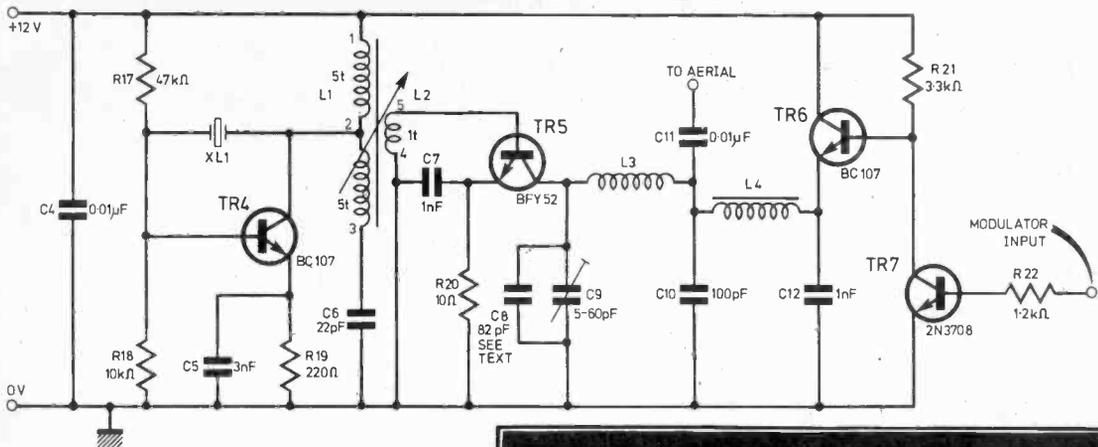


Fig. 5. Circuit diagram of the Transmitter

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

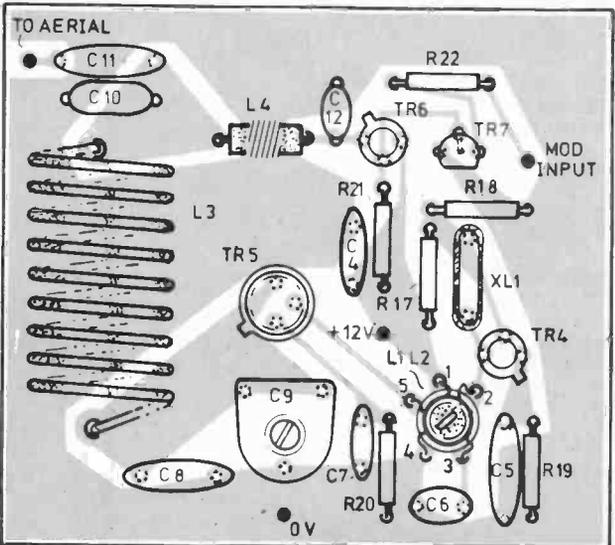
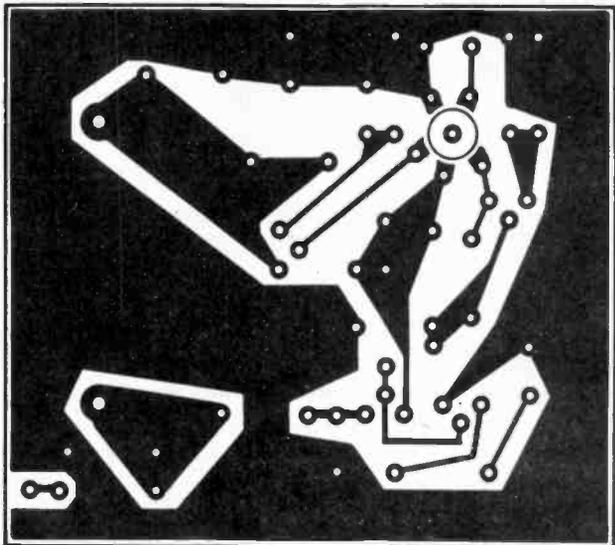
- TR4 BC107B
- TR5 BFY52
- TR6 BC107B
- TR7 2N3708

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.

SPECIAL CALCULATOR SALE

New Texas Instruments SR56—10 + 2, 9 levels of brackets, 2 looping capabilities, 4 levels of sub-routine, 10 data memory register. £79.95; T.I. SR52. £248. CBM 4190R. Melcor SCP700 10 memory—algebraic programmable—S.A.E. for price. All subject to availability.

SC60 (Realtone)—10-digit mantissa, 2-digit exponent, algebraic logic, 3 user addressable memories which include Sum memory, Sum of Squares memory and Index memory plus index register. It has double bracketing as well as arithmetic mean, norm (sq. rt. of sum of squares) STANDARD deviation, factorial, binomial, co-efficient, permutation, function, normal distribution function, Gamma function, trig functions and their inverse, Logs and anti logs, group operation and group controls, flexible memory control, factor reversal, degree/radian selection, error detection and display. £46 plus £3.68 VAT. Total £49.68.

SC6010 (Realtone)—50 functions, 66 keyboard commands. As SC60 but with 10 memories which allow memory storage for up to 10 intermediate results or 10 constants at the user's option. The extra memories may be used to store a group of variables for repeated processing of the variables. £60 plus £4.80 VAT. Total £64.80.

SC44 (Realtone)—22 functions, 40 keys, 8 digit mantissa, 2 digit exponent, two levels of brackets, algebraic logic works to 10 rounds to 6 trig functions and their inverse, log and anti log, exponentiation (y^x), factorials, pi, ix, x², Vx (sq. rt. of x) degree/radian selection (trig or inverse trig) full feature memory STO, RCL, M+, exchange operation x-y, automatic error detection and display Clearing operation (CA, CE). £30 plus £2.40 VAT. Total £32.40.

All rechargeable with 220 240V adaptors. Size 3 1/2 x 3 1/2 x 1 1/2 in. Weight 330 grams. Realtone Calcs. New—10 + 2 green display cassette power supplier including rechargeable batteries and self-contained battery charger—LC40d. Memory + % green or red display calculators under £10 S.A.E.

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'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

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.

3rd PRIZE £50

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

for a ALPHA/BETA
PARTICLE DETECTOR

RUNNERS-UP

The following 25 readers each receive a MAGISPARK GAS IGNITOR

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

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 demonstrably 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

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

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

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 its **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.

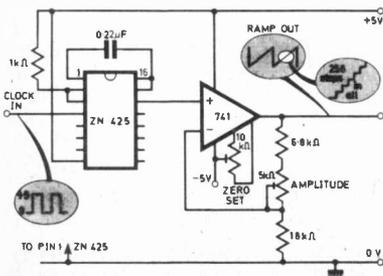


Fig. 1. Linear ramp generator

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.

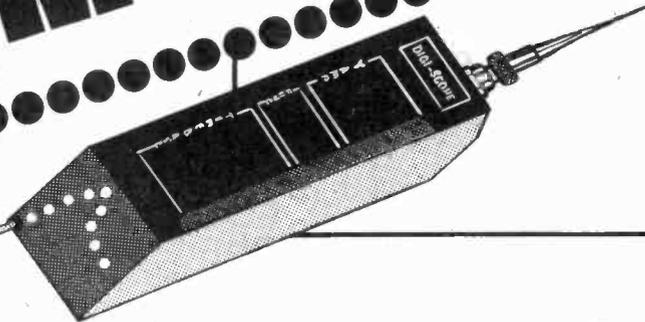
Power consumption of the c.m.o.s. circuit is very low, so low in fact that it is not necessary even to use an on-off switch!

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!

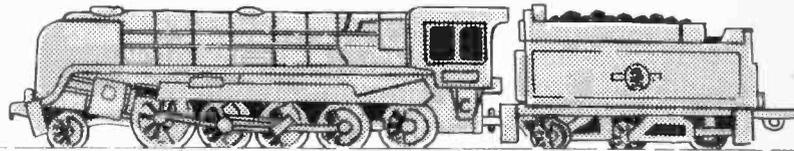
P.E. DIGISCOPE

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 i.e.d. matrix to form a flat screen display



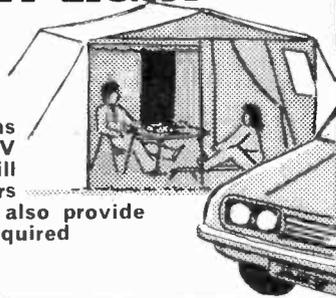
AUTOSTOP for Model Railways...

A design to halt a model train for a pre-determined 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

PLEASE NOTE:

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PRACTICAL

ELECTRONICS

JULY ISSUE ON SALE JUNE 11, 1976

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INGENUITY UNLIMITED



A selection of readers suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

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 a ÷ 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 LOGICALL 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.

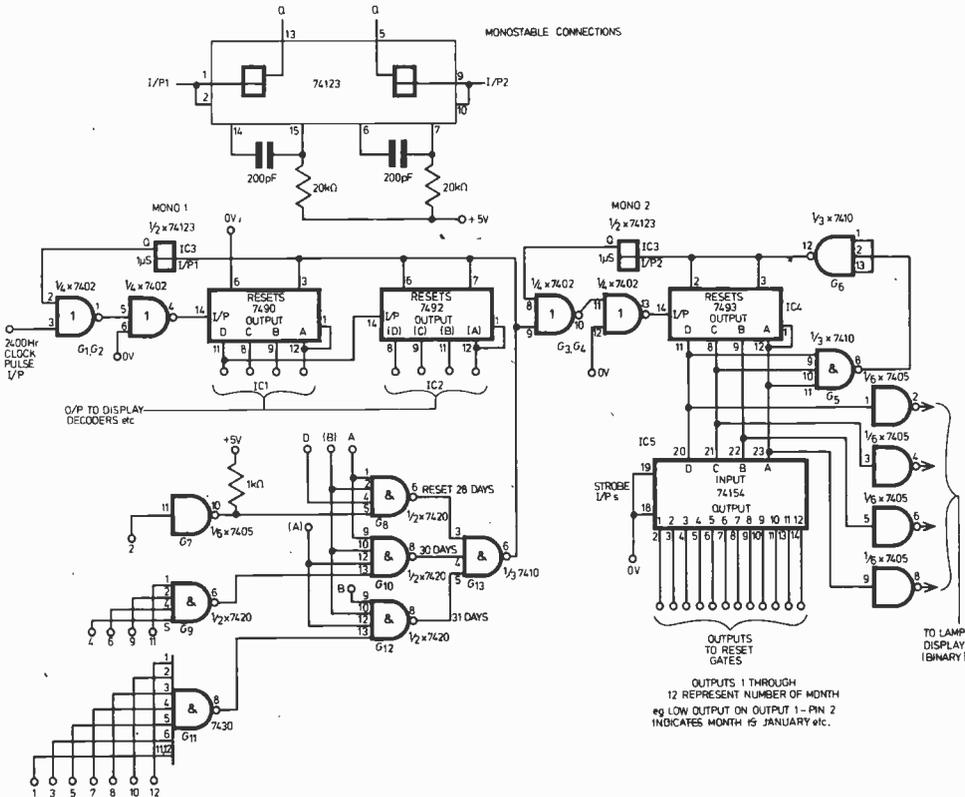


Fig. 1

ELECTRONIC DOORBELL

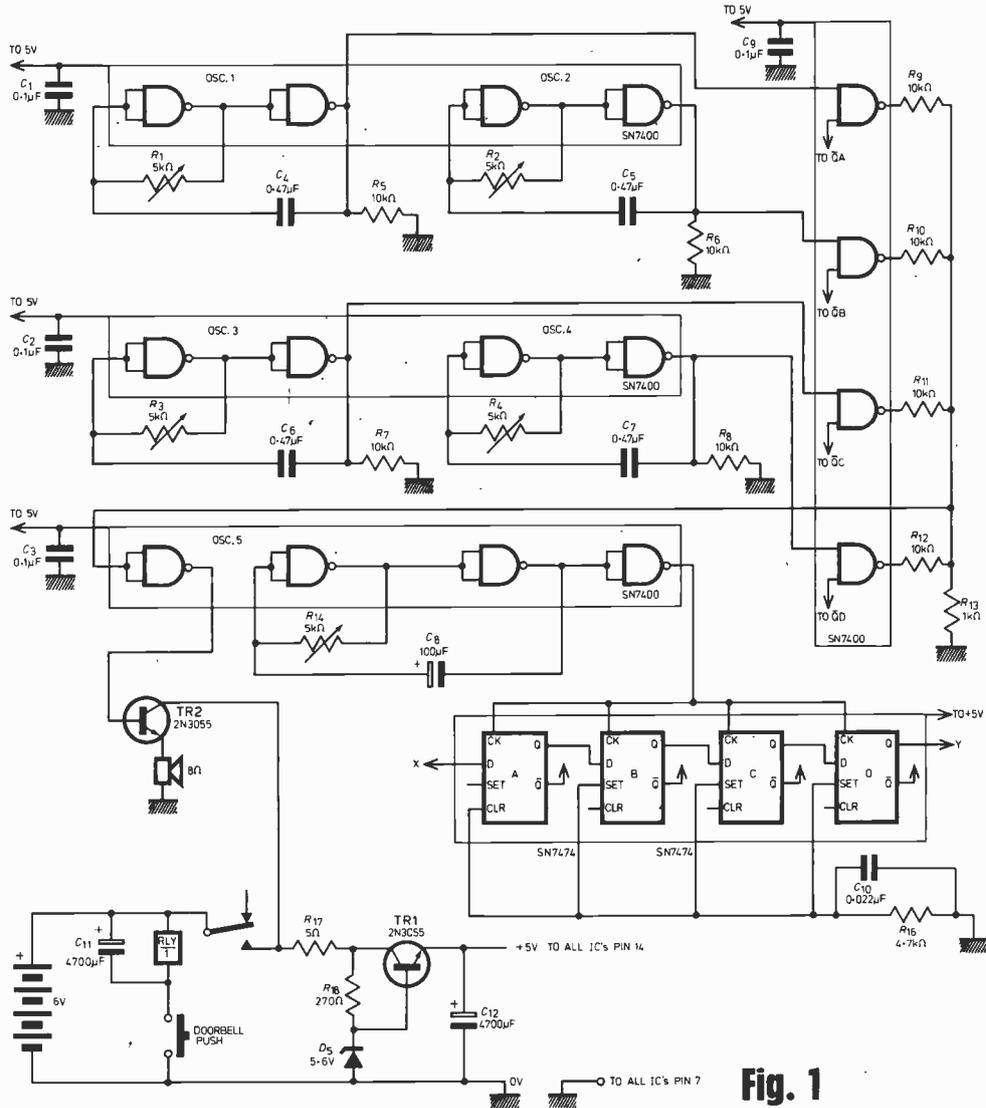


Fig. 1

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 \bar{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

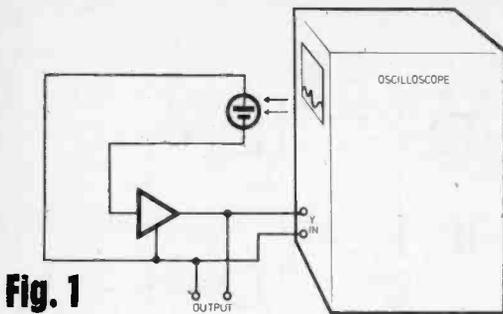


Fig. 1

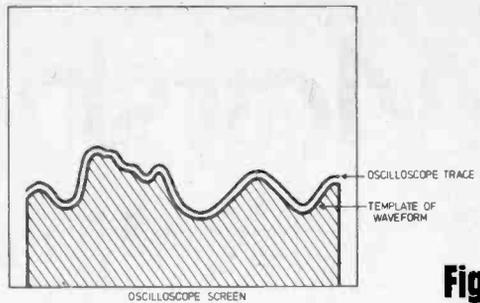


Fig. 2

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 wave-

form 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 I.D.R. with a resistor and battery may be used in place of the photocell.

J. Samson,
Bishop's Stortford

SQUARE WAVE GENERATOR

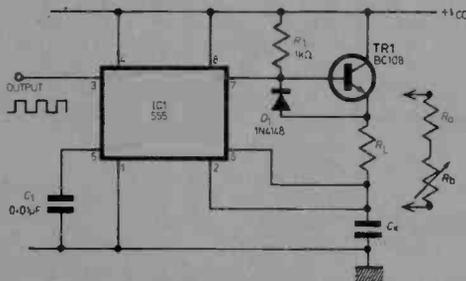


Fig. 1

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

$$f_0 \text{ (frequency of oscillation)} = \frac{0.722 \text{ Hz}}{R_1 C_X} \text{ approx. the period}$$

$$\frac{1}{f_0} = 1.386 R_1 C_X \text{ sec.}$$

By making the resistor variable (R_1) with current limiting resistor (R_2) in place of R_1 , a frequency variation of 1,000:1 can be obtained with typical values of $1k\Omega$ for R_2 , $1m\Omega$ (variable) for R_1 . C_X charges via R_1 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_1 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.

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2N492	5-00	2N3390	0-45	2N5295	0-48	AF118	0-35	BC237	0-16	BF177	0-29	8D1L	0-38	OC83	0-24
2N493	5-20	2N3391	0-28	2N5296	0-48	AF124	0-30	BC238	0-17	BF178	0-35	14D1L	0-40	ORP12	0-60
2N496	0-22	2N3391A	0-29	2N5296	0-48	AF125	0-30	BC239	0-15	BF179	0-43	LM710	0-47	R53	1-80
2N697	0-16	2N3392	0-15	2N5458	0-29	AF126	0-28	BC251	0-25	BF180	0-35	LM723C	0-66	SL1414A	1-80
2N698	0-82	2N3393	0-15	2N5457	0-29	AF127	0-28	BC253	0-25	BF181	0-36	LM741	0-40	SL610C	2-35
2N699	0-59	2N3394	0-15	2N5458	0-29	AF139	0-59	BC257	0-16	BF182	0-35	T099	0-40	SL611C	2-35
2N706	0-14	2N3402	0-18	2N5459	0-46	AF186	0-46	BC258	0-16	BF183	0-35	8D1L	0-40	SL612C	2-35
2N708	0-17	2N3414	0-18	2N5494	0-58	AF200	0-85	BC259	0-17	BF184	0-30	14D1L	0-38	SL620C	3-50
2N709	0-42	2N3415	0-21	2N5496	0-61	AF209	0-85	BC262	0-25	BF185	0-30	LM747	1-00	SL621C	3-50
2N711	0-50	2N3416	0-24	2N5776	0-45	AF240	0-90	BC262	0-25	BF194	0-12	LM748	0-40	SL623	5-75
2N718	0-23	2N3417	0-29	2N6027	0-45	AF279	0-70	BC263	0-25	BF195	0-12	8D1L	0-44	SL640C	4-00
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2N914	0-22	2N3442	1-40	3N140	1-00	BC107	1-14	BC303	0-54	BF198	0-18	LM7805	2-50	SN76013N	1-95
2N916	0-28	2N3638A	0-15	3N200	2-49	BC109	0-15	BC307	0-17	BF200	0-40	LM7812	1-99	SN76023N	1-60
2N918	0-32	2N3638B	0-15	3N200	2-49	BC113	0-15	BC308A	0-15	BF225J	0-23	LM7815	1-99	SN76033N	2-92
2N929	0-25	2N3639	0-27	40361	0-40	BC115	0-15	BC309C	0-20	BF244	0-21	LM7824	1-99	ST2	0-20
2N930	0-26	2N3641	0-17	40362	0-45	BC115	0-17	BC317	0-12	BF246	0-45	MC1300	1-50	TAA263	1-20
2N1302	0-19	2N3702	0-12	40363	0-88	BC116	0-17	BC318	0-12	BF247	0-65	MC1300P	0-90	TAA300	1-84
2N1303	0-19	2N3703	0-13	40369	0-46	BC116A	0-18	BC337	0-20	BF248	0-58	MC1351P	0-80	TAA350	1-96
2N1304	0-26	2N3704	0-15	40395	0-56	BC117	0-21	BC338	0-20	BF254	0-19	MC1352P	0-80	TAA550	0-32
2N1305	0-24	2N3705	0-15	40395	0-65	BC118	0-14	BCY30	0-30	BF257	0-47	MC1468	3-50	TAA611C	2-18
2N1306	0-31	2N3706	0-15	40406	0-44	BC119	0-29	BCY31	0-85	BF258	0-53	MC1469	2-75	TAA621	2-03
2N1307	0-30	2N3707	0-18	40407	0-35	BC121	0-35	BCY32	1-15	BF259	0-55	ME0402	2-25	TAA661B	1-03
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2N1907	0-57	2N3714	1-38	40601	0-67	BC137	0-17	BCY56	0-30	BF329	0-35	MJ490	1-05	TI2P29A	0-49
2N2102	0-60	2N3715	1-50	40602	0-61	BC140	0-68	BCY59	0-32	BF330	0-35	MJ491	1-45	TI2P29C	0-80
2N2147	0-78	2N3716	1-80	40603	0-58	BC141	0-68	BCY70	0-17	BF384	0-30	MJ2955	1-00	TI3P0A	0-40
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2N2180	0-47	2N3723	1-80	40636	1-10	BC143	0-28	BCY72	0-72	BF387	0-28	MJE2955	1-20	TI3P31A	0-62
2N2218A	0-47	2N3723	2-65	40669	1-00	BC147	0-10	BD115	0-75	BF388	0-30	MJE3055	0-75	TI3P31C	1-00
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2N2222	0-20	2N3819	0-15	AC151TV	0-27	BC157	0-16	BD131	0-40	BFY53	0-18	MP8111	0-32	TI3P4A	1-01
2N2221A	0-21	2N3794	0-37	AC152V	0-49	BC158	0-16	BD132	0-50	BFY90	1-27	MP8112	0-40	TI3P4A	2-60
2N2222A	0-25	2N3820	0-29	AC153	0-35	BC160	0-78	BD135	0-21	BFY93	0-48	MP8113	0-47	TI3P5A	2-90
2N2368	0-17	2N3823	0-78	AC153K	0-40	BC167B	0-15	BD136	0-22	BSX20	0-28	MPF102	0-39	TI3P6A	3-70
2N2369	0-20	2N3904	0-19	AC154	0-25	BC168B	0-15	BD137	0-24	BSX21	0-30	MPSA05	0-25	TI414A	0-79
2N2369A	0-22	2N3906	0-19	AC176	0-40	BC168C	0-15	BD138	0-26	BU104	2-00	MPSA06	0-31	TI414C	1-40
2N2646	0-55	2N4036	0-67	AC176K	0-40	BC169B	0-15	BD139	0-71	BU115	2-25	MPSA12	0-35	TI4P2A	0-90
2N2647	0-48	2N4037	0-42	AC187K	0-35	BC169C	0-15	BD140	0-87	CI06D	0-65	MPSA55	0-21	TI4P2C	1-60
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2N2905	0-47	2N4060	0-15	AC188	0-95	BC172	0-12	BDY20	1-05	CA3035	1-37	MPSU06	0-58	TI3055	0-50
2N2905A	0-50	2N4061	0-15	AD142	0-57	BC177	0-19	BF115	0-20	CA3046	0-70	MPSU55	0-63	TI543	0-28
2N2906	0-33	2N4062	0-15	AD143	0-58	BC178	0-18	BF117	0-55	CA3052	2-11	MPSU56	0-60	ZTX300	0-13
2N2906A	0-42	2N4126	0-21	AD149V	0-74	BC179	0-21	BF121	0-35	CA3089E	1-62	NE555V	0-70	ZTX301	0-13
2N2907	0-23	2N4289	0-34	AD150	1-15	BC182	0-12	BF123	0-33	CA3089A	1-08	NE556	1-30	ZTX302	0-20
2N2907A	0-24	2N4919	0-95	AD161	0-89	BY182L	0-12	BF125	0-35	CA3089E	1-96	NE560	4-48	ZTX500	0-15
2N2924	0-20	2N4920	1-10	AD162	0-89	BC183	0-12	BF152	0-20	CA3090Q	4-23	NE561	4-48	ZTX501	0-15
2N2925	0-20	2N4921	0-83	AD161	PR	BC183L	0-12	BF153	0-25	LM301A	0-48	NE565A	4-48	ZTX502	0-18
2N2926	0-19	2N4922	1-00	AD162	1-58	BC184	0-13	BF154	0-20	LM308	1-17	OC23	1-35	ZTX530	0-23
Green	0-12	2N4923	1-00	AF106	0-40	BC184L	0-13	BF159	0-27	LM309K	1-88	OC28	1-48	ZTX531	0-22

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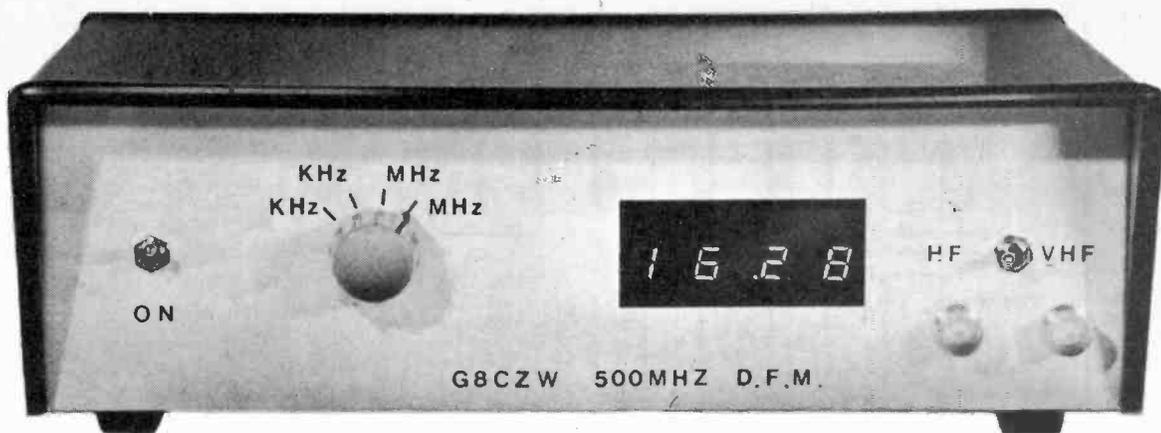
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DIGITAL FREQUENCY METER

By A. J. BUXTON

PART TWO

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

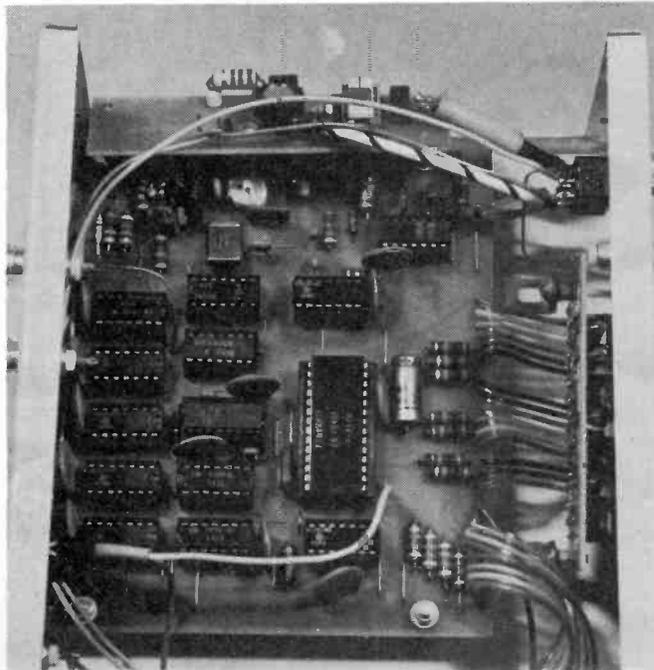
ZN1040E is 28 pins and can be made either by cutting two 14 pin sockets in half or by using strips of pins.

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



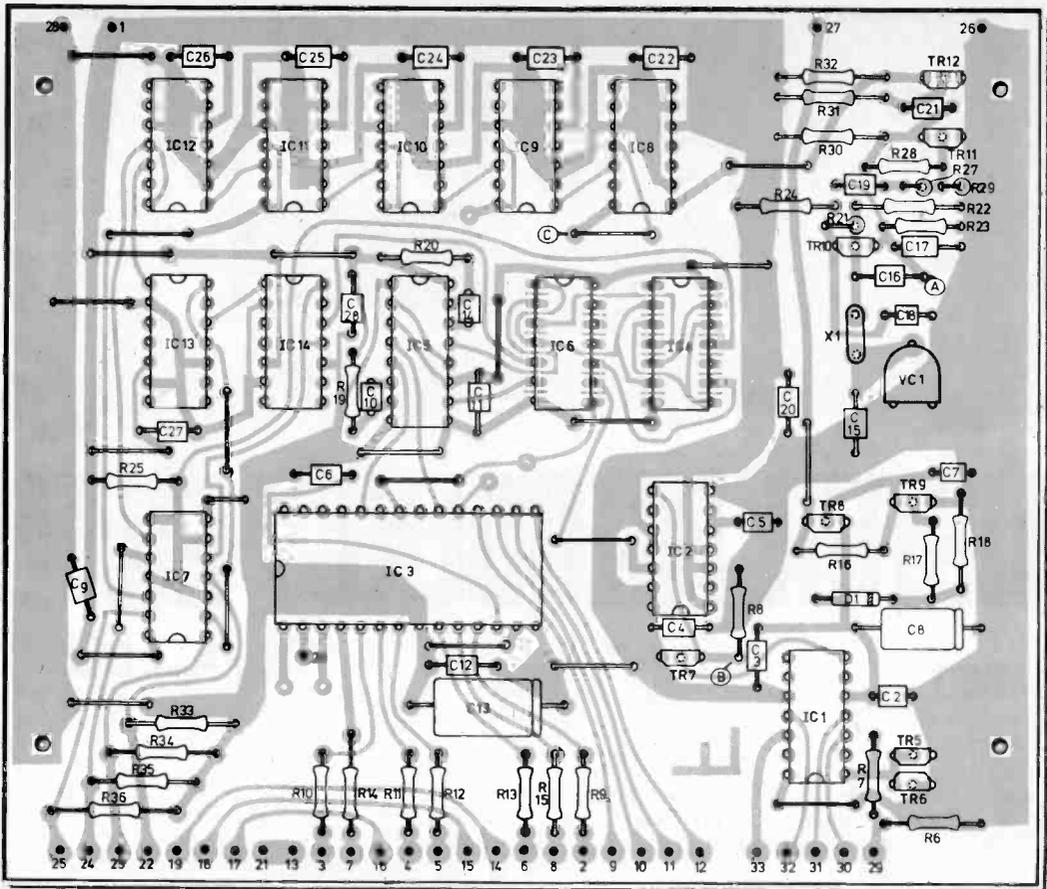


Fig. 7. Layout of the components on the main printed circuit board. Note that if the high impedance buffer is used then C1 and transistors TR5 and TR6 are not required. The three signal test points in Fig. 2 are marked as "A", "B" and "C". I.C. sockets should be used especially for IC3 as replacing a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

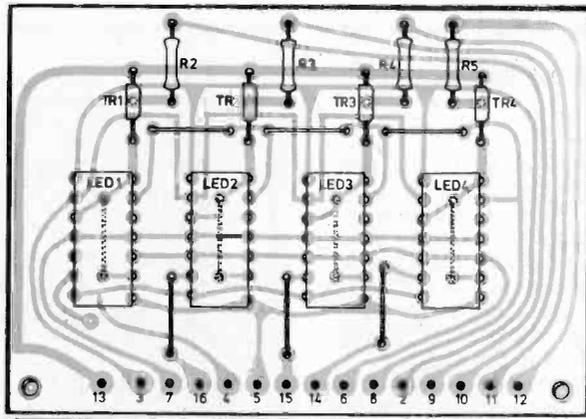


Fig. 9. Layout of the components on the display board. The 15 pads are wired to pads with the corresponding numbers on the main board

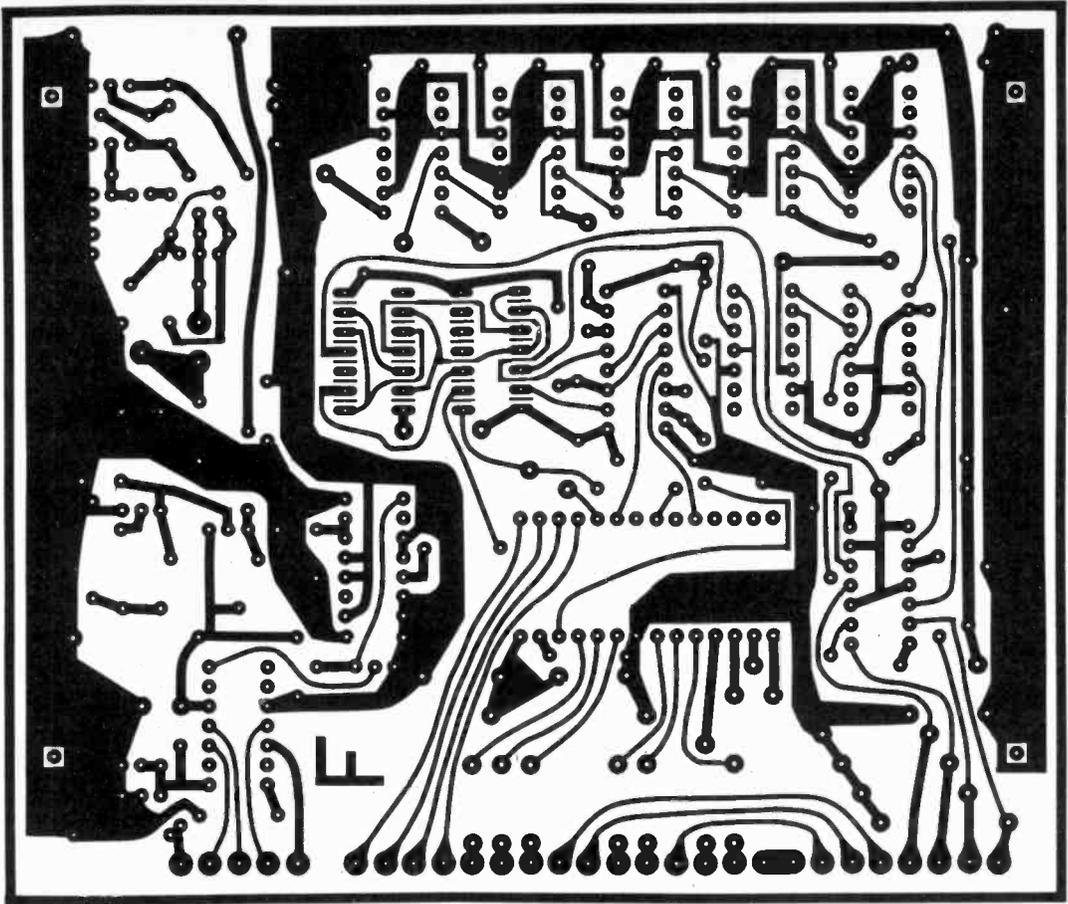


Fig. 8. Full size printed circuit master of the main board as viewed from the copper side

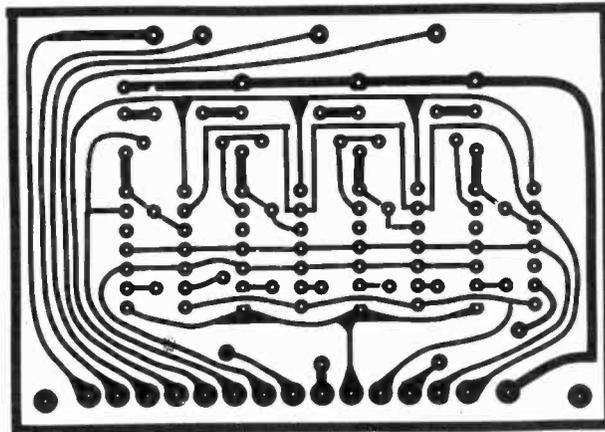


Fig. 10. Full size printed circuit master of the display board

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.

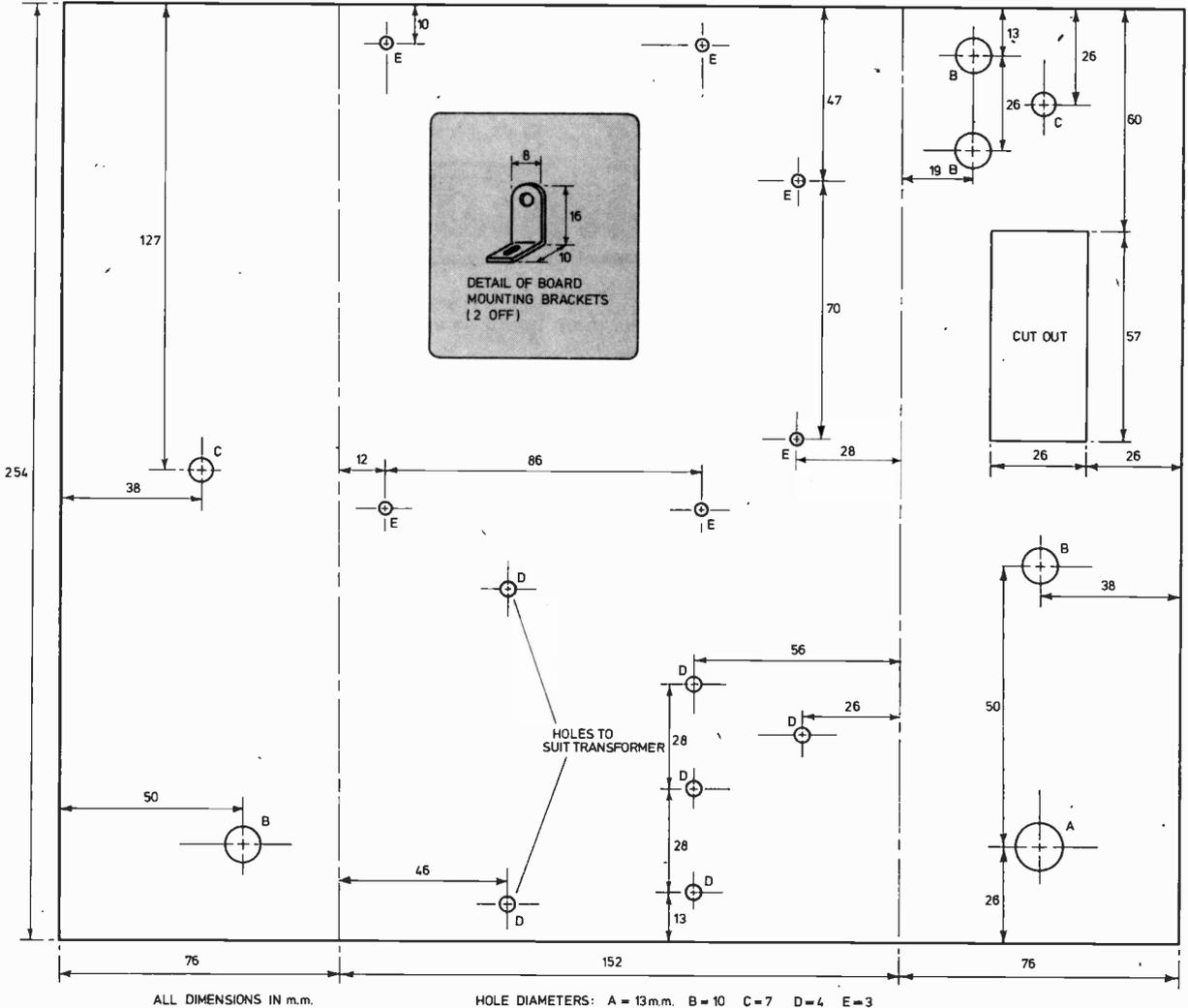
Carefully check for mistakes, then switch the instrument on.

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



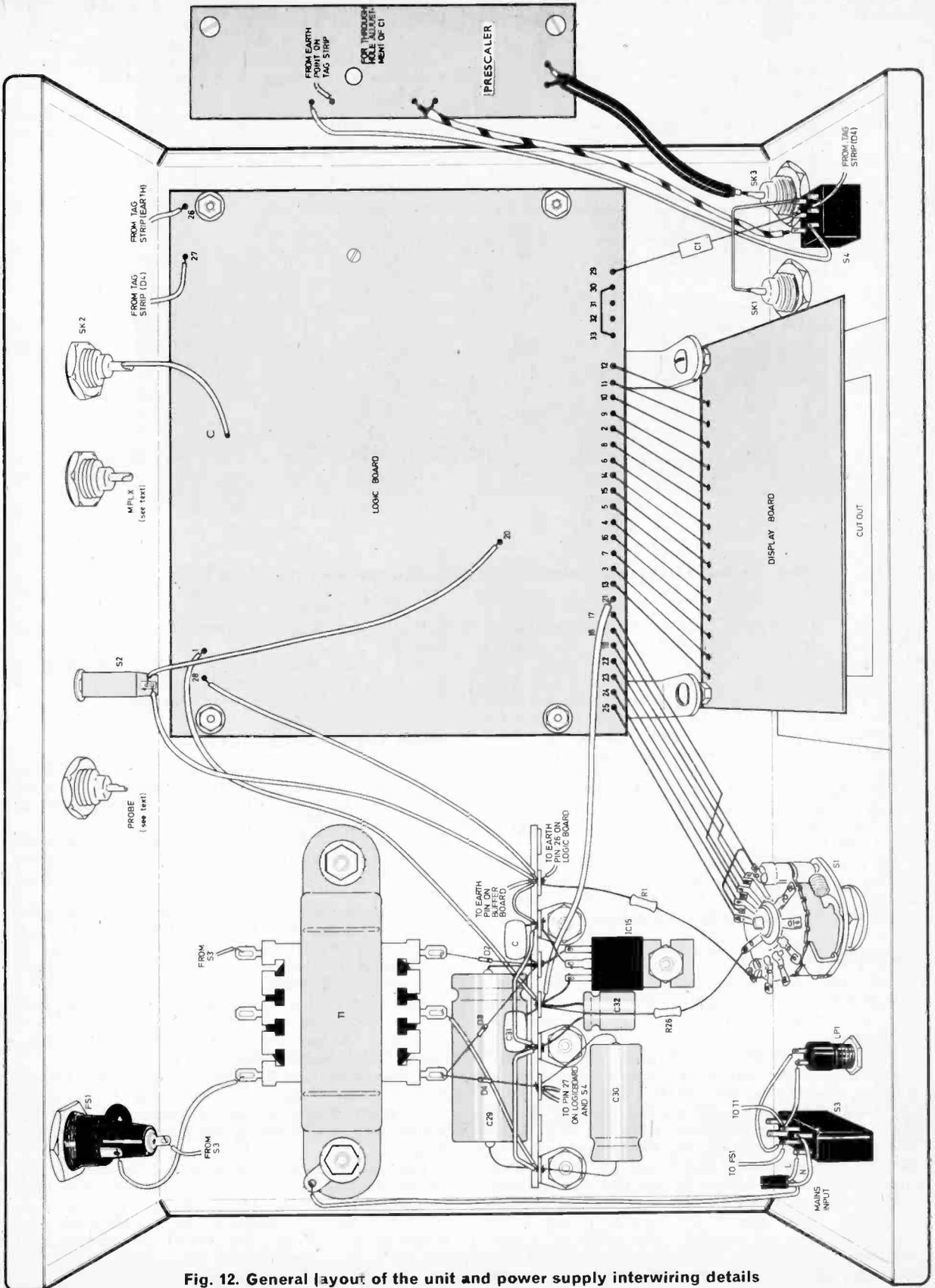
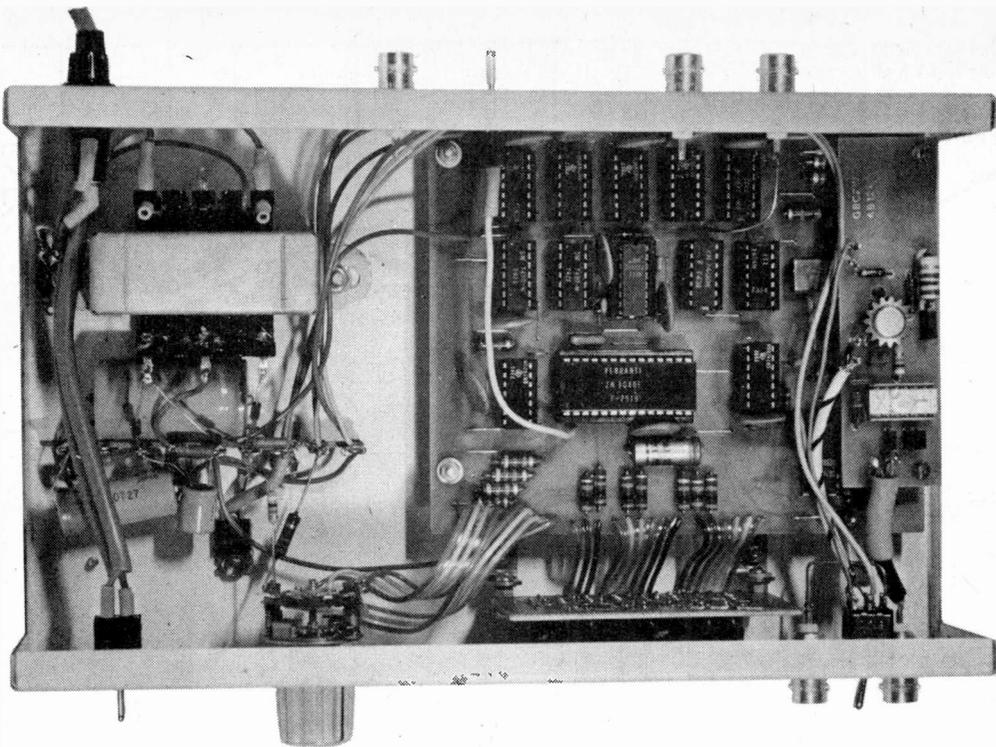


Fig. 12. General layout of the unit and power supply interwiring details



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	100k Ω
R38	47k Ω
R39	47k Ω
R40	470k Ω
R41, R42	100 Ω (2 off)
R43	180 Ω
R44	3.8k Ω
R45	6.3k Ω
R46	330 Ω
R47	180 Ω
R48	1.5k Ω
R49	470 Ω
All $\pm 5\%$ $\frac{1}{4}$ or $\frac{1}{2}$ W	

Potentiometer

VR1	2k Ω horizontal skeleton preset
-----	--

Capacitors

C33	0.047 μ F
C34	150pF polystyrene
C35-C40	0.01 μ F disc (6 off)
C41	10 μ F 63V elect
C42	0.1 μ F disc

Transistors

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

Integrated Circuit

IC16	ZN54L90
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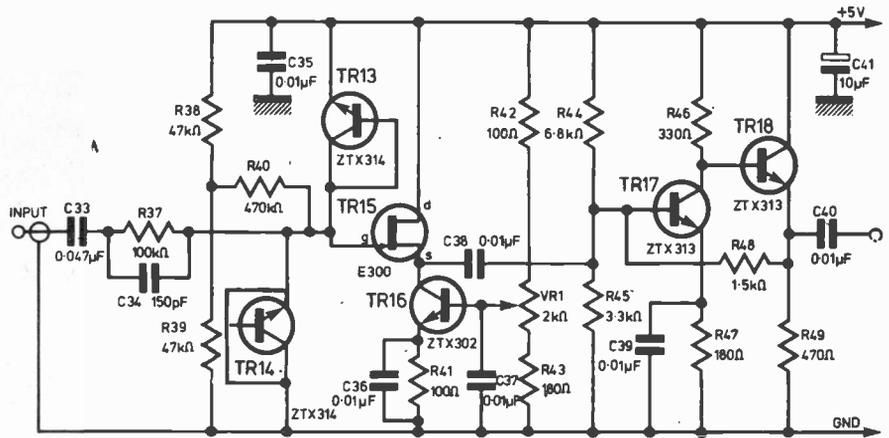


Fig. 13 (a). Circuit diagram of the high impedance buffer

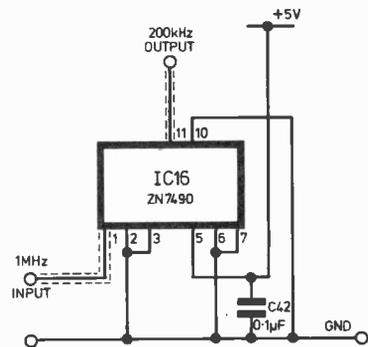


Fig. 13 (b). Circuit diagram of the divider to give the 200kHz calibration signal from the 1MHz available on the main board. Both circuits are mounted on the one board

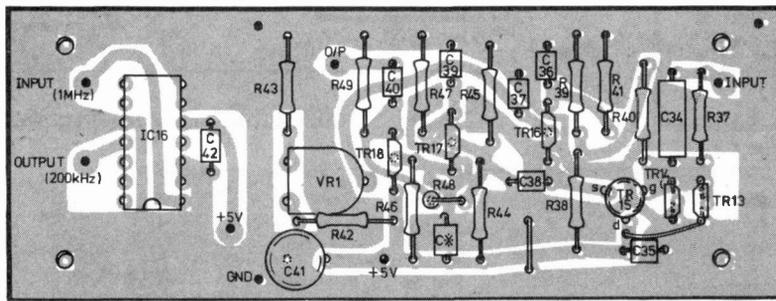


Fig. 14. Layout of the buffer and calibration circuits on the printed circuit board

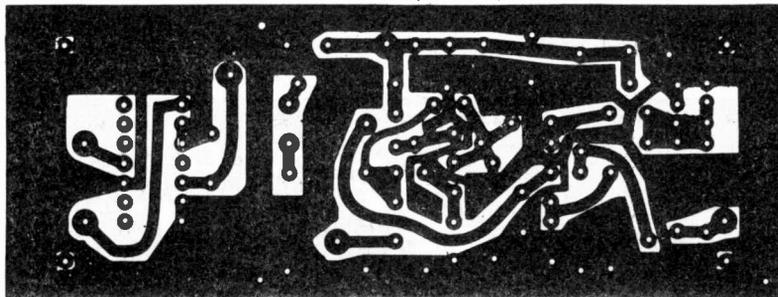


Fig. 15. Full size printed circuit master for the buffer and calibration board

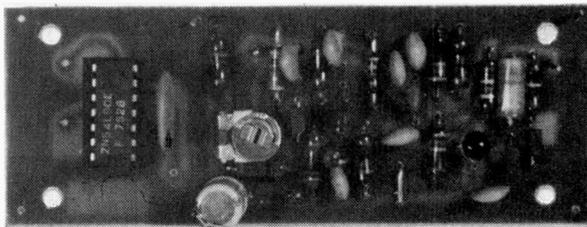
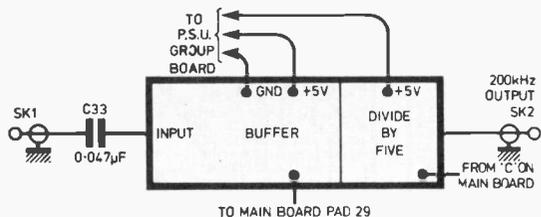


Fig. 16. Connections from the buffer and calibration board to the main unit

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
R51	450Ω
R52	100Ω
R53	100Ω
± 5% ¼W	
Capacitors	
C43-C47	1,000pF (5 off)
C48	0.1µF
Semiconductors	
D5	4.5V 400mW Zener
TR19	2N3053 with heatsink
IC17	SP630

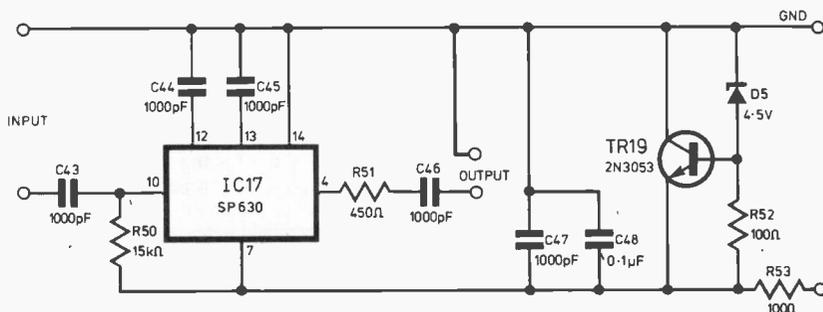


Fig. 17. Circuit diagram of the VHF Prescaler

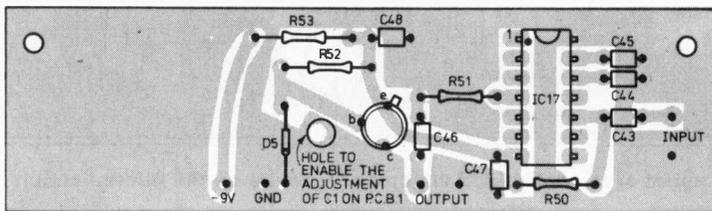


Fig. 18. Layout of the components on the VHF Prescaler board

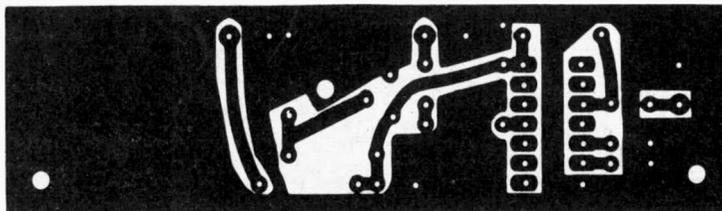


Fig. 19. Full size printed circuit master of the VHF Prescaler board

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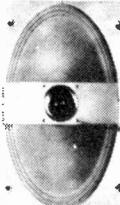
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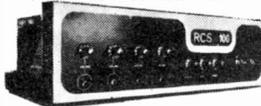
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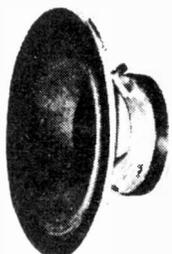
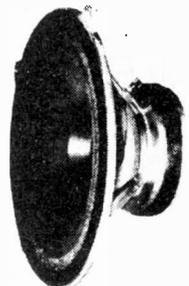
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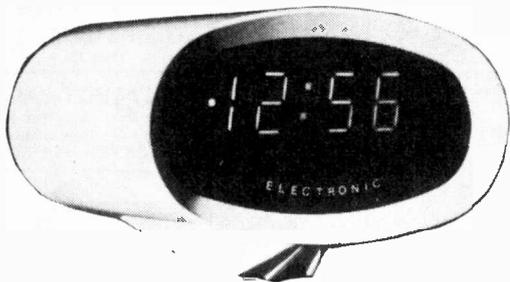
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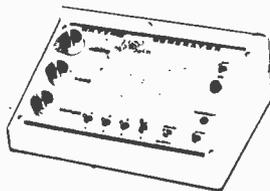
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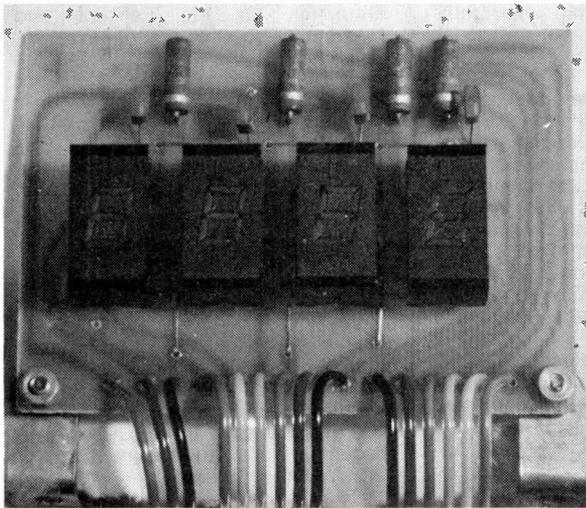
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The display board

PRE-SCALER CONSTRUCTION

In this circuit a 100 ohm $\frac{1}{2}$ 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).

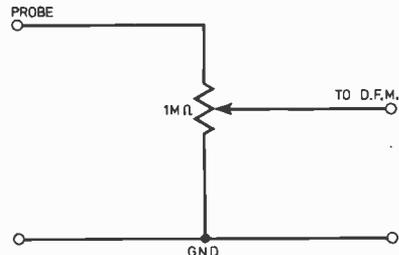


Fig. 20. A potentiometer across the input of the Digital Frequency Meter reduces the loading effects

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. ★

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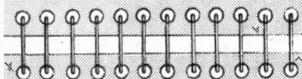
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INDUSTRY NOTEBOOK

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 mouth-piece, 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.

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

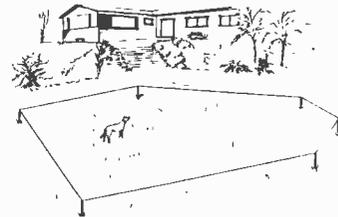


Fig. 1

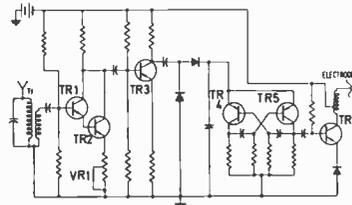


Fig. 2

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.

BP 1 418 006

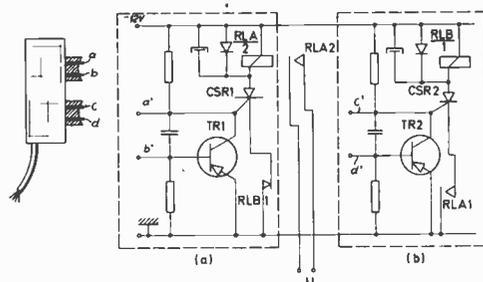


Fig. 1



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BA154 10p BR100-1 39p BY207 27p OA200 13p
BA155 11p BR101 62p BYX10 23p OA202 9p
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SYNTHESISERS AND KEYBOARDS

P.E. JOANNA

(P.E. May to Aug. 1975)

The new electronic piano that has switchable alternative voicing of Piano Honky-Tonk and Harpsichord. All PCB's are "as published".

Power Supply	£7.96
Tone Generator and Top C Envelope Shaper	£9.25
PCB for above	£1.30
Envelope Shapers	£32.16
12 sets (full requirement)	£15.00
Set of 12 PCB's (full requirement)	£8.37
Voicing and Pre-Amplifier Circuits	£1.84
PCB for above circuits	£14.50
Power Amplifier	95p
PCB for power amp	

KEYBOARDS

Kimber-Allen Keyboards as required for many published circuits, including the P.E. Joanna, P.E. Minisonic and P.E. Synthesiser. The manufacturers claim that these are the finest moulded plastic keyboards made.

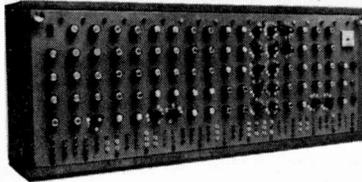
3 Octave Keyboard (37 notes C to C)	£20.50
4 Octave Keyboard (49 notes C to C)	£23.50
5 Octave Keyboard (61 notes C to C)	£27.00

Contact Assemblies for use with above keyboards: Single-pole change-over (SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally-open make-break (2P) as for P.E. Synthesiser. Special contact assembly (4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables the same keyboard to be used with the P.E. Synthesiser, P.E. Minisonic, and P.E. Synthesiser simultaneously thus avoiding the cost of more than one keyboard.

	3 Octave	4 Octave	5 Octave
Contact Each Set	Set	Set	Set
SP	20p	£7.40	£9.80
2P	24p	£8.88	£11.76
4PS	48p	£17.76	£23.52
			£29.28

Printed Circuit Boards for use with the above contacts and thus eliminating most of the inter-wiring required, are available—details in our lists.

PHONOSONICS



P.E. SYNTHESISER

(P.E. Feb. 1973 to Feb. 1974)

The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. All function circuits may be used independently, or interconnected. The greater the number of circuits, the greater the versatility. Other circuits in our lists may be used with the Synthesiser to good advantage.

THE MAIN SYNTHESISER

Stabilised Power Supply	£12.05
Two Linear Voltage Controlled Oscillators and one Inverter—all 3 circuits:	£16.38
PCB (2 are required)—each	£1.48
Two Ramp Generators and Two Input Amplifiers—all 4 circuits	£5.62
PCB (holds all 4 circuits)	£1.38
Sample-and-Hold and Noise Generator—PCB (holds both circuits)	£6.64
Tone Control, £2.43	PCB, 80p
Reverbation Amplifier	£6.36
Spring Line unit for Reverb Amp	£4.95
Ring Modulator	£3.75
Peak Level Meter Circuit	£1.50
100µA Panel Meter	
PCB for Rev., R-Mod. & Meter Ccts., Envelope Shaper, £5.33;	PCB, £1.46
Voltage Controlled Amp. and Diff. Amp.	£6.96
PCB (holds both circuits)	£1.32

THE SYNTHESISER KEYBOARD CIRCUITS	
Can be used without the Main Synthesiser to make an independent musical instrument)	
2 Log. Voltage Controlled Oscillators	£14.55
PCB for both log VCO's	£2.60
Divider, 2 Hold Circuits, 2 Modulation Amplifiers, Mixer and 2 Envelope Shapers	£19.64
PCB (Holds the first 6 circuits)	£1.80
PCB for both Envelope Shapers	£1.35
Keyboard Stabilised Power Supply	£7.30
Printed Circuit Board	94p



P.E. MINISONIC

(P.E. Nov. 1974 to March 1975)

A portable, battery or mains operated, miniature sound synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser, the functions offered by this design give it great scope and versatility.

Two Voltage Controlled Oscillators	£5.22
Voltage Controlled Filter	£3.41
and Voltage Reference Circuit	
Two Envelope Shapers and Two Voltage Controlled Amplifiers	£7.28
Keyboard Controller and Hold Circuits	£2.66
Keyboard Divider Resistors (select type to suit keyboard used, all are 2% tolerance), 2 Octave, £1; 3 Oct., £1.48; 4 Oct., £1.96; 5 Oct., £2.44.	
H.F. Oscillator and Detector	£1.66
Ring Mod., Noise Gen. & Env. Inverter	£5.27
Two Power Amplifiers and Two Mixers	£3.55
Battery Eliminator	£5.88
Temperature Stabiliser	£1.47
PCB to hold 2 VCOs, VCF and V-Ref	£2.02
PCB to hold 2 ESs, 2 VCAs, 2 Mixers, Ring Mod, Keyboard Control and Hold	£2.20
PCB to hold 2 Power Amps, Noise Gen, Envelope-Inverter, HF Osc. and Detector	£1.45
PCB for Battery Elim. & Temp. Stab.	£1.35

FOR ADDRESS, INFORMATION REGARDING POST AND PACKING VAT, LISTS, AND EXPORT TERMS SEE OUR ADVERTISEMENT ON OPPOSITE PAGE

Photos: 2 of our units containing some of the P.E. projects built from our kits and PCBs. (The cases were built by ourselves and are not for sale.)

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Mini Bulk Offers

All devices brand new and full spec. All prices include VAT.

1N4001/2	32p/10	BC108	85p/10
1N4003/4/5	48p/10	BC109	85p/10
1N4006/7	50p/10	BC212	95p/10
1N4148	20p/10	BFY50	£1.50/10
BC107	85p/10		£1.50/10

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Jumbo display comm. anode	£2-75/2
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ELECTRONICS POCKET BOOK by P. J. McGoldrick. Price £4.15.

T.T.L. COOKBOOK by D. Lancaster. Price £5.80.

WORLD RADIO TV HANDBOOK 1976 Price £5.

LINEAR I/C DATA AND COMPARISON TABLES Price £3.

THE POCKET CALCULATOR GAME BOOK by E. Schlossberg. Price £3.40.

THE RADIO AMATEUR'S HANDBOOK 1976 by A.R.R.L. Price £4.85.

RADIO VALVE AND SEMICONDUCTOR DATA by A. M. Ball. Price £2.50.

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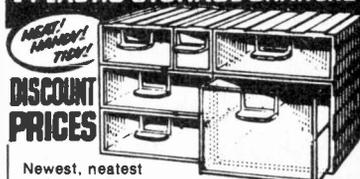
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SOUND-TO-LIGHT (P.E. Apr./Aug. 71)
The ever-popular AURORA—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A MUST for any Disco, and a fascinating visual display for the home.

4 channel component set (excl. thyristors) £13.05
8 channel component set (excl. thyristors) £22.56
Power supply component set £4.96
PCB for 4 frequency channels £3.32
PCB for power supply and 8 lamp drivers £1.56
1 Amp 400V thyristors (1 per chan. requ.) each 75p
Panel meter (1µA) (optional) £3.75

VOICE OPERATED FADER (P.E. Dec. 73)
For automatically reducing music volume during "talk-over" particularly useful for Disco work or for home-movie shows.

Component set incl. PCB £3.05

TAPE-NOISE LIMITER
Very effective circuit for reducing the hiss found in most tape recordings.

Component set (incl. PCB) £2.60
Regulated power supply (incl. PCB) £3.98

P.E. MINIMIX 6

DETAILS IN LIST

GUITAR EFFECTS PEDAL (P.E. July 75)
Will modify an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range.

Component set with special foot operated switches £6.25
Alternative component set with panel mounting switches £4.60
Printed Circuit Board £1.30

HI-FI TAPE-LINK (P.E. Mar./Apr. 73)
Designed for use with reasonable quality tape-decks, this high performance pre-amp includes record, playback and metering circuits. While stocks last.

Stereo component set (excl. panel meter) £24.25
Mono component set (excl. panel meter) £14.70
Power supply component set £5.93
Stereo main PCB £2.80
Stereo sub-assembly PCB 98p

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.

Transistors	BFY51	22p	2N3055	48p
AC128	20p	BFY52	24p	2N3702
AC176	20p	BSY95A	22p	2N3703
BC107	13p	MJE2955	110p	2N3704
BC108	13p	OC28	60p	2N3819
BC109	13p	OC71	14p	2N3822E
BC147	12p	OC72	14p	2N4871
BC148	12p	OC84	25p	2N5245
BC149	12p	ORP12	66p	2N5777
BC157	13p	ZTX107	12p	
BC158	13p	ZTX108	73p	
BC159	13p	ZTX501	13p	
BC182L	12p	ZTX503	15p	
BC184	12p	ZTX531	33p	
BC187	25p	2N4001	4p	
BC204	14p	2N706	13p	
BC209C	14p	2N914	22p	
BC212L	15p	2N1304	22p	
BC213	15p	2N2905	27p	
BC478	29p	2N2907	22p	
BCY71	22p	2N3053	18p	
BFY50	22p	2N3054	66p	
			Z5171	16p

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
PCB for above circuits (double-sided) £2.94
Component set for all 8 effects circuits £10.49
Set of PCB's to hold all 8 effects £3.60
Simple mixer (no PCB available) £2.76
Alternative mixer with external volume controls and adjustable gain (independently designed), including PCB £9.93
Power Supply, including PCB £6.42

SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.
Component set for above functions (excl. SWs) £6.58
Printed circuit board £1.58
Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.
Component set (incl. PCB) £2.55

PHASING UNIT (P.E. Sept. 73)

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

POWER SUPPLIES

Sophisticated low-noise highly-stabilised power supply kits complete with PCB's and detailed information are now available. Details in list.

Other PCBs (all "as published") While stocks last
Bench Power Supply (P.E. Sept. 1974) 70p

CCTV:
Master Logic, Video Amp., Sync Mixer and Cathode Switch PCB (P.E. Oct. 1974) £2.20
PCB for remaining Circuits (P.E. Oct. 1974) £2.20
Digital Power Supply (P.E. Aug. 1972) 50p

Electronic Piano:
Pre-amp PCB (P.E. Oct. 1972) 85p
Power Supply PCB (P.E. Oct. 1972) 60p

Power Slaves: Power Supply PCB (P.E. Aug. 1974) 55p

Rondo:
Pre-Amp PCB (P.E. Oct. 1973) 60p
Tone, Balance and Volume Control PCB (P.E. Oct.) £1.40

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

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

Pre-Amplifier Module £3.71
Component set and PCB

Basic Output Circuits
Combined component set with PCBs, for alphaphone cardiophone, frequency meter and visual feedback lamp driver circuits £5.39

Audio Amplifier Module £5.50
Type PC7

SINE AND SQUARE WAVE GENERATOR (P.E. July 75)

Suitable for audio, digital, or general purpose. Controllable through 4 decade ranges 10Hz to 100kHz. Switched attenuation through 10 ranges from 10V to 1mV peak-to-peak.
Component set £8.88
PCB for above components £1.60
Power Supply £5.70
PCB for Power Supply 96p

P.E. TUNING FORK

(P.E. NOVEMBER, 1975)
Main component set incl. PCB £13.50
Power supply set incl. PCB £6.57

REVERBERATION UNIT (P.V. Nov./Dec. 72)

A high quality unit having microphone and line input pre-amps, and providing full control over reverberation level.
Component set (excl. spring unit) £7.55
Printed circuit board £1.76
9 inch spring unit £4.95
Panel meter (50µA) (optional) £3.75

SEMI-CONDUCTOR TESTER (P.E. Oct. 73)

Essential test equipment for the enterprising home constructor. While stocks last.
Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB £8.44
Panel meter (500µA) £3.75

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For colour and B & W, an indispensable dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage. While stocks last.
Component set (excl. meter) £10.72
Printed Circuit Board £1.74
Panel meter (1mA) £3.75

P.E. SYNCHRONOME

(P.E. MARCH, 1976)
COMPONENT SET £10.20
PRINTED CIRCUIT BOARD £1.70

PHOTOCOPIES

Of P.E. texts for most of our kits are available. Prices in our lists.

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LIST
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Add 12½% (or current rate if different) to full total of goods, post and handling.
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Overseas—will be charged extra. minimum charge 74p. Details of kit weights, and postage rates will be sent with list.
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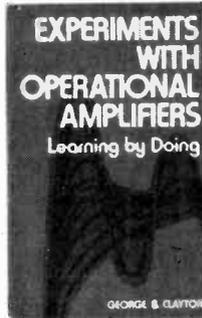
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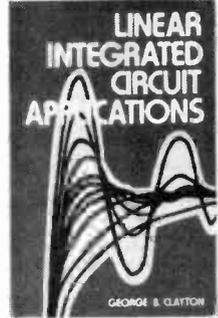
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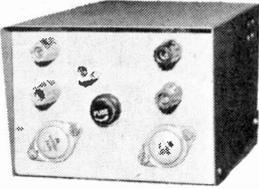
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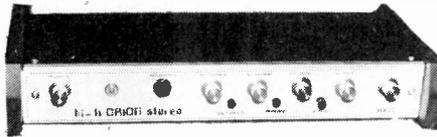
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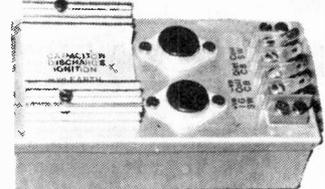
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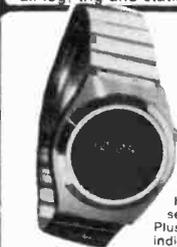
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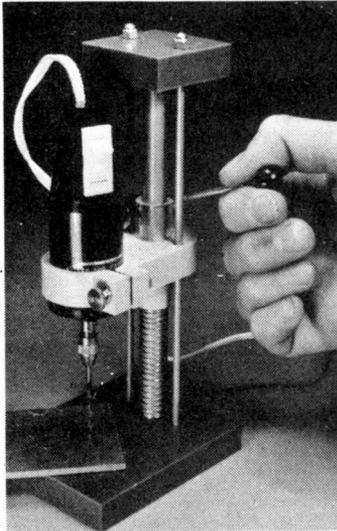
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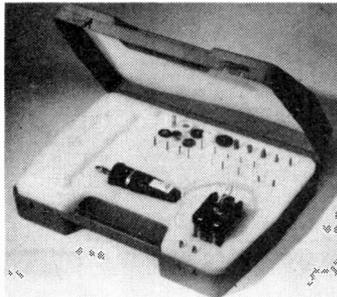
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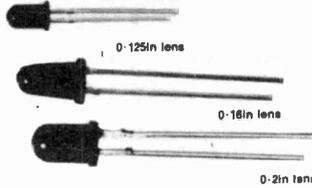
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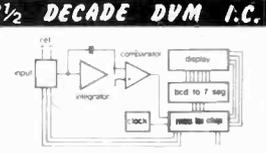
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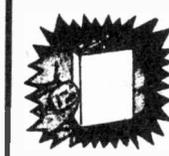
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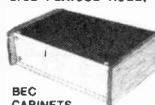
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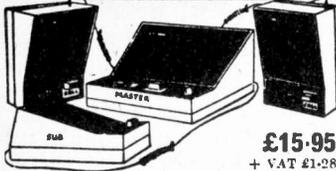
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7409	22p	7498	116p	MC14500	Dual Op. Amp. 8 pin DIL	75p	OP/O ELECTRONICS	AF139	MJE3055	70p	2N3704/5	14p
7410	15p	7497	32p	NE536T	FET Op. Amp. TO99	300p	OCF70	AF239	MPSA06	37p	2N3706	12p
7411	25p	74110	64p	LINEAR ICs			OCF71	BC107/8	MPSA12	56p	2N3707	14p
7412	25p	74118	90p	CA3028	Diff. Cascade Amp.	112p	OCF72	BC149/8	MPSA12	56p	2N3708/9	11p
7413	34p	74121	32p	CA3046	5 Transistor Array	62p	OCF73	BC147/9	MPSA12	56p	2N3709	14p
7414	85p	74122	53p	CA3048	Quad Low Noise Amps.	250p	ORP60	BC149/8	MPSA12	56p	2N3866	90p
7415	32p	74123	79p	CA3089E	FM IF System 18 DIL	250p	ORP61	BC157	OC35	70p	2N3904	32p
7417	32p	74126	76p	CA3090AQ	FM Stereo Decoder	450p	2N5777	BC157	OC41/2	20p	2N3905/6	32p
7420	15p	74128	90p	ICL8038CC	VCO Funct. Gen.	300p	SCR-THYRISTORS	BC158/9	OC44/5	20p	2N4058	17p
7422	19p	74132	76p	LM380	2W Audio Amp	115p	1A 50V T05	BC169C	OC71	20p	2N4060	17p
7423	36p	74136	81p	LM381	Stereo Pre Amp.	200p	1A 100V T05	BC177	OC72	25p	40361	43p
7425	33p	74141	70p	MC1310P	FM Stereo Dec.	200p	1A 400V T05	BC178	OC83	35p	40360	40p
7427	40p	74145	76p	MC1495L	Multiplexer	360p	3A 100V Stud	BC182/3	OC28	85p	40361	41p
7430	15p	74148	17p	MC1498L	Bal Mod/Demod.	100p	3A 400V Stud	BC184	TIP29A	45p	40362	45p
7432	28p	74150	135p	MFC4000B	iW Audio Amp	75p	7A 400V	BC187	TIP30A	54p	40410	59p
7437	28p	74151	77p	MFC8040	Electronic Attenuator	140p	7A 400V	BC212	TIP31A	56p	40411	243p
7440	15p	74153	92p	NE555V	Timer 8 pin DIL	40p	T05 + HS	BC213	TIP32A	63p	40584	81p
7441	70p	74154	164p	NE556	Dual 555 14 pin DIL	108p	16A 100V Plastic	BC214	TIP33A	97p	40595	92p
7442	84p	74155	82p	NE561B	PLL with AM Demod.	350p	16A 400V Plastic	BC217	TIP34A	124p	FETA	
7443	130p	74156	82p	NE562B	PLL with VCO	350p	16A 800V Plastic	BCY70	TIP35A	243p	BF244	40p
7444	130p	74160	107p	NE565	PLL	216p	16A 800V Plastic	BCY71	TIP36A	297p	MPF102	34p
7445	100p	74162	107p	NE568V	PLL Function Gen.	200p	4A 100V	BD131	TIP41A	70p	MPF103/4	34p
7447	81p	74183	107p	NE567V	PLL Tone Decoder	200p	10 amp	BD132	TIP42A	78p	MPF105	34p
7448	75p	74164	130p	2567	Dual 567	400p	3 amp	BD135	ZTX108	11p	2N3819	25p
7450	16p	74166	136p	SN72733	Video Amp	150p	6 amp	BD139	ZTX300	15p	2N3820	50p
7451	16p	74174	130p	SN78013N	Pwr. Audio Amp + HS	175p	10 amp	BD140	ZTX500	17p	2N3823	54p
7453	17p	74175	92p	SN78023N	Pwr. Audio Amp + HS	175p	15 amp	BF115	ZTX504	54p	2N5457	34p
7454	18p	74176	130p	TBA491B	Audio Amp	275p	BR100	BF125	2N697	14p	2N5458/9	34p
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7470	28p	74180	108p	TBA810	7W Audio Amp	125p	BY100	BF195	2N706	13p	3N140	92p
7472	27p	74181	322p	TBA820	2W Audio Amp	100p	1A 50V	BF196	2N708	19p	3N141	81p
7473	32p	74182	89p	TBA820	2W Audio Amp	100p	1A 100V	BF197	2N830	15p	3N187	28p
7474	32p	74185	146p	TDA2020	20W Audio Amp.	375p	1A 400V	BF200	2N1131/2	19p	3N202	130p
7475	48p	74190	155p	XR2240	Prog./Timer Counter	400p	1A 200V	BF220	2N1304/5	23p	40603	63p
7478	32p	74192	130p	ZN414	TRF Radio Receiver	140p	1A 800V	ZENERS	2N1306	30p	40673	63p
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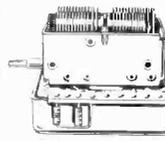
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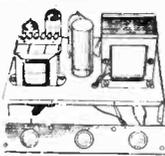
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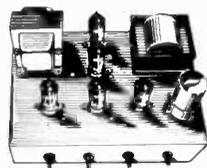
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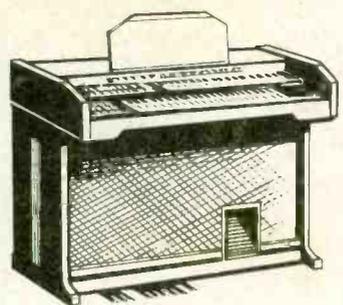


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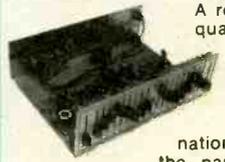
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