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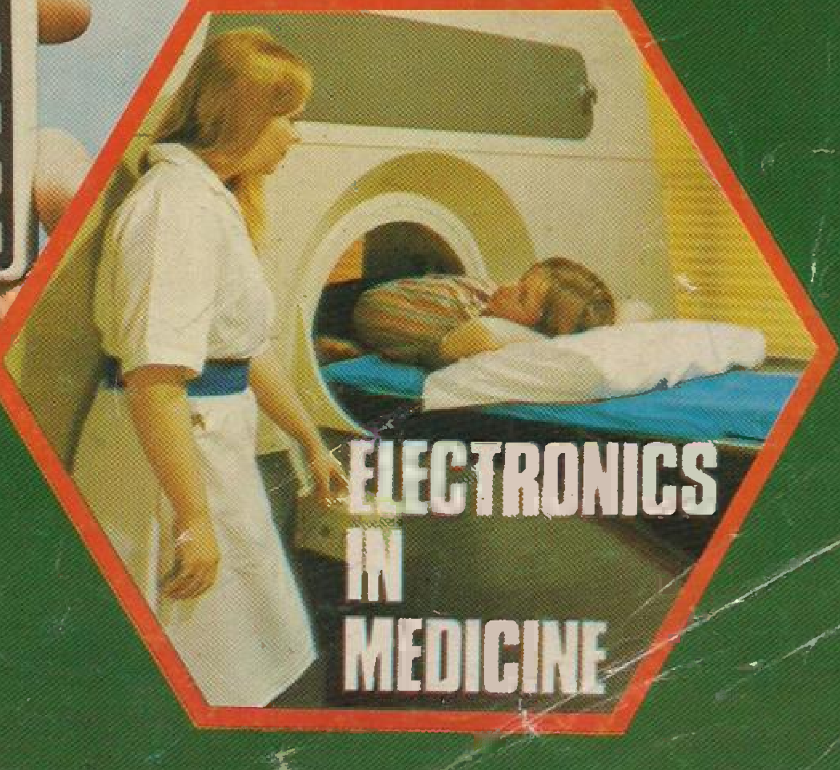

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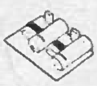
POWER AMPS

SS103



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SS103-3

Stereo version of above. (Two I.Cs.) **£3.25**

NEW! SS105 Mk. 2

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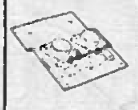
SS140



Beautifully designed. Will give up to 40w R.M.S. into 4Ω. Excellent S.N.R. and transient response. Fine for P.A., disco use, etc. Operates from 45V DC. Two in bridge formation will give 80w R.M.S. into 8Ω. **£3.60**

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SS101

Pre-amp for stereo ceramic cartridges, radio and tape. **£1.60**

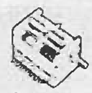
SS102

Pre-amp for low-output stereo magnetic cartridges, radio and tape. **£2.25**

BUILD A STEREO F.M. TUNER

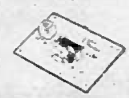
FM Tuners

SS201



Front End assembly. Ganged tuning with well engineered slow-motion geared drive in robust housing. A.F.C. facility. Requires 6-16V. Excellent sensitivity. 88-108mHz. **£6.25**

SS202



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SAVE £5 ON THE S/S TUNER

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- **CP1** Mixed bag of capacitors — Electrolytic, Paper, Silver Mica (Approx. 150 — sold by weight).
- **CP2** 200 (approx.) Resistors, various types, values, watts. (Sold by weight.)
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- **CP4** 12 pots — pre-set w/wound, carbon, dual, with/without switches — all mixed.
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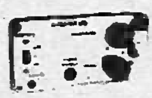

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OCTOBER 1975 Vol. 4. No. 10.

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AC113	0.19	BC172	0.15	BFY50	0.20	2N718A	0.51
AC115	0.20	BC173	0.15	BFY51	0.20	2N726	0.29
AC117K	0.30	BC174	0.15	BFY53	0.20	2N727	0.29
AC122	0.12	BC175	0.22	BFY53	0.18	2N743	0.20
AC125	0.18	BC177	0.19	BSX19	0.16	2N744	0.20
AC126	0.18	BC178	0.19	BSX20	0.16	2N914	0.15
AC127	0.19	BC179	0.19	BSY25	0.16	2N918	0.31
AC128	0.19	BC180	0.25	BSY26	0.16	2N929	0.21
AC132	0.15	BC181	0.25	BSY27	0.16	2N930	0.31
AC134	0.15	BC182	0.15	BSY28	0.16	2N1131	0.20
AC137	0.15	BC182L	0.15	BSY29	0.16	2N1132	0.22
AC141	0.19	BC183	0.15	BSY38	0.19	2N1302	0.15
AC141K	0.30	BC183L	0.15	BSY39	0.19	2N1303	0.15
AC142	0.19	BC184	0.20	BSY40	0.29	2N1304	0.18
AC142K	0.26	BC184L	0.20	BSY41	0.29	2N1305	0.18
AC151	0.16	BC186	0.29	BSY95	0.13	2N1306	0.21
AC154	0.20	BC187	0.29	BSY95A	0.13	2N1307	0.21
AC155	0.20	BC207	0.11	BU105	2.04	2N1308	0.24
AC156	0.20	BC208	0.11	C111E	0.51	2N1309	0.24
AC157	0.25	BC209	0.12	C400	0.31	2N1613	0.20
AC165	0.20	BC212L	0.13	C407	0.26	2N1711	0.20
AC166	0.20	BC213L	0.13	C424	0.26	2N1889	0.32
AC167	0.20	BC214L	0.17	C425	0.51	2N1890	0.46
AC168	0.25	BC225	0.26	C426	0.36	2N1893	0.38
AC169	0.15	BC226	0.36	C428	0.20	2N2147	0.73
AC176	0.20	BC301	0.28	C441	0.31	2N2148	0.58
AC177	0.25	BC302	0.25	C442	0.31	2N2160	0.61
AC178	0.29	BC303	0.31	C444	0.36	2N2192	0.36
AC179	0.29	BC304	0.37	C450	0.22	2N2193	0.36
AC180	0.20	BC440	0.31	MAT100	0.19	2N2194	0.36
AC180K	0.30	BC460	0.37	MAT101	0.20	2N2217	0.22
AC181	0.20	BCY30	0.25	MAT120	0.19	2N2218	0.20
AC181K	0.30	BCY31	0.27	MAT121	0.20	2N2219	0.20
AC187	0.22	BCY32	0.31	MJE521	0.56	2N2220	0.22
AC187K	0.23	BCY33	0.22	MJE2955	0.88	2N2221	0.20
AC188	0.22	BCY34	0.26	MJE3055	0.57	2N2222	0.20
AC188K	0.23	BCY70	0.15	MJE3440	0.51	2N2368	0.18
ACY17	0.26	BCY71	0.20	MPF102	0.43	2N2369	0.15
ACY18	0.20	BCY72	0.15	MPF104	0.38	2N2369A	0.15
ACY19	0.20	BCZ10	0.20	MPF105	0.38	2N2411	0.25
ACY20	0.20	BCZ11	0.26	OC19	0.36	2N2412	0.25
ACY21	0.20	BCZ12	0.26	OC20	0.65	2N2646	*0.48
ACY22	0.17	BD115	0.63	OC22	0.47	2N2711	0.21
ACY27	0.19	BD116	0.81	OC23	0.49	2N2712	0.21
ACY28	0.19	BD121	0.61	OC24	0.57	2N2714	0.21
ACY29	0.36	BD123	0.67	OC25	0.39	2N2904	0.15
ACY30	0.29	BD124	0.70	OC26	0.30	2N2904A	0.21
ACY31	0.29	BD131	0.51	OC28	0.51	2N2905	0.21
ACY34	0.21	BD132	0.61	OC29	0.51	2N2905A	0.21
ACY35	0.21	BD133	0.67	OC35	0.43	2N2906	0.16
ACY36	0.29	BD135	0.41	OC36	0.51	2N2906A	0.19
ACY40	0.18	BD137	0.46	OC41	0.20	2N2907	0.20
ACY41	0.19	BD138	0.51	OC42	0.25	2N2907A	0.22
ACY44	0.36	BD139	0.56	OC44	0.16	2N2923	0.15
AD130	0.39	BD140	0.61	OC45	0.13	2n2924	0.15
AD140	0.49	BD155	0.81	OC70	0.10	2N2925	0.15
AD142	0.49	BD175	0.61	OC71	0.10	2N2926G	0.13
AD143	0.39	BD176	0.61	OC72	0.15	2N2926Y	0.11
AD149	0.51	BD177	0.67	OC74	0.15	2N2926O	0.10
AD161	0.36	BD178	0.67	OC75	0.16	2N2926R	0.10
AD162	0.36	BD179	0.71	OC76	0.16	2N2926B	0.10
AD161 &		BD180	0.71	OC77	0.26	2N3091	0.71
AD162(MP)	0.69	BD185	0.67	OC81	0.16	2N3011	0.15
ADT140	0.51	BD186	0.67	OC81D	0.16	2N3053	0.18
AF114	0.25	BD187	0.71	OC82	0.16	2N3054	0.47
AF115	0.25	BD188	0.71	OC82D	0.16	2N3055	0.42
AF116	0.25	BD189	0.77	OC83	0.20	2N3319	0.15
AF117	0.25	BD190	0.77	OC139	0.20	2N3391A	0.17
AF118	0.36	BD195	0.87	OC140	0.20	2N3392	0.15
AF124	0.31	BD196	0.87	OC169	0.26	2N3393	0.15
AF125	0.31	BD197	0.92	OC170	0.26	2N3394	0.15
AF126	0.29	BD198	0.92	OC171	0.26	2N3395	0.18
AF127	0.29	BD199	0.98	OC200	0.26	2N3402	0.21
AF139	0.31	BD200	0.98	OC201	0.29	2N3403	0.21
AF178	0.51	BD205	0.81	OC202	0.29	2N3404	0.29
AF179	0.51	BD206	0.81	OC203	0.26	2N3405	0.34
AF180	0.51	BD207	0.98	OC204	0.26	2N3414	0.16
AF181	0.51	BD208	0.98	OC205	0.36	2N3415	0.16
AF186	0.51	BDY20	1.02	OC309	0.41	2N3416	0.29
AF239	0.38	BF115	0.25	OCP71	*0.44	2N3417	0.29
AL102	0.68	BF117	0.46	ORP12	*0.44	2N3525	*0.77
AL103	0.68	BF118	0.71	ORP60	*0.41	2N3614	0.69
ASY26	0.26	BF119	0.71	ORP61	*0.41	2N3615	0.76
ASY27	0.31	BF121	0.46	P20	*0.51	2N3616	0.76
ASY28	0.26	BF123	0.51	P346A	0.20	2N3646	0.09
ASY29	0.26	BF125	0.46	P397	0.43	2N3702	0.12
ASY50	0.26	BF127	0.51	ST140	0.13	2N3703	0.12
ASY51	0.26	BF152	0.46	ST141	0.18	2N3704	0.13
ASY52	0.26	BF153	0.46	TIP29	0.44	2N3705	0.12
ASY54	0.26	BF154	0.46	TIP30	0.52	2N3706	0.12
ASY55	0.26	BF155	0.71	TIP31A	0.56	2N3707	0.13
ASY56	0.26	BF156	0.49	TIP32A	0.68	2N3708	0.08
ASY57	0.26	BF157	0.56	TIP41A	0.68	2N3709	0.09
ASY58	0.26	BF158	0.56	TIP42A	0.81	2N3710	0.09
ASY73	0.26	BF159	0.61	TIS43	*0.31	2N3711	0.09
ASZ21	0.41	BF160	0.41	UT46	*0.28	2N3819	0.29
BC107	0.08	BF162	0.41	ZN414	1.11	2N3820	0.51
BC108	0.05	BF163	0.41	2G301	0.19	2N3821	0.36
BC109	0.08	BF164	0.41	2G302	0.19	2N3823	0.29
BC113	0.16	BF165	0.41	2G303	0.19	2N3903	0.29
BC114	0.16	BF167	0.22	2G304	0.25	2N3904	0.31
BC115	0.16	BF173	0.22	2G306	0.41	2N3905	0.29
BC116	0.16	BF176	0.36	2G308	0.36	2N3906	0.28
BC117	0.19	BF177	0.36	2G309	0.37	2N4058	0.12
BC118	0.10	BF178	0.31	2G339	0.20	2N4059	0.10
BC119	0.31	BF179	0.31	2G339A	0.17	2N4060	0.12
BC120	0.81	BF180	0.31	2G344	0.19	2N4061	0.12
BC125	0.12	BF181	0.31	2G345	0.17	2N4062	0.12
BC126	0.19	BF182	0.41	2G371	0.17	2N4284	0.18
BC132	0.12	BF183	0.41	2G371B	0.12	2N4285	0.18
BC134	0.19	BF184	0.26	2G373	0.18	2N4286	0.18
BC135	0.12	BF185	0.31	2G374	0.18	2N4287	0.18
BC136	0.16	BF187	0.28	2G377	0.31	2N4288	0.18
BC137	0.16	BF188	0.41	2G378	0.17	2N4289	0.18
BC139	0.41	BF194	0.12	2G381	0.17	2N4290	0.18
BC140	0.31	BF195	0.12	2G382	0.17	2N4291	0.18
BC141	0.31	BF196	0.15	2G401	0.31	2N4292	0.18
BC143	0.31	BF197	0.15	2G414	0.31	2N4293	0.18
BC145	0.46	BF200	0.46	2G417	0.26	2N5172	0.12
BC147	0.10	BF222	0.98	2N388	0.36	2N5194	0.56
BC148	0.10	BF257	0.46	2N388A	0.56	2N5294	0.56
BC149	0.12	BF258	0.61	2N404	0.20	2N5296	0.56
BC150	0.19	BF259	0.87	2N404A	0.29	2N5457	0.32
BC151	0.20	BF262	0.56	2N524	0.43	2N5458	0.32
BC152	0.18	BF263	0.56	2N527	0.50	2N5459	0.41
BC153	0.29	BF270	0.36	2N598	0.43	2N6122	0.69
BC154	0.31	BF271	0.31	2N599	0.46	2S301	0.51
BC157	0.19	BF272	0.81	2N696	0.13	2S302A	0.43
BC158	0.12	BF273	0.36	2N697	0.14	2S302	0.43
BC159	0.12	BF274	0.36	2N698	0.25	2S303	0.56
BC160	0.46	BFW10	0.61	2N699	0.36	2S304	0.71
BC161	0.51	BFX29	0.28	2N706	0.08	2S305	0.80
BC167	0.12	BFX84	0.22	2N706A	0.09	2S306	0.80
BC168	0.12	BFX85	0.31	2N708	0.12	2S307	0.80
BC169	0.12	BFX86	0.22	2N711	0.31	2S321	0.75
BC170	0.12	BFX87	0.25	2N717	0.36	2S322	0.43

* 74 SERIES T.T.L. I.C.'s

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
7400	0.14	0.13	0.12	7486	0.32	0.31	0.30
7401	0.14	0.13	0.12	7489	3.70	3.47	3.24
7402	0.14	0.13	0.12	7490	0.60	0.58	0.56
7403	0.14	0.13	0.12	7491	1.02	0.97	0.93
7404	0.14	0.13	0.12	7492	0.69	0.66	0.59
7405	0.14	0.13	0.12	7493	0.69	0.66	0.59
7406	0.36	0.31	0.29	7494	0.79	0.76	0.69
7407	0.36	0.31	0.29	7495	0.79	0.76	0.69
7408	0.23	0.22	0.21	7596	0.89	0.86	0.80
7409	0.23	0.22	0.21	74100	1.39	1.34	1.30
7410	0.14	0.13	0.12	74104	0.56	0.54	0.51
7411	0.23	0.22	0.21	74105	0.56	0.54	0.51
7412	0.26	0.25	0.24	74107	0.41	0.39	0.37
7413	0.30	0.29	0.28	74110	0.56	0.51	0.46
7416	0.28	0.27	0.26	74111	0.83	0.81	0.78
7417	0.28	0.27	0.26	74118	0.93	0.88	0.83
7420	0.14	0.13	0.12	74119	1.39	1.30	1.20
7422	0.28	0.27	0.26	74121	0.46	0.44	0.41
7423	0.37	0.36	0.35	74122	0.65	0.63	0.60
7425	0.37	0.36	0.35	74123	0.69	0.68	0.65
7426	0.37	0.35	0.33	74141	0.79	0.76	0.73
7427	0.37	0.35	0.33	74145	1.20	1.16	1.11
7428	0.42	0.39	0.37	74150	1.39	1.30	1.20
7430	0.14	0.13	0.12	74151	1.02	0.97	0.93
7432	0.37	0.35	0.33	74153	0.93	0.88	0.83
7433	0.39	0.37	0.35	74154	1.57	1.43	1.48
7437	0.32	0.30	0.28	74155	1.11	1.06	1.02
7438	0.32	0.30	0.28	74156	1.11	1.06	1.02
7440	0.14	0.13	0.12	74157	0.93	0.88	0.83
7441	0.69	0.66	0.59	74160	1.30	1.25	1.20
7442	0.69	0.66	0.59	74161	1.30	1.25	1.20
7443	1.11	1.06	1.02	74162	1.30	1.25	1.20
7444	1.11	1.06	1.02	74163	1.30	1.25	1.20
7445	1.48	1.44	1.39	74164	1.67	1.62	1.55
7446	1.11	1.06	1.02	74165	1.67	1.62	1.55
7447	1.02	0.99	0.97	74166	1.48	1.44	1.39
7448	1.02	0.99	0.97	74174	1.48	1.44	1.39
7450	0.14	0.13	0.12	74175	1.02	0.97	0.93
7451	0.14	0.13	0.12	74176	1.16	1.11	1.06
7453	0.14	0.13	0.12	74177	1.16	1.11	1.06
7454	0.14	0.13	0.12	74180	1.16	1.11	1.06
7460	0.14	0.13	0.12	74181	3.66	3.56	3.47
7470	0.30	0.27	0.25	74182	1.16	1.11	1.06
7472	0.30	0.27	0.25	74184	1.67	1.62	1.55
7473	0.38	0.36	0.32	74190	1.81	1.76	1.71
7474	0.38	0.36	0.32	74191	1.81	1.76	1.71
7475	0.56	0.54	0.52	74192	1.81	1.76	1.71
7476	0.41	0.40	0.39	74193	1.81	1.76	1.71
7480	0.56	0.54	0.51	74194	1.20	1.16	1.11
7481	1.02	0.97	0.93	74195	1.02	0.97	0.93
7482	0.83	0.79	0.74	74196	1.11	1.06	1.02
7483	1.11	1.06	0.97	74197	1.11	1.06	1.02
7484	0.93	0.90	0.88	74198	2.55	2.50	2.45
7485	1.48	1.44	1.39	74199	2.31	2.21	2.11

Devices may be mixed to qualify for quantity price (TTL 74 series only) data is available for the above series of I.C.'s in booklet form. PRICE 35p

* D.T.L. 930 SERIES

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
BP930	0.14	0.13	0.12	BP948	0.28	0.26	0.23
BP932	0.15	0.14	0.13	BP951	0.65	0.60	0.56
BP933	0.15	0.14	0.13	BP962	0.14	0.13	0.12
BP935	0.15	0.14	0.13	BP9093	0.42	0.40	0.38
BP936	0.15	0.14	0.13	BP9094	0.42	0.40	0.38
BP944	0.15	0.14	0.13	BP9097	0.42	0.40	0.38
BP945	0.28	0.26	0.23	BP9099	0.42	0.40	0.38
BP946	0.14	0.13	0.12				

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

* THYRISTORS

PIV	0.6A TO18	0.8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	0.13	0.15	—	—	—	—	—	—	—	—
20	0.15	0.18	—	—	—	—	—	—	—	—
30	0.19	0.22	—	—	—	—	—	—	—	—
50	0.22	0.28	0.20	0.25	0.36	0.36	0.48	0.51	0.54	1.18
100	0.25	0.30	0.25	0.25	0.48	0.48	0.51	0.57	0.58	1.43
150	0.31	0.38	—	—	—	—	—	—	—	—
200	0.38	0.44	0.25	0.30	0.50	0.50	0.57	0.62	0.62	1.63
400	—	—	0.30	0.39	0.55	0.57	0.62	0.71	0.77	1.79
600	—	—	0.39	0.48	0.69	0.69	0.78	0.99	0.90	—
800	—	—	0.58	0.65	0.81	0.81	0.92	1.22	1.39	4.07

LINEAR I.C.'s

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
72702	0.46	0.44	0.42	TAA350A	1.71	1.67	1.57
72709	0.23	0.21	0.19	uA703C	0.26	0.24	0.22
72709P	0.19	0.18	0.17	uA709C	0.19	0.18	0.17
72710	0.32	0.31	0.28	uA711C	0.32	0.31	0.28
72741	0.28	0.27	0.26	uA712C	0.32	0.31	0.28
72741C	0.26	0.25	0.24	uA723C	0.45	0.43	0.40
72741P	0.28	0.27	0.26	76003	1.39	1.34	1.30
72747	0.79	0.74	0.61	76023	1.39	1.34	1.30
72748P	0.35	0.33	0.31	76660	0.88	0.86	0.83
SL201C	0.46	0.42	0.37	LM380	0.93	0.90	0.88
SL701C	0.46	0.42	0.37	NE555	0.45	0.43	0.40
SL702C	0.46	0.42	0.37	NE556	0.88	0.86	0.83
TAA263	0.74	0.65	0.56	TBA800	1.39	1.34	1.30
TAA293	0.93	0.88	0.83	ZN414	1.11	—	—

SILICON RECTIFIERS

PIV	(DO7)	300mA (S016)	750mA Plastic	1A (SO16)	1.5A (SO10)	3A (SO10)	10A	30A (TO48)
50	0.05	0.06	IN4001	0.05	0.07	0.14	*0.19	*0.56
100	0.05	0.07	IN4002	0.06	0.09	0.16	*0.21	*0.69
200	0.06	0.09	IN4003	0.07	0.12	0.20	*0.23	*0.93
400	0.07	0.14	IN4004	0.08	0.14	0.28	*0.35	*0.25
600	0.08	0.16	IN4005	0.09	0.16	0.33	*0.42	*1.76
800	0.11	0.18	IN4006	0.10	0.18	0.35	*0.51	*1.94
1000	0.13	0.28	IN4007	0.11	0.23	0.44	*0.80	*2.31
1200		0.32			0.28	0.54	*0.69	*2.88

* TRIACS

	Case	100V	200V	400V
2 Amp	TO5	0.31	0.51	0.73
6 Amp	TO66	0.51	0.61	0.77
10 Amp	TO48	0.77	0.92	1.12

SUPER UNTESTED PAKS

Pak No.	Description	Price
U 1	120 Glass Sumbmin. G.P. Germ. diodes	0.60
U 2	50 Mixed Germanium transistors AF/RF	0.60
U 3	75 Germ. gold bonded sub-min. like OA47	0.60
U 4	30 Germ. transistors like OC81, AC128	0.60
U5	60 200mA sub-min. silicon diodes	0.60
U 6	30 Sil. trans. NPN like BSY95A, 2N706	0.60
U 7	16 Sil. rect. 750mA up to 1000	0.60
U 8	50 Sil. diodes DO-7 250mA like OA200/202	0.60
U 9	20 Mixed voltages, 1 Watt Zener Diodes	0.60
U10	20 BAY50 charge storage diodes DO-7	0.60
U11	20 PNP Sil. trans. TO-5 like 2N1132, 2N2904	0.60
U13	30 PNP-NPN Sil. trans. OC200 & 2S104	0.60
U14	150 Mixed silicon and germ. diodes	0.60
U15	20 NPN Sil. trans. TO-5 like 2N696	0.60
U16	10 3Amp Sil. rect. stud up to 1000 PIV	0.60
U17	30 Germ. PNP AF trans TO-5 like ACY17-22	0.60
U18	8 6 Amp sil rect. BYZ13 tupe up to 600 PIV	0.60
U19	20 Silicon NPN trans. like BC108	0.60
U20	12 1.5 Amp sil. rect. top hat up to 1000 PIV	0.60
U21	30 AF. Germ. trans. 2G300 series & OC71	0.60
U23	25 MADT's like MHz series PNP series	0.60
U24	20 Germ. 1 Amp rect. GJM up to 300 PIV	0.60
U25	25 300MHZ NPN sil. trans. 2N708, BSY27	0.60
U26	30 Fast switching sil. diodes like IN914	0.60
U29	10 1 Amp SCR's TO-5 up to 600 PIV	*1.20
U32	25 Zener diodes 400mW DO-7 3-33 volts mixed	0.60
U33	15 Plastic 1Amp sil. rect. 1N4000 series	0.60
U34	30 Sil. PNP trans. TO-5 BCY26 2S302/4	0.60
U35	25 Sil. trans. PNP TO-18 2N2906	0.60
U36	20 Sil NPN trans. TO-5 BFY50/51/52	0.60
U37	30 Sil. trans. SO-2 PNP OC200, wS322	0.60
U38	30 Fast switch sil. trans. NPN 400MHz	0.60
U39	30 RF.Germ. PNP trans. 2N1301/5 TO-5	0.60
U40	10 Dual trans. 6 lead TO-5 2N2060	0.60
U43	25 Sil. trans. plastic TO-18 BC113/114	0.60
U44	20 Sil. trans. plastic TO-5 BC115	0.60
U45	7 3A SCR. TO66 up to 600 PIV	*1.20
U46	20 Unijunction trans. similar to TIS43	*0.60
U47	10 TO220AB plastic triacs 50V 6A	*1.20
U48	9 NPN sil. power trans. like 2N3055	1.20
U49	12 NPN sil. plastic power 60W like 2N5294	1.20

Code Nos. mentioned above are given as a guide to the type of device in the pak. The devices themselves are normally unmarked.

QUALITY TESTED PAKS

Pak No.		Price £ p
Q 1	20 Red spot transistors PNP	0.60
Q 2	16 White spot R.F. transostors PNP	0.60
Q 3	4 OC77 type transistors	0.60
Q 4	6 Matched transistors OC44/45/81/81D	0.60
Q 5	4 OC75 transistors	0.60
Q 6	5 OC72 transistors	0.60
Q 7	4 AC128 transistors PNP high gain	0.60
Q 8	4 AC126 transistors PNP	0.60
Q 9	7 OC81 type transistors	0.60
Q10	7 OC71 type transistors	0.60
Q11	2 AC127/128 Compmentary pairs PNP/NPN	0.60
Q12	3 AF116 type transistors	0.60
Q13	3 AF117 type transistors	0.60
Q14	3 OC171 H.F. type transistors	0.60
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0.60
Q17	5 NPN 2 x ST141 & 3 x ST140	0.60
Q18	4 MADT's 2 x MAT100 & 2 x MAT120	0.60
Q19	3 MAT's 2 x MAT101 & 1 x MAT121	0.60
Q20	4 OC44 Germanium transistors A.F.	0.60
Q21	4 AC127 NPN Germanium transistors	0.60
Q22	20 NKT transistors A.F. R.F. coded	0.60
Q23	10 OA202 Silicon diodes sub-min	0.60
Q24	8 OA81 diodes	0.60
Q25	15 IN914 Silicon diodes 75PIV 75mA	0.60
Q26	8 OA95 Germanium diodes sumb-min-IN59	0.60
Q27	2 10A 500 PIV Silicon rectifiers 1S425B	*0.60
Q28	2 Silicon power rectifiers BYZ13	*0.60
Q29	4 Sil. transistors 2 x 2N696, 1 x 3N697, 1 x 2N698	0.60
Q30	7 Silicon switch transistors 2N706 NPN	0.60
Q31	6 Silicon switch transistors 2N708 NPN	0.60
Q32	3 PNP Sil. trans. 2 x 2N1131, 1 x 2N1132	0.60
Q33	3 Silicon NPN transistors 2N1711	0.60
Q34	7 Sil. NPN trans. 2N2369, 500MHz (Code P397)	0.60
Q35	3 Silicon PNP TO-5 2 x 2N2904 & 1 x 2N2905	0.60
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	0.60
Q37	3 2N3053 NPN Silicon transistors	0.60
Q38	5 PNP transistors 3 x 2N3703, 2 x 2N3702	0.60
Q39	5 NPN transistors 3 x 2N3704, 2 x 2N3705	0.60
Q40	5 NPN transistors 3 x 2N3707, 2 x 2N3708	0.60
Q41	3 Plastic NPN TO18 2N3904	0.60
Q43	5 BC107 NPN transistors	0.60
Q44	5 NON transistors 3 x BC108, 2 x BC109	0.60
Q45	3 BC113 NPN TO-18 transistors	0.60
Q46	3 BC115 NPN TO-5 transistors	0.60
Q47	4 NPN high gain transistors 2 x BC167, 2 x BC168	0.60
Q48	3 BCY70 PNP transistors TO-18	0.60
Q49	3 NPN transistors 2 x BFY51, 1 x BFY52	0.60
Q50	7 BSY28 NPN switch transistors TO-18	0.60
Q51	7 BSY95A NPN transistors 300MHz	0.60
Q52	8 BY100 type silicon rectifiers	1.20
Q53	25 Sil. & Germ. trans., mixed all marked new	1.50
Q54	6 TIL209 Red LED	*1.20

UNTESTED TTL PAKS *

Pak no	Contents	Price
UIC00	= 12x7400	0.60
UIC01	= 12x7401	0.60
UIC02	= 12x7402	0.60
UIC03	= 12x7403	0.60
UIC04	= 12x7404	0.60
UIC05	= 12x7405	0.60
UIC06	= 8x7406	0.60
UIC07	= 8x7407	0.60
UIC10	= 12x7410	0.60
UIC13	= 8x7413	0.60
UIC20	= 12x7420	0.60
UIC30	= 12x7430	0.60
UIC40	= 12x7440	0.60
UIC41	= 5x7441	0.60
UIC42	= 5x7442	0.60
UIC43	= 5x7443	0.60
UIC44	= 5x7444	0.60
UIC45	= 5x7445	0.60
UIC46	= 5x7446	0.60
UIC47	= 5x7447	0.60
UIC48	= 5x7448	0.60
UIC50	= 12x7450	0.60
UIC51	= 12x7451	0.60
UIC53	= 12x7453	0.60
UIC54	= 12x7454	0.60
UIC60	= 12x7460	0.60
UIC70	= 8x7470	0.60
UIC72	= 8x7472	0.60
UIC73	= 8x7473	0.60
UIC74	= 8x7474	0.60
UIC75	= 8x7475	0.60
UIC76	= 8x7476	0.60
UIC80	= 5x7480	0.60
UIC81	= 5x7481	0.60
UIC82	= 5x7482	0.60
UIC83	= 5x7483	0.60
UIC86	= 5x7486	0.60
UIC90	= 5x7490	0.60
UIC91	= 5x7491	0.60
UIC92	= 5x7492	0.60
UIC93	= 5x7493	0.60
UIC94	= 5x7494	0.60
UIC95	= 5x7495	0.60
UIC96	= 5x7496	0.60
UIC100	= 5x74100	0.60
UIC121	= 5x74121	0.60
UIC141	= 5x74141	0.60
UIC151	= 5x74151	0.60
UIC154	= 5x74154	0.60
UIC193	= 5x74193	0.60
UIC199	= 5x74199	0.60
UICX1	25 Assorted 74s	1.50

VOLTAGE REGULATORS

TO.3 Plastic Encapsulation

μA7805/L129 5V (equiv. to MVR5V)	1.25
μA7812/L130 12V (Equiv. to MVR12V)	1.25
uA7815/L131 15V (Equiv. to MVR15V)	1.25
uA7818 18V (Equiv. to MVR18V)	1.25

ALL PRICES EXCLUDE V.A.T.

Postage & packing add 20p overseas add extra for airmail.

Minimum order 75p

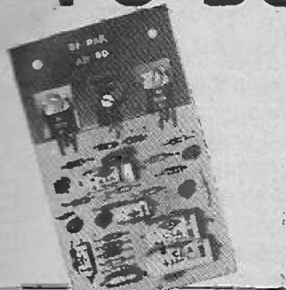
D.I.L. SOCKETS

	1	25	100+
TSO 14 14 pin type	0.31	0.28	0.25
TSO16 16 pin type	0.35	0.32	0.30
TSO24 24 pin type	0.69	0.64	0.62
BPS8 8 pin type (low cost)	0.14	0.12	0.10
BPS14 14 pin type (low cost)	0.15	0.13	0.11
BPS16 16 pin type (low cost)	0.16	0.14	0.12

DIODES

Type	Price	Type	Price
AA119	0.09	BYZ16	0.41
AA120	0.08	BYZ17	0.36
AA129	0.08	BYZ18	0.36
AAY30	0.09	BYZ19	0.28
AAZ13	0.10	CG62	
BA100	0.10	(OA91Eq)	0.06
BA116	0.21	CG651	
BA126	0.22	(OA70-OA79)	
BA148	0.15		0.07
BA154	0.12	OA5 Short	
BA155	0.15	Leads	0.21
BA165	0.14	OA10	0.14
BA173	0.15	OA47	0.07
BB104	0.15	OA70	0.07
BY100	0.16	OA79	0.07
BY101	0.12	OA81	0.07
BY105	0.18	OA85	0.09
BY114	0.12	OA90	0.07
BY124	0.12	OA91	0.07
BY126	0.15	OA95	0.07
BY127	0.16	OA200	0.07
BY128	0.16	OA202	0.07
BY130	0.17	SD10	0.06
BY133	0.21	SD19	0.06
BY164	0.51	IN34	0.07
BYX38/30	0.43	IN34A	0.07
BYZ10	0.36	IN914	0.06
BYZ11	0.31	IN916	0.06
BYZ12	0.31	IN4148	0.06
BYZ13	0.26	1S021	0.10
		1S951	0.07

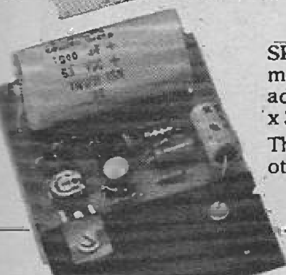
PO BOX 6 WARE HERTS



AL 60 — ONLY £3.95

50w. PEAK (25w. R.M.S.)

● Max Heat Sink temp 90°C ● Frequency Response 20Hz to 100K Hz ● Distortion better than 0.1 at 1KHz ● Supply voltage 15-50 volts ● Thermal Feedback ● Latest Design Improvements ● Load — 3, 4, 5 or 16 ohms ● Signal to noise ratio 80dH ● Overall size 63mm x 105mm x 13mm. Especially designed to a strict specification. Only the finest components have been used and the latest solid state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

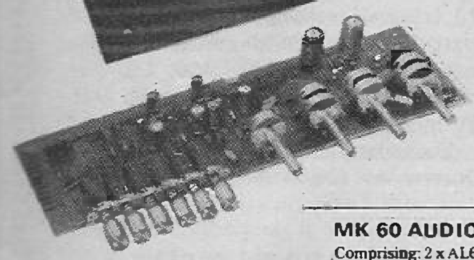


STABILISED POWER MODULE SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm x 105mm x 30mm.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems. Public Address Intercom Units, etc. Handbook available 10p.

TRANSFORMER BMT80 £2.60 — **PRICE £3.00**



STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100 which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

£13.20

MK 60 AUDIO KIT

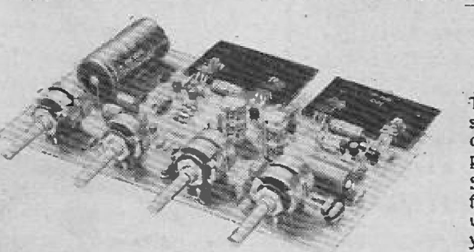
Comprising: 2 x AL60, 1 x SPM80, 1 x BTM80, 1 x PA100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets.

COMPLETE PRICE: £27.55 plus 45p postage.

TEAK 60 AUDIO KIT

Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc.

KIT PRICE: £9.20 plus 45p postage.



STEREO 30 COMPLETE AUDIO CHASSIS

7 + 7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This with only the addition of a transformer or overwind, will produce a high quality audio unit suitable for use with a wide range of inputs, i.e. high quality ceramic pickup, stereo tuner, stereo tape deck, etc.

Simple to install, capable of producing really first-class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse & fuse holder and universal mounting bracket, enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available.

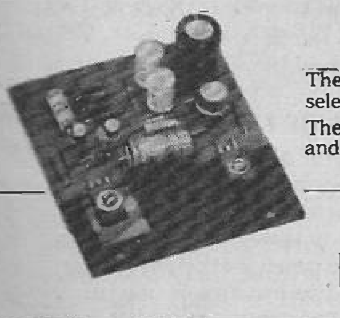
Ideal for the beginner or advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty. Can be installed in 30 mins.

PRICE £15.75 Plus 45p postage & packing

TRANSFORMER £2.45 plus 45p postage & packing — **TEAK CASE £3.65** plus 45p postage & packing

PLEASE ADD V.A.T. AT 25% TO ALL ITEMS EXCEPT
*** ADD 8%**
 # NO V.A.T.

GIRO NUMBER 388-7006



AL 10/AL 20/AL 30

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

AL10 £2.30, AL20 £2.65, AL30 £2.95

SPEAKERS

E.M.I. LEK 350 Loudspeakers Enclosure kit in teak veneer including speakers. Rec. retail price £4.50 per pair.
OUR SPECIAL PRICE ONLY £27.75 per pair P&P £3
WHILE STOCKS LAST!

HEADPHONES

4-16 ohms impedance frequency response 20 to 20,000 Hz stereo/mono switch and Volume Control £4.55

FRONT PANEL

FOR PA100. Attractive matt silver. Finish with black trim and lettering. Adds that professional touch. £1.10 only.

M.P.A.30

[illegible] quality of a magnetic cartridge with [illegible] ceramic equipment using the new [illegible] M.P.A.30 which is a high quality [illegible] exist for the use of ceramic [illegible] only.

[illegible] the construction are 4 low noise, high [illegible] transistors and it is provided with a [illegible] DIN input socket for ease of [illegible]

[illegible] full, easy to follow instructions.

PRICE £2.65

STORAGE-CARRY CASES

RECORD CASES
7 in E.P. 18 3/8th in. x 7 in x 8 in (50 records) *£2.48
12 in L.P. 13¾in x 7 3/8th in x 12¾ in (50 records) *£3.30

CASSETTE CASES
Holds 15. 10in x 3¼in x 5in. Lock and handle *£1.50

8-TRACK CARTRIDGE CASES
Holds 14. 13in x 5in x 6in. Lock and handle *£2.20
Holds 24. 13 3/8th in x 8 in x 5 3/8th in Lock and handle *£3.20

CARTRIDGES

ACOS	GP91-1SC	200mV at 1.2cms/sec	£1.11
	GP93-1	280mV at 1cm/sec	£1.43
	GP96-1	100mV at 1cm/sec	£2.31
TTC	J—2005	Crystal/Hi Output	£0.97
	J—2010C	Crystal/Hi Output Compatible	£1.11
	J—2006S	Stereo/Hi Output	£1.52
	J—2105	Ceramic/Med Output	£1.81
	J—2203	Magnetic 5mV/5cm/sec including stylus	£4.78
	J—22038	Replacement stylus for above	£2.88
	AT—55	Audio-technica magnetic cartridge 4mV/5cm/sec	£3.06

DYNAMIC MICROPHONE

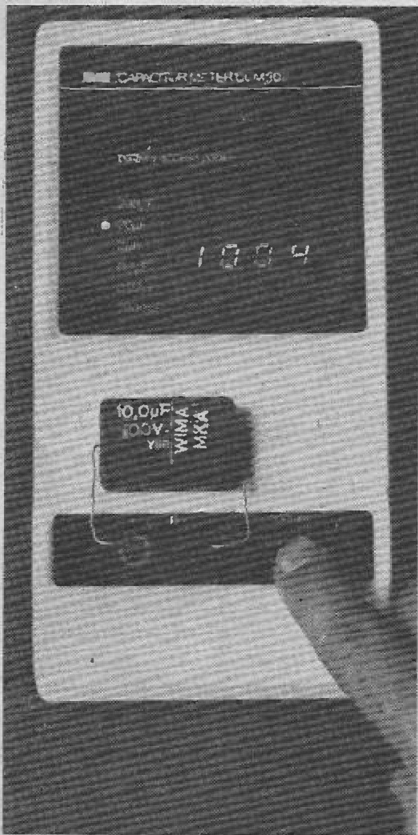
TYPE B1223 200 ohms impedance. Complete with stand, on/off switch and 2.5mm and 3.5mm plugs. Suitable for cassette tape recorders.
PRICE £1.67

JUST OUT!

STEREO FM TUNER

WRITE *NOW* FOR FULL DETAILS

news digest



DIGITAL CAPACITOR METER

A compact capacitance meter with digital readout has just been introduced by Aim Cambridge Ltd. The DCM302, as it is known, is available for £89 and autoranges over 6 decades from 1999pF to 199.9μF full scale. The 3½ digit display gives accuracy of ±0.5% of reading.

The DCM302 is battery operated and requires no setting up before taking measurements.

Aim Cambridge Ltd. Nuffield Road Industrial Estate, St. Ives, Huntingdon, Cambs.

RCA TEST SETS

Arrow Electronics now stock a new range of RCA test equipment. The range goes from the Handyman Special, a rugged low cost volt/ohm/milliameter, to the high sensitivity AC. Further details from Arrow Electronics Ltd., 7, Coptfold Road, Brentwood, Essex.

SPACE LUBRICANTS

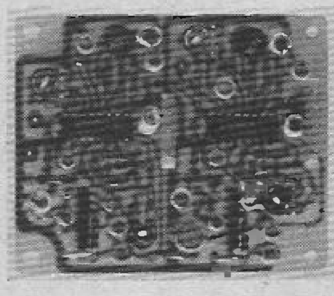
Normal lubricants are not very satisfactory in space but a group of Soviet scientists claim to have solved the problem by using microwave radiation.

Apparently a short exposure to this radiation allows surfaces to slide over each other in a vacuum.

ANRS INTEGRATED INTO A SINGLE IC CHIP

In 1972, JVC first introduced their Automatic Noise Reduction System (ANRS) into their top-range cassette decks. Since then, ARNS has been incorporated into a wide range of tape decks. Recent improvements however, in cassette deck quality and the possibility of "noise-reduced" FM broadcasts have meant improvements in the quality of noise reduction systems and the application of these systems to components other than cassette tape decks.

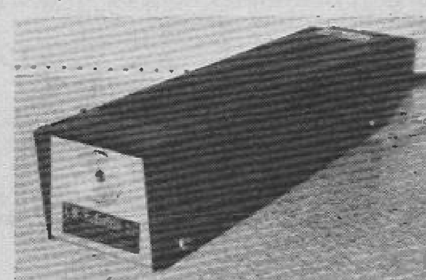
To meet these new requirements, JVC has recently completed the development of the ANRS IC. The new ANRS IC chip will improve both



the performance and reliability of ANRS systems and make them considerably easier to add to existing units. JVC have replaced the bulky mechanical switch in the ANRS circuitry with integrated electronic switches. The compender circuit is totally integrated into a single monolithic IC.

LOW PRICE LASER

A complete mains-powered Laser is now available for under £100 from Wilton Electronics (Scotland) Ltd. Manufactured in the USA by C.W Radiation and designated the W-100, the Laser produces 0.5mW; it is a Helium-Neon type with an output at 6328A. Beam divergence is less than 2 milliradians; beam diameter is 2mm and polarisation is 1000:1.



Wilton offer a years guarantee with the W-100. The price is £97.20 including VAT and carriage.

Wilton Electronics (Scotland) Ltd, 44 St. Andrews Square, Glasgow G1 5PL.

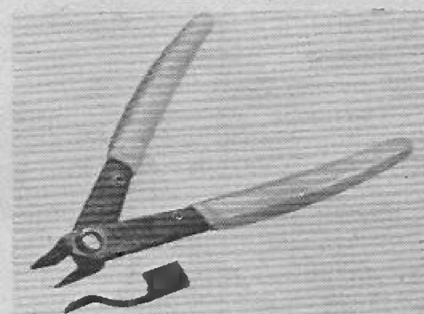
NEW LC DISPLAYS FOR WATCHES

A new series of Liquid Crystal displays have been announced by Beckman for digital watches. These display hours and minutes continually with either date or seconds, selected by a push-button. Contrast ratio is

20:1. power requirement is 1 microwatt so that even with constant readout battery life is over a year. LC modules are available for both 3V and 6V models and a CMOS compatible.

Beckman Instruments Ltd., Queensway, Glenrothes, Fife, Scotland.

THIN PROFILE WIRE SHEARS



For cutting wires in electronic assemblies where space is restricted and conventional cutters are impractical, a thin profile shearing tool known as the Microshear 170 has been newly introduced to this country by Welwyn Tool Co. Ltd. of Welwyn Garden City, Herts.

AN OCEAN OF ENERGY

More ideas for utilising the power of sea waves are being developed by European scientists. Wave theory from other branches of physics helps scientists to develop efficient energy absorbers. For instance, if you can produce interference patterns at sea this provides you with small areas of concentrated energy. Two Norweigan physicists K. Budar and J. Falnes have found that energy can be concentrated onto a buoy by using a circular wave to cause such patterns. When the buoy is resonating with the waves its energy can be absorbed by a system fixed to the sea bed.

INTERPLEX SINGLE-TUBE COLOUR TELEVISION CAMERA SYSTEM

A new single-tube colour camera - Interplex - developed by Siemens, incorporates a tube which gives uniformly high colour rendition of high resolution. The unit consists of a compact camera with a tube and a decoder which converts the colour information into standard PAL television signals.

The Interplex single-tube colour camera uses a new type of dichroic strip filter. In contrast to a normal three-tube camera, the colour distributor used to break down the image arriving from the lens into red, green and blue channels is integrated in the Interplex picture tube. This has made it possible to reduce the size of the camera considerably by dispensing with the accessories for colour coincidence which is so difficult to attain with a three-tube system.

The signal information supplied by the television camera tube in the 4.43MHz range is converted into standard PAL signals in a decoder with comb filter systems and electronic circuitry. Each frequency spectrum of the black-and-white and colour information is separated by the comb filter and here the spectral lines of the video signals are broken down into colour (chrominance) and luminance information. Additional electronic circuits suppress interference from repetitive luminance in the chrominance channel (cross-colour suppression), and are also used to suppress interference in the opposite direction (cross luminance suppression). The individual colour signals are processed without loss of information or colour rendition and uniformity, and can be passed on to a receiver as a PAL coded colour signal. The decoder can also be used for horizontal and vertical aperture correction and addition/subtraction of blue, green, red and white colour components (matrixing).

CMOS FOR 15V OPERATION

Motorola are the first manufacturers of CMOS to provide full min/max specifications for CMOS working at 15V supply voltages. This applies to all parameters and all types presently available. While other manufacturers claim that 15V working is possible with their products, none specify the performance limits that are actually achieved or can be expected at this voltage. The main advantages to be obtained from using CMOS at 15V are higher speed and maximum noise immunity (typically 6.75V).

RADIO CONTROL FOR YOUR CAR?

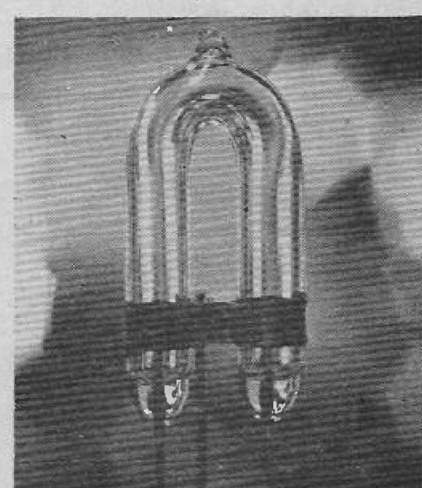
Blaupunkt, the German car radio company, have made a device which could provide motorists in Germany with directions along the route to any one of 65,000 places. A small display on the dashboard tells the driver when to turn off the road and which direction he should take. Any destination can be defined, to within 1½ miles, by four characters entered into a keyboard like that on a pocket calculator. The first character locates one of 16 regions (covering the whole country), the second selects one of 16 areas within this region, and so on.

This all sounds a bit fantastic for a couple of small boxes in the car. There is more to it: the car system is linked by radio to transceivers along the major roads. The car unit tells the road unit what its destination is and in return the road unit gives an appropriate reply — turn left, turn right or continue.

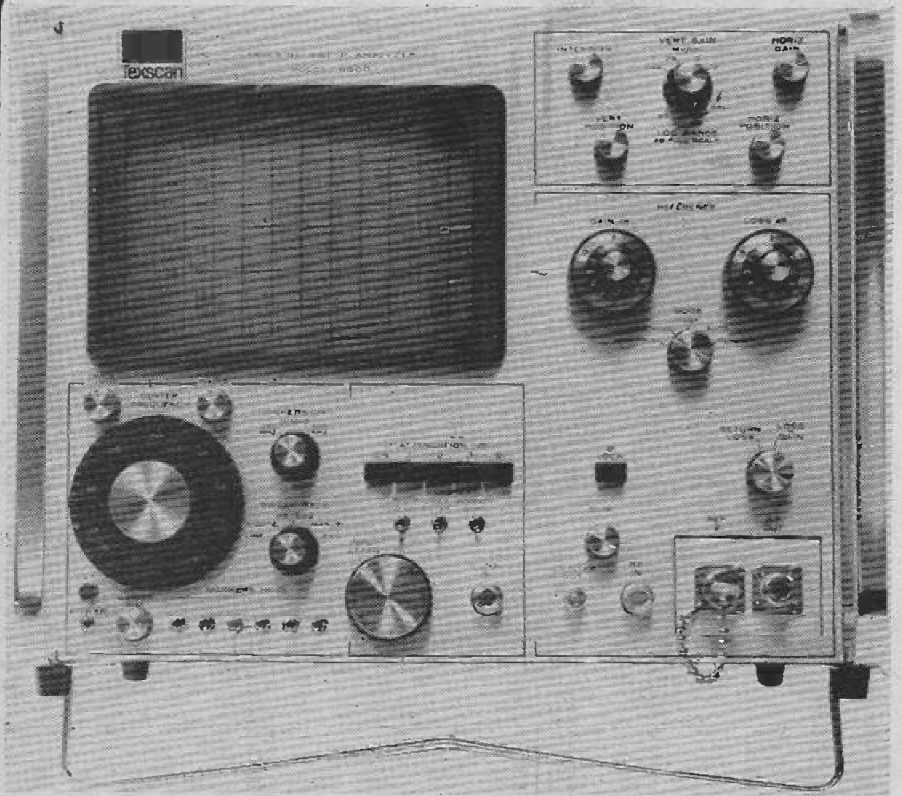
Once the system is fitted to the car it is easy to use it to supply other information to the driver. A central control can warn him of fog, diversions, etc.

NEW FLASH TUBES

Siemens who are marketing Heimann flash tubes in the UK, have just introduced two new types.



One is the BUB 0641 (illustrated). This is designed for use in roadside warning beacons, marine and vehicular applications. The BUS 0641 which is similar in appearance to the first type is designed for stroboscopic applications such as car ignition timing.



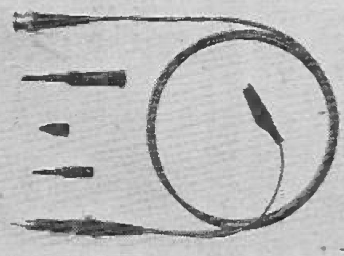
NEW RF TEST SYSTEM

Texscan's new 9600/9650 RF Tracking Sweeper/Analyser provides precision measurements in the range 1MHz to 350MHz. The system incorporates a tracking sweep generator/spectrum analyser, display unit, reflection coefficient bridge, test comparator, and gain and loss measuring attenuators.

It has been designed to facilitate a wide range of measurements including gain and loss, frequency response, field strength and modulation, and its high stability enables accurate measurements to be made equally well on broad and narrow band devices.

Versions of the systems are available for 75 ohm or 50 ohm operation. The dynamic range is 80dB, sensitivity is 1mV and sweep system flatness is ±0.25dB over the full frequency range. The features of the instrument include automatic phase lock, 50dB bridge balance for return loss meaurements, 120dB range for isolation and crosstalk and provision for up to six plug-in crystal markers. From Texscan Instruments Ltd., 1 North Bridge Road, Berkhamsted, Herts.

OSCILLOSCOPE PROBE KITS



The latest addition to the Interprobe range of oscilloscope passive probe kits is the triple function INTERPROBE-3 giving x10 attenuation up to 80MHz, x1 attenuation up to 15MHz and an earth reference check as selected by a 3-position switch built into the probe body. Features include ultra flexible cable, a fixed earth lead, a strong sprung hook tip and input capacitance range of 15-50pF.

The Casio Memory 8-A is an eight digit calculator which offers the usual four calculating functions plus a constant, an independent accumulating memory, square root and a percentage key.

TELETEXT RECEIVER AT SCIENCE MUSEUM

The BBC's CEEFAX service can be viewed by members of the public in the Radio Room at the Science Museum in Kensington.

At present 50 pages are being broadcast but this will eventually expand to 100. CEEFAX is expanding at present and the BBC are advertising for additional staff.

Teletext was described in some detail in the July 1975 issue of ETI.

BUZZING BEES

Experiments are taking place in Russia using the amplified playback of the sound of feeding bees to bring others to the spot.

It appears that when bees find a good food gathering area, they change the frequency of the wing beats, attracting others.

CANNON PLUGS

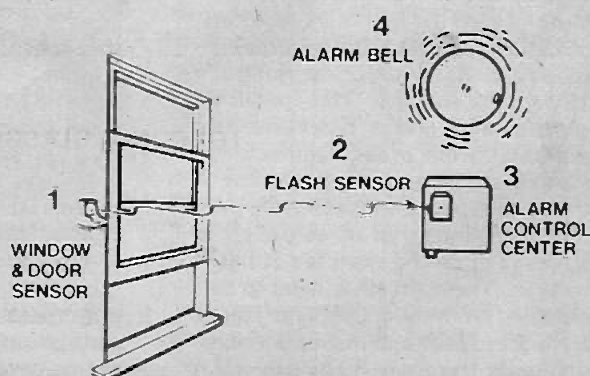
In our Line amplifier project (ETI July) we gave details of how to wire up a Cannon plug and socket. However there seems to be more than one standard for doing this.

Most manufacturers now use the DIN standard which goes as follows — pin 1 is used for the screen connection, pin 2 is used for the live signal, pin 3 is unused except with balanced lines when it carries the return signal.

LIGHT BURST BURGLAR ALARM

The major cost of most professionally installed burglar alarms is inter-unit wiring.

A new system which overcomes this cost has been developed by a US company called Flashguard. The Flashguard system uses self-powered pyrotechnic flash 'cubes' to guard windows and doors. If an intrusion is attempted, the pyrotechnic sensors trigger and direct an intense flash of light to alarm control sensors.



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2N456A	0.85	2N3391	0.28	2N5296	0.48	AF117	0.35	BC208	0.11	BF160	0.23	LM5TI	1.50	OC45	0.32
2N457A	1.20	2N3391A	0.29	2N5298	0.50	AF118	0.35	BC212K	0.16	BF163	0.32	LM380	1.10	OC71	0.17
2N490	3.16	2N3392	0.15	2N5457	0.49	AF124	0.30	BC212L	0.16	BF166	0.40	LM381	2.20	OC72	0.25
2N491	4.38	2N3393	0.15	2N5458	0.45	AF125	0.30	BC214L	0.18	BF167	0.26	LM702C	0.75	OC81	0.25
2N492	3.00	2N3394	0.15	2N5459	0.49	AF126	0.28	BC237	0.16	BF173	0.27	LM709T099	0.48	OC83	0.24
2N493	5.20	2N3402	0.18	2N5492	0.58	AF127	0.28	BC238	0.15	BF177	0.29	8DIL	0.38	ORP12	0.55
2N696	0.22	2N3403	0.19	2N5494	0.58	AF139	0.65	BC239	0.15	BF178	0.35	14DIL	0.40	R53	1.80
2N697	0.16	2N3440	0.59	2N5496	0.61	AF186	0.46	BC251	0.25	BF179	0.43	LM710	0.47	SL414A	1.80
2N698	0.82	2N3441	0.97	2N6027	0.45	AF200	0.65	BC253	0.25	BF180	0.35	LM3900	0.70	SL610C	1.70
2N699	0.59	2N3442	1.40	2N5777	0.45	AF239	0.65	BC257	0.15	BF181	0.36	LM723C	0.90	SL611C	1.70
2N706	0.14	2N3414	0.10	3N128	0.73	AF240	0.90	BC258	0.16	BF182	0.35	LM741T099	0.40	SL612C	1.70
2N706A	0.16	2N3415	0.10	3N139	1.42	AF279	0.70	BC259	0.17	BF183	0.55	8DIL	0.40	SL620C	2.60
2N708	0.17	2N3416	0.15	3N140	1.00	AF280	0.79	BC261	0.25	BF184	0.30	14DIL	0.38	SL621C	2.60
2N709	0.42	2N3417	0.21	3N141	0.81	AL102	1.00	BC262	0.25	BF185	0.30	LM747	1.00	SL623	4.59
2N711	0.50	2N3638	0.15	3N200	2.49	AL103	1.00	BC263	0.25	BF194	0.12	LM7488DIL	0.60	SL640C	3.10
2N718	0.23	2N3638A	0.15	40361	0.40	BC107	0.14	BC300	0.38	BF195	0.12	LM7805	2.00	SL641C	3.10
2N718A	0.28	2N3639	0.27	40362	0.45	BC108	0.14	BC301	0.34	BF196	0.13	14DIL	0.73	SN76003N	2.92
2N720	0.67	2N3641	0.17	40363	0.88	BC109	0.14	BC302	0.29	BF197	0.15	LM7805	2.50	SN76013N	1.95
2N914	0.39	2N3702	0.11	40389	0.46	BC113	0.15	BC303	0.54	BF198	0.18	LM7812	2.50	SN76023N	1.60
2N916	0.28	2N3703	0.12	40394	0.56	BC115	0.17	BC307	0.17	BF200	0.40	LM7815	2.50	SN76033N	2.92
2N918	0.32	2N3704	0.15	40395	0.65	BC116	0.17	BC308A	0.15	BF225J	0.23	LM7824	2.50	ST2	0.20
2N929	0.37	2N3705	0.15	40406	0.44	BC116A	0.18	BC309C	0.20	BF244	0.21	MC1303	1.50	TAA300	1.80
2N930	0.22	2N3706	0.15	40407	0.35	BC117	0.21	BC327	0.27	BF245	0.45	MC1310	2.92	TAA263	1.10
2N1302	0.19	2N3707	0.18	40408	0.50	BC118	0.14	BC328	0.28	BF246	0.58	MC1330OP	0.90	TAA350	2.10
2N1303	0.19	2N3708	0.14	40409	0.52	BC119	0.29	BC337	0.20	BF247	0.65	MC1351P	0.80	TAA550	0.60
2N1304	0.26	2N3709	0.15	40410	0.52	BC121	0.35	BC338	0.20	BF254	0.19	MC1352P	0.80	TAA611C	2.18
2N1305	0.24	2N3710	0.15	40411	2.25	BC125	0.16	BCY30	0.80	BF255	0.19	MC1466	3.50	TAA621	2.03
2N1306	0.31	2N3711	0.15	40594	0.74	BC126	0.23	BCY31	0.85	BF257	0.47	MC1469	2.75	TAA661B	1.32
2N1307	0.30	2N3712	1.20	40595	0.84	BC132	0.30	BCY32	1.15	BF258	0.53	ME0402	0.20	TBA641B	2.25
2N1308	0.47	2N3713	1.20	40601	0.67	BC134	0.13	BCY33	0.85	BF259	0.56	ME0404	0.13	TBA651	1.69
2N1309	0.47	2N3714	1.38	40602	0.61	BC135	0.13	BCY34	0.78	BFR39	0.24	ME0412	0.18	TBA810	1.50
2N1671	1.54	2N3715	1.50	40603	0.58	BC136	0.17	BCY38	1.00	BFR79	0.24	ME4102	0.11	TBA820	1.15
2N1671A	1.67	2N3716	1.80	40604	0.56	BC137	0.17	BCY39	1.50	BFS21A	2.30	ME4104	0.11	TBA920	4.00
2N1671B	1.85	2N3771	2.20	40636	1.10	BC138	0.24	BCY40	0.97	BF528	0.92	MJ480	0.95	TIL209	0.30
2N1711	0.45	2N3772	1.80	40669	1.00	BC140	0.68	BCY42	0.28	BFS61	0.27	MJ481	1.20	TIP29A	0.49
2N1907	5.50	2N3773	2.65	40673	0.73	BC141	0.68	BCY58	0.30	BFS98	0.25	MJ490	1.05	TIP30A	0.58
2N2102	0.66	2N3779	3.15	AC126	0.20	BC142	0.23	BCY59	0.32	BFX29	0.30	MJ491	1.45	TIP31A	0.62
2N2147	0.78	2N3790	2.40	AC127	0.20	BC143	0.25	BCY70	0.17	BFX30	0.27	MJ2955	1.00	TIP32A	0.74
2N2148	0.94	2N3791	2.35	AC128	0.20	BC145	0.21	BCY71	0.22	BFX84	0.24	MJE340	0.48	TIP33A	1.01
2N2160	0.90	2N3792	2.60	AC151V	0.27	BC147	0.14	BCY72	0.15	BFX85	0.30	MJE370	0.65	TIP34A	1.51
2N2218A	0.22	2N3794	0.10	AC152V	0.49	BC148	0.14	BD115	0.75	BFX87	0.28	MJE371	0.75	TIP35A	2.90
2N2219	0.24	2N3819	0.37	AC153	0.36	BC149	0.15	BD116	0.75	BFX88	0.25	MJE520	0.60	TIP36A	3.70
2N2219A	0.26	2N3820	0.38	AC153K	0.40	BC153	0.18	BD121	1.00	BFX89	0.90	MJE521	0.70	TIP41A	0.79
2N2220	0.25	2N3823	1.42	AC154	0.25	BC154	0.18	BD123	0.82	BFY50	0.23	MJE2955	1.20	TIP42A	0.90
2N2221	0.18	2N3904	0.27	AC176	0.30	BC157	0.16	BD124	0.67	BFY51	0.23	MJE3055	0.75	TIP29c	0.80
2N2221A	0.21	2N3906	0.27	AC176K	0.40	BC158	0.16	BD131	0.40	BFY52	0.21	MP8111	0.32	TIP30c	0.85
2N2222	0.20	2N4036	0.67	AC187K	0.35	BC160	0.60	BD132	0.50	BFY53	0.18	MP8112	0.40	TIP31c	1.00
2N2222A	0.25	2N4037	0.42	AC188K	0.40	BC167B	0.15	BD135	0.43	BFY90	0.75	MP8113	0.47	TIP32c	1.25
2N2368	0.26	2N4058	0.18	ACY18	0.24	BC168B	0.15	BD136	0.49	BRY39	0.48	MPF102	0.30	TIP33c	1.45
2N2369	0.20	2N4059	0.15	ACY19	0.27	BC168C	0.15	BD137	0.56	BSX20	0.21	MPSA05	0.25	TIP34c	2.60
2N2369	0.22	2N4060	0.15	ACY20	0.22	BC169B	0.15	BD138	0.63	BSX20	0.21	MPSA06	0.31	TIP41c	1.40
2N2646	0.55	2N4061	0.15	ACY21	0.26	BC169C	0.15	BD139	0.71	BSX21	0.29	MPSA12	0.35	TIP42c	1.60
2N2647	0.98	2N4062	0.15	ACY28	0.20	BC170	0.15	BD140	0.87	BU104	2.00	MPSA55	0.26	TIP49	0.70
2N2904	0.22	2N4126	0.21	ACY30	0.58	BC171	0.16	BD529	0.80	BU105	2.25	MPSA56	0.31	TIP53	0.53
2N2904A	0.24	2N4289	0.34	AD142	0.57	BC172	0.17	BD530	0.80	C106D	0.65	MPSU05	0.65	TIP2955	0.98
2N2905	0.25	2N4919	0.95	AD143	0.68	BC177	0.28	BFR39	0.24	CA3180A	0.86	MPSU06	0.58	TIP3055	0.50
2N2905A	0.26	2N4920	1.10	AD149V	1.20	BC178	0.27	BFR79	0.24	CA3020A	1.80	MPSU55	0.63	TIS43	0.28
2N2906	0.19	2N4921	0.80	AD150	0.63	BC179	0.30	BDY20	1.05	CA3028A	0.79	MPSU56	0.80	ZTX300	0.13
2N2906A	0.21	2N4922	0.83	AD161	1.15	BC182	0.12	BF115	0.36	CA3035	1.37	NE555V	0.70	ZTX301	0.13
2N2907	0.22	2N4923	1.00	AD162	1.15	BC182L	0.12	BF117	0.55	CA3052	1.62	NE556	1.30	ZTX302	0.20
2N2907A	0.24	2N5190	0.92	AD161	pr	BC183	0.12	BF121	0.35	CA3046	0.70	NE560	4.48	ZTX500	0.15
2N2924	0.20	2N5191	0.96	AD162	1.05	BC183L	0.12	BF123	0.35	CA3048	2.11	NE561	4.48	ZTX501	0.13
2N2926	0.20	2N5192	1.24	AF106	0.40	BC184	0.13	BF125	0.36	CA3089E	1.96	NE565A	4.48	ZTX502	0.18
2N3053	0.25	2N5195	1.46	AF109R	0.40	BC184L	0.13	BF152	0.20	CA3090Q	4.23	OC23	1.35	ZTX530	0.23
2N3054	0.60	2N5245	0.47	AF114	0.35	BC186	0.28	BF153	0.25	LM301A	0.48	OC28	0.76		
2N3055	0.76	2N5294	0.48	AF115	0.35	BC187	0.27	BF154	0.16	LM308	2.50	OC35	0.60		

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SN7404	0.19	SN7417	0.35	SN7442	0.65	SN7472	0.26	SN7486	0.32	SN74121	0.37	SN74161	1.10	SN74192	1.15
SN7405	0.19	SN7420	0.16	SN7445	0.90	SN7473	0.36	SN7490	0.45	SN74122	0.50	SN74162	1.10	SN74193	1.15
SN7406	0.45	SN7423	0.29	SN7446	0.95	SN7474	0.36	SN7491	0.85	SN74123	0.60	SN74163	1.10	SN74196	1.60
SN7407	0.45	SN7425	0.29	SN7447	0.85	SN7475	0.50	SN7492	0.45	SN74141	0.85	SN74164	2.01	SN74197	1.58
SN7408	0.19	SN7427	0.29	SN7448	0.90	SN7476	0.35	SN7493	0.45	SN74145	0.90	SN74165	2.01	SN74198	2.25
SN7409	0.22	SN7430	0.16	SN7450	0.16	SN7480	0.50	SN7494	0.82	SN74150	1.50	SN74167	4.10	SN74199	2.25

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ELECTRONICS IN MEDICINE

The never-ending fight against disease has led to many advanced electronic applications. This month Dr. Peter Sydenham deals with blood and other aspects of pathology.

PART ONE

PATHOLOGY is the science and study of disease in both humans and animals. And behind the scenes of every hospital and the many GP's who service our health, there is, in one form or another, a pathology centre. As we will see, these centres play a vital and dominant part in modern medicine. It is a discipline wherein the practical knowledge of the medical professional combines with the skills and achievements of simple to advanced electronics.

Today a major part of pathology relies on sensing and measuring methods that extend the natural ability given to the surgeon or family doctor in order that they can obtain more precise diagnoses of the myriads of illnesses that can befall us.

In this two part feature we report on the type of work that a pathology centre undertakes – and on how the many varied tests are made having due regard to adequate recognition of the precision and the timeliness required if the tests are to be of value in curing or rectifying malfunctions of the biological system of man and animals.

CHEMICAL ANALYSIS OF BLOOD

The greater part of effort in a Biochemistry division is to analyse blood, determining the concentration of over eighteen constituents. These measurements comprise the greatest proportion of individual tests but now require the least man-power for they are almost all completely automated. Once the samples are loaded into an automatic analyser the rest is machine handled right through to the printed report.

The system that does this is known as the multi-channel Auto-Analyser. To understand multiple operation of this system let us start by looking at the basic single channel system used (Fig. 1). Small specimen cups filled with blood are arranged in a rotating turntable. Interlocked mechanical drives advance the table one phial at a time and lower a sampling tube into each in turn. A persistaltic metering

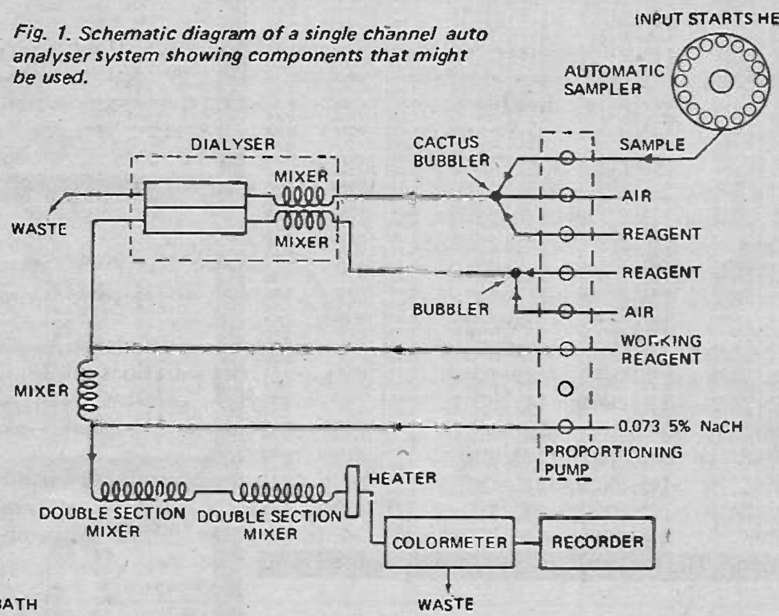


Fig. 1. Schematic diagram of a single channel auto analyser system showing components that might be used.

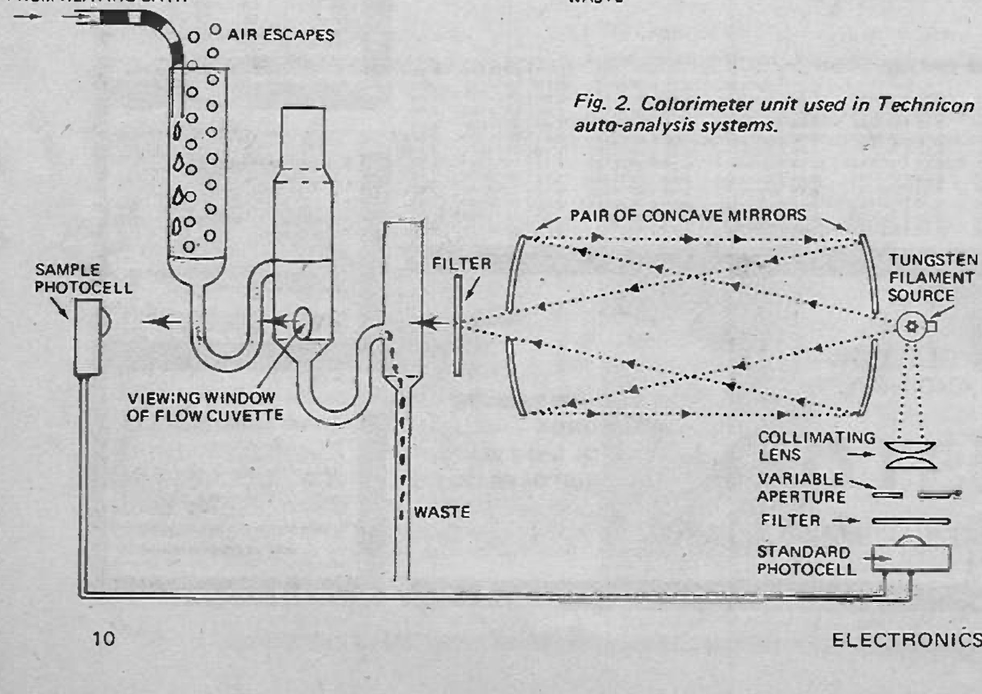


Fig. 2. Colorimeter unit used in Technicon auto-analysis systems.

pump (liquid is conveyed by squeezing a flexible tube with a moving roller) transfers the extracted sample into the entrance tube of the analyser unit – placing a small air bubble between successive samples in order to separate them. Diluent may also be added at this stage.

The train of samples then moves around spirals that mix the sample and added fluids ready for the next step which is to dialyse out the chosen constituents. Dialysis is a process of chemical separation which relies on the various molecular sizes passing, or not passing, through semi-permeable membranes. Using the appropriate choice of membrane the fluid stream is chemically separated as desired. The required fluid, that remains after dialysis or that dialysed out, is then transferred to the analytical measuring device to be used. When agents are added it is often necessary to heat the mixture to a precise temperature at the appropriate part in the flow path.

The output of the particular analytical unit used is obtained as an electronic signal level which can be used to provide digital readout and a printed data value for each successive sample. The basic sampler system will take successive samples at a rate of 60 per hour with the complete pass through the auto analyser taking around eight minutes.

To increase the throughput the company marketing these systems (Technicon Equipment Pty. Ltd) developed a sequential multiple analyser which provides six different tests (compared with just one in the basic device) on each sample at the rate of 60 samples per hour.

The sampler unit of this system similarly dips each serum phial in turn but the samples are then split into five separate streams that feed six analytical units (two results come from one stream) each determining different blood chemistry parameters.

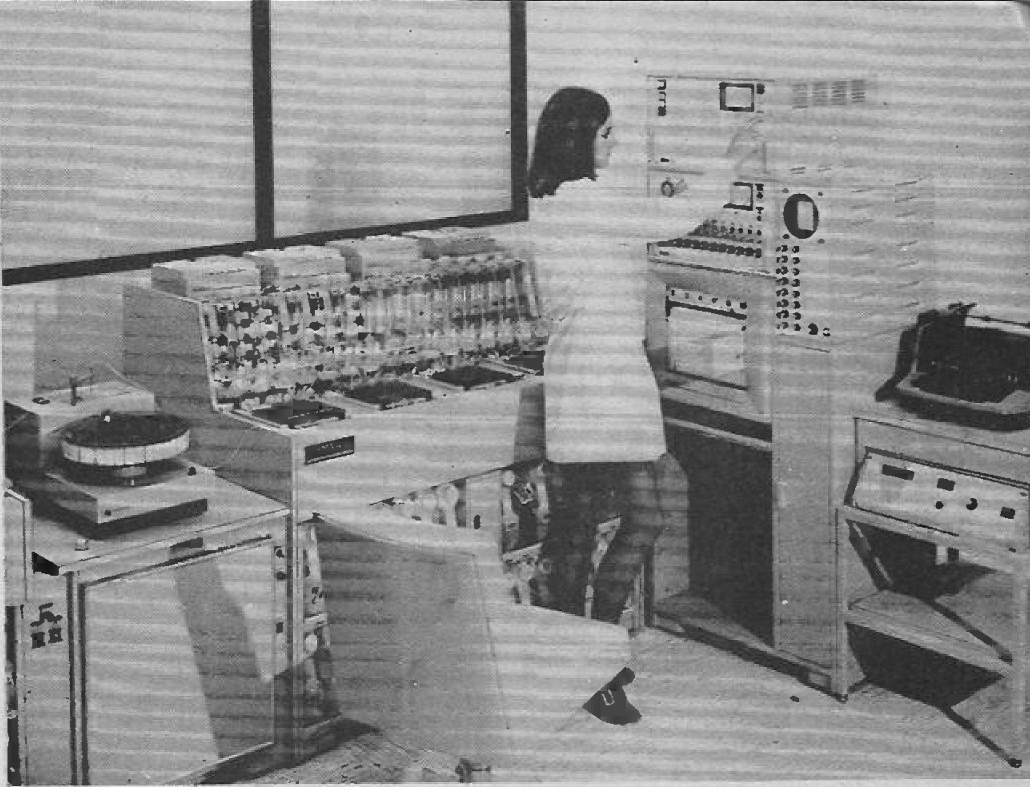


Fig. 3. Twelve tests on sixty samples an hour are performed by this automatic serum analyser from Technicon.

Four streams go to colorimeters, one to a flame photometer which has three photo cells with specific pass filters for detection of Sodium and Potassium against a constant background level of Lithium.

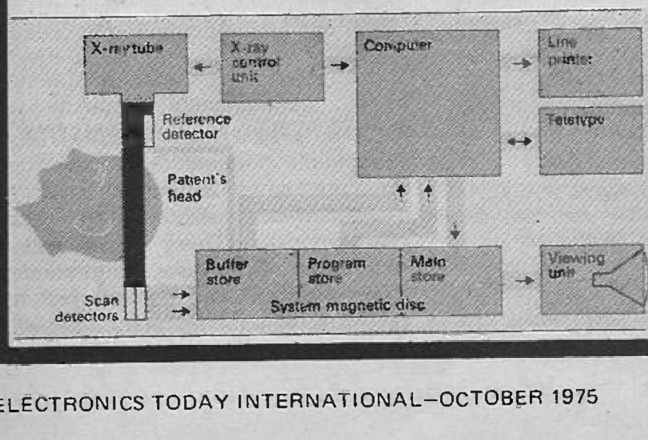
Colorimeters are photoelectric units designed to monitor the difference between a standard colour and that of a sample solution. Provided the sample has been accurately diluted and suitably chemically treated and separated before the measurement, the colour density will be directly proportional to the concentration of the required parameter in the solution. Colour density is determined by photoelectric comparison of the sample solution with a standard solution. If the colour density is increased, the process is said to be of positive colorimetric result. A blood urea nitrogen test is positive; the glucose test negative. The now treated sample flows through the viewing cuvette altering the transmission of the light source radiating through to the measuring photo cell. This value is automatically compared with the standard cell to indicate the concentration as an equivalent electrical signal. (The block diagram of the Auto Analyser Colorimeter is given in Fig. 2).

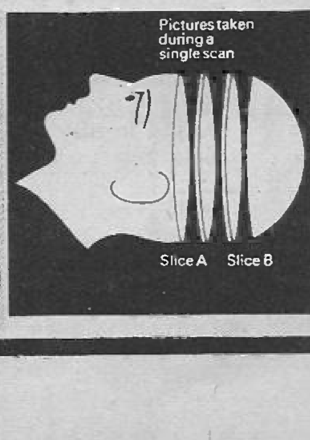
Colorimetric methods enable many different concentrations of serum to be assessed – chloride, bicarbonate, protein, albumin, calcium, alkaline phosphatase, bilirubin, urea nitrogen, glucose, cholesterol, uric acid, plus others depending on the reagents added and the dialysing membranes used in each channel.

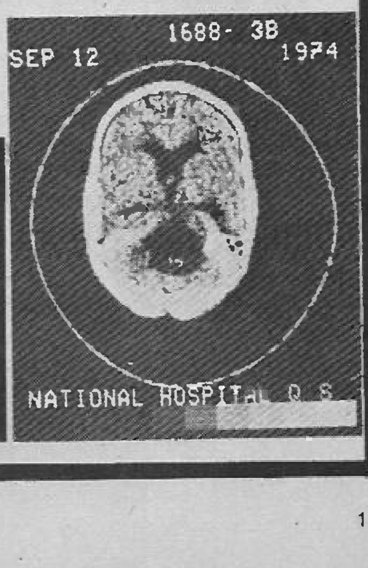
Flame photometry, the second sensor used at the end of the autoanalyser system is also based on

The EMI-Scanner, shown on the cover, represents a major breakthrough in diagnostic techniques. Conventional radiographic techniques have only about a 1% resolution due to the difficulties of differentiating tiny variations in tissue density. This is more difficult in the brain where the tissue is surrounded by the cranium.

The EMI-Scanner uses advanced techniques enabling a 'slice' of the brain – or the body in another version – to be displayed directly. This design has won a number of major awards since 1972 and is being exported all over the world.







ELECTRONICS IN MEDICINE

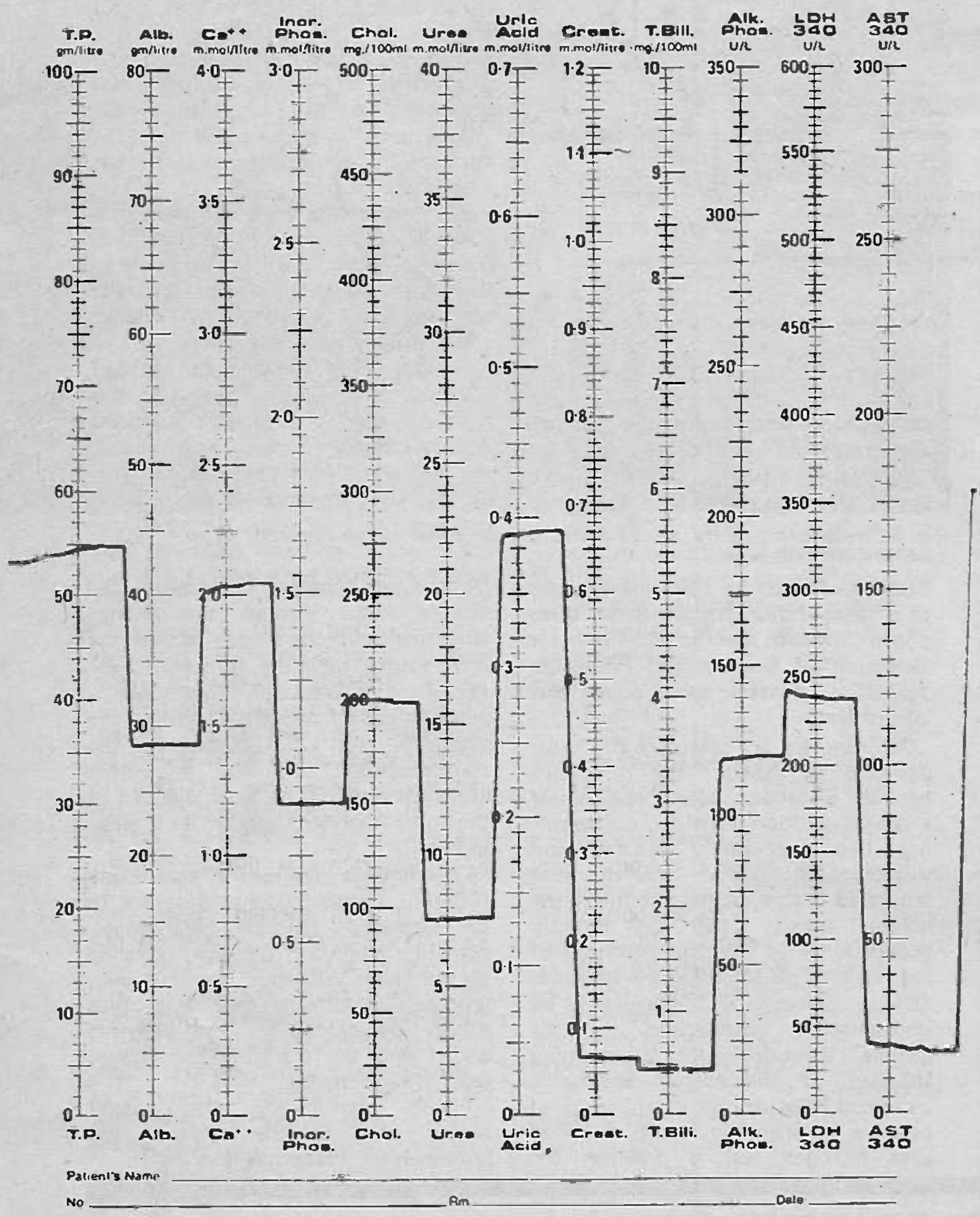


Fig. 4. Typical record format produced by the SMA 12/60 Multi analyser unit. Each scale represents the expected range of concentration of twelve basic serum constituents.

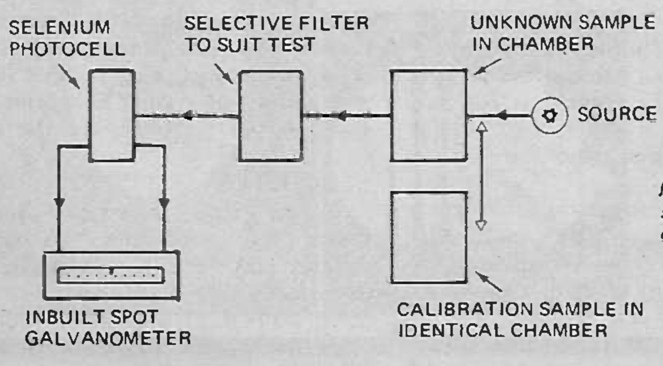


Fig. 5. Schematic of simple photo-electric colorimeter.

colour comparison but in the form of colour measurement of a standard flame burning the treated solution. As the flame burns the unknown element the emission spectra is altered. The colour produced in this way is compared with a control flame burning a known substance; lithium in this case. Flame photometry is used to measure sodium and potassium concentration in the serum.

So that several flame photometric tests can be carried out on a sample at one time, flame photometers are available in multi-test form. One interesting feature of this is a multiple oscilloscope display that shows the state in time of each of the twelve tests being carried out on each sample. In setting up the machine the operator has to carefully select the mixing spirals so as to add in the correct amount of time delay. This is necessary if the results are to be obtained in the correct sequence at the output.

Output comes in two forms from this unit. First, as an analogue chart record like that shown in Fig. 4, where the pen traces across the appropriate scale at the level of concentration measured — this should demonstrate the reason for needing accurate phasing of the recorder and the twelve tests! The second output form is for a direct line to the central computer centre.

In a single day 250 samples are analysed for twelve parameters and 200 samples for six parameters. The two Auto-analyser units are set up differently to provide 18 different blood parameters if needed. It is considerably cheaper to carry out all 12 tests than to run just one on the single channel unit. This equipment revolutionised analysis. For all its complication and sophisticated electro-mechanical design the unit reliably performs tests at a few pence a parameter.

Multichannel analysers such as these are now just over a decade old in concept and advances are now available that enable the system to be further automated. The next step in development would be to add a mini-computer that will control daily self checks of electronic performance, calibrate itself and provide maintenance instructions for the technicians' use.

MORE BLOOD MEASUREMENTS

Very much related to the chemical measurements performed on the multi-analyser are other blood parameters. These tests include estimation of cellular properties of blood-number and size of red and white cells, concentration of haemoglobin (the colouring matter of

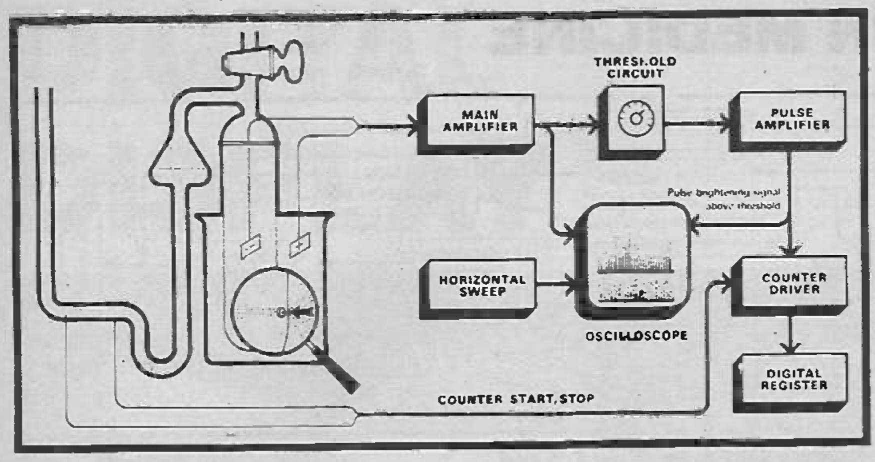


Fig. 6. Particles, blood cells in this case, pass through the small orifice (shown under the eyeglass) producing pulses that are counted. This is the basis of the Coulter Counter.

red corpuscles of the blood which serve to convey oxygen to the body tissues) in red cells and its level in the serum.

Colorimetry is used extensively in the measurement of haemoglobin, for its concentration is proportional to optical density. A haemoglobinometer (or haemochrometer) is an extremely old instrument concept. The whole blood is first diluted with a pure dilutent, such as distilled water, in an accurate proportion. The colour of this fluid is then compared with coloured papers in the simplest technique. More precise methods make use of photo-electronic colour matching. The Unicam SP300 colorimeter developed over 40 years ago still serves a useful purpose. A light source, see Fig. 5. shines on a large area selenium barrier through an optically selective filter and a standard size cuvette.

The output of the photocell drives a mirror galvanometer that is self-contained within the equipment. In use the appropriate filter is inserted along with a standard, suitably filled container which acts as the reference optical density. The galvanometer is then balanced to the datum value and the reference changed for the unknown which, due to greater optical density, produces a different deflection value that is related to concentration. These give a measure of haemoglobin concentration in grams per hundred millilitres of whole blood. Checks on these devices are made using purchased standard "blood" solutions which have the right optical density for various concentrations. More advanced instruments perform the reference-unknown changeover process by comparing the relative signals produced by alternately or simultaneously viewing each with the same common source. This was shown earlier in Fig. 2.

Another simple test to do with whole blood cells is the determination of packed cell volume PCV. The whole blood sample is placed in a slender tube container of fixed volume and length. This is placed on a small centrifuge that rotates at speed, packing the more dense blood particles on the outer radius. After centrifuging, the phial is compared with a graduated chart that, by way of measurement of the distance along the tube, reads the PCV value. Simple — yet quite adequate.

Prior to the early 1950s the often necessary diagnostic task of counting and sizing blood cells (red, white and platelets), was extremely arduous for the operator had to view a smear on a microscope and *literally* count what was seen in a standard area. There is still need for direct observation of this nature for other reasons, but fortunately there is now an automatic machine that performs the bulk of the counting requirements. In a cubic millimetre of blood there are around 5 million red corpuscles and they account for 98.5% of the corpuscular mass. In the same volume there are typically 10 000 white cells and 400 000 platelets.

Around 1956 Coulter marketed a basic instrument that, as their patent described, used "an electric current path of small dimensions modulated by the passage of individual particles". As the particles (not only blood cells can be counted of course) pass through a small orifice containing electrodes (see Fig.8), the conductivity changes each time a particle passes thereby producing an electric pulse suitable for counting. Furthermore, the magnitude of the pulse is related to the size of the particle. It was able to count cells at the rate of 50 000 cells in 20 seconds. And it didn't get tired!

Today, Coulter counters can be most sophisticated as the following description of the multiparameter Model S unit (installed at the IMVS) will show. This unit, shown in Fig. 9, accepts one millilitre samples which are fed in by the technician along with diluent. It processes these samples to provide seven blood parameters — more again on top of the 18 obtainable from the Auto-analyser systems. The values are printed on a report card. Soon they will go direct to the computer. This machine is a marvel of automated fluid transport combined with sophisticated electronic data-processing. To see how this system operates we will trace the path of the serum sample using the flow chart given in Fig. 8.

The first step is to draw blood plus diluent into a dilution module that accurately mixes the two in a one in 224 ratio — which suffices for white cell counting. Some of this diluted serum passes back for a second 1 in 224 ratio dilution ready for red cell counting after lysing. Lysing is the process whereby a reagent is added that destroys the red cells still existing in the one in 244 first dilution picked off from the white cell channel. Both channels are now ready for counting: one contains predominantly red cells and the other predominantly white cells.

The counting bath in each path contains three counting sensors each having typically 100μm diameter orifices. Triplication is used to provide redundancy and averaging of values. Before the white cell fluid is expired to waste, it passes into a colorimetric style of haemoglobinometer which provides the raw data for the seventh parameter which is not a counting value.

The pulses selected from the appropriate height representing the sizes needed are produced by the two sets of three count-generating sensors. These pass to proceeding units that decide if the counts are indeed valid — if one channel is unduly different from the others it records a failure — as happens when an orifice blocks. The reds are counted with the fewer whites still remaining, for statistically the latter are too few to be of any consequence. Knowing the dilution ratios, volumes and averaged counts for each channel, the computing circuits provide the seven parameters to the report and printer — total haemoglobin Hb mean cell haemoglobin concentration MCHC, mean cell haemoglobin MCH, mean cell volume MCV, haematocrit Hct, red cell count and white cell count. The printer is seen on the right-hand of the unit.

ELECTRON MICROSCOPY

Whereas a large amount of diagnostic results are obtainable by viewing suitably prepared slides in the optical microscope, the useful magnification, being limited to around X 2000, is often inadequate. If greater detail is

ELECTRONICS IN MEDICINE

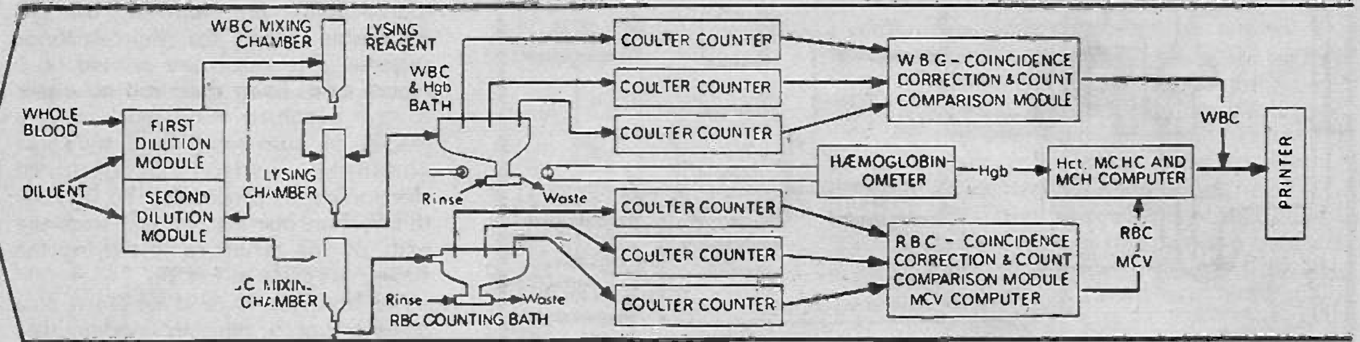


Fig. 8. Flow chart of a specimen passing through the Model S counter.

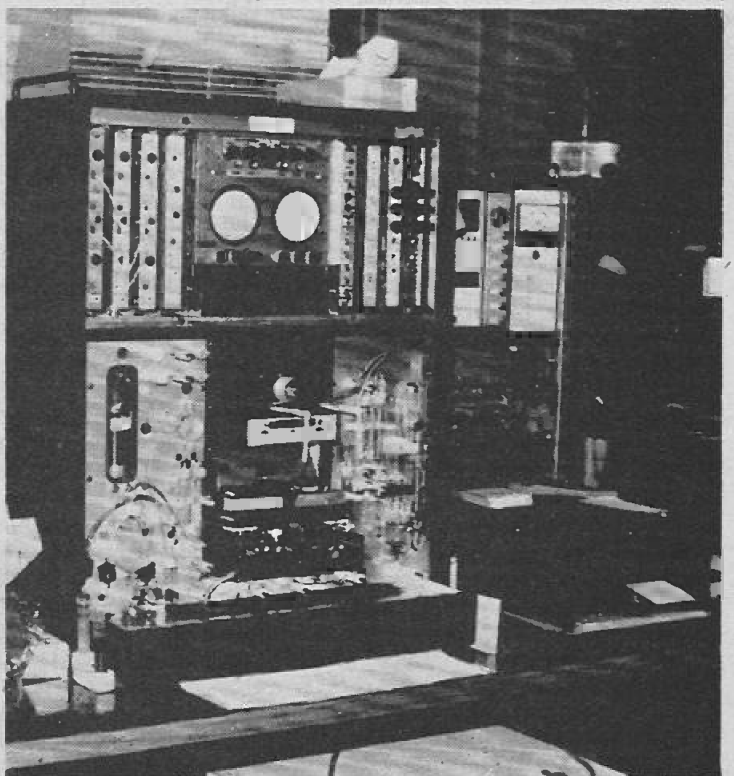


Fig. 7. Multiparameter Model S Coulter Counter with covers removed.

needed the study must be made using an electron microscope; Two well known units are the Hitachi HU11E and the Joel JEM100c analytical electron microscope. These can provide magnifications to X 10 000 000 if required, being able to resolve detail about 0.5 nM dimensions.

With these, pathologists are able to study mounted specimens from numerous sources — tumours, kidney, lung, intestines — taken both from humans and animals.

Interesting here is the sophisticated preparation of specimens that is often required. In the simplest case the specimen is mounted onto a platen grid (a supporting mesh is used to support the microtomed (very thin) slice, for a glass support is not practical in transmission electron microscopy). To improve the contrast the specimen maybe treated with heavy-metal chemicals.

The extreme situation occurs when the specimen will not endure the bombardment of the electron beam, exposure to atmosphere or the ultra-high vacuum. It may also lack adequate contrast to the electrons probing it. In such cases a special freeze-etching machine is used to prepare a suitable specimen. First, a small piece of sample is placed in the machine which freezes the slice in an incredibly short time. The frozen sample is then sliced (really a progressive surface fracture for it is ice that is being cut) to expose a uniform flat surface. This process ensures dimensional and chemical stability of the sample. But the sample must still be placed into the vacuum chamber of the electron microscope. And even though the sample is frozen it would still melt and be destroyed unless it is further protected.

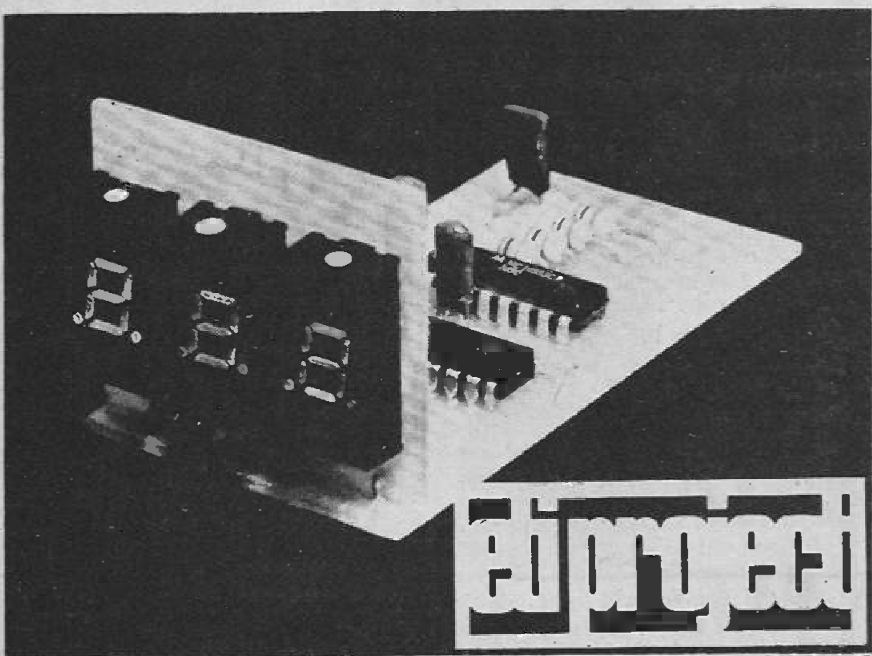
The next stage, therefore, is to etch the frozen sample by controlled melting of the sliced surface. Using vacuum deposition, a layer of platinum and carbon is then deposited onto the specimen taking up the contours produced by etching. The original material is then digested away leaving the replicated sample which is suitable for use in the electron microscope. To complicate matters the whole preparation process must be carried out at high vacuum (0.0005 Torr). The average preparation time for a sample is around 90 minutes so samples needing this much pre-treatment are not done in large quantity.

Whereas the Hitachi instrument is a reasonably standard electron-microscope, the Jeol model incorporates a scanning facility and the ability to carry out chemical analyses of the various parts of the specimen whilst it is mounted in the microscope. Generally speaking the scanning style of electron-microscope sacrifices resolution (about 10 nM is the normal limit) in exchange for the ability to picture the specimen with remarkable depth of focus. There are other advantages, however, which are the merits needed in pathological work. Here the scanning mode enables the operator to view specimens that are less loaded with heavy metal chemicals and to use a lower operating voltage, thereby obtaining longer life from the specimen: the reduced contrast of the specimen can be counteracted by the ability to brighten and increase the contrast in the reconstructed scanned image output. It also enables thicker sections, that are easier to cut, to be used. This particular electron microscope incorporates a mini-computer which is programmed to increase the wanted image quality by automatically removing a predetermined unwanted signal background from the video waveforms before the image is reconstituted.

To be continued.

DIGITAL DISPLAY

This project forms a module which will be used in other ETI projects including the DVM in this issue.



Three digit module for experimenters.

ALL digital instruments have a common assembly in the display system. Again, almost all instruments require decade counters, stores and decoder-drivers for the display.

Normal systems using TTL logic generally have a 7490, a 7475 and a 7447 to drive each 7 segment LED display digit. Hence to build a three-digit display nine ICs are required in addition to three display ICs.

Complex logic functions are available in CMOS which allow a 3 digit display to be built using only two ICs — and such ICs are available at reasonable cost. One of the devices is a three-digit, decade-counter, store and the second is a three-digit decoder-driver. Thus three digit displays can be built which have the following advantages.

1. Small size
2. Low power consumption (120 mA compared to 600 mA in TTL)
3. Wide power supply range (5-15V unregulated).

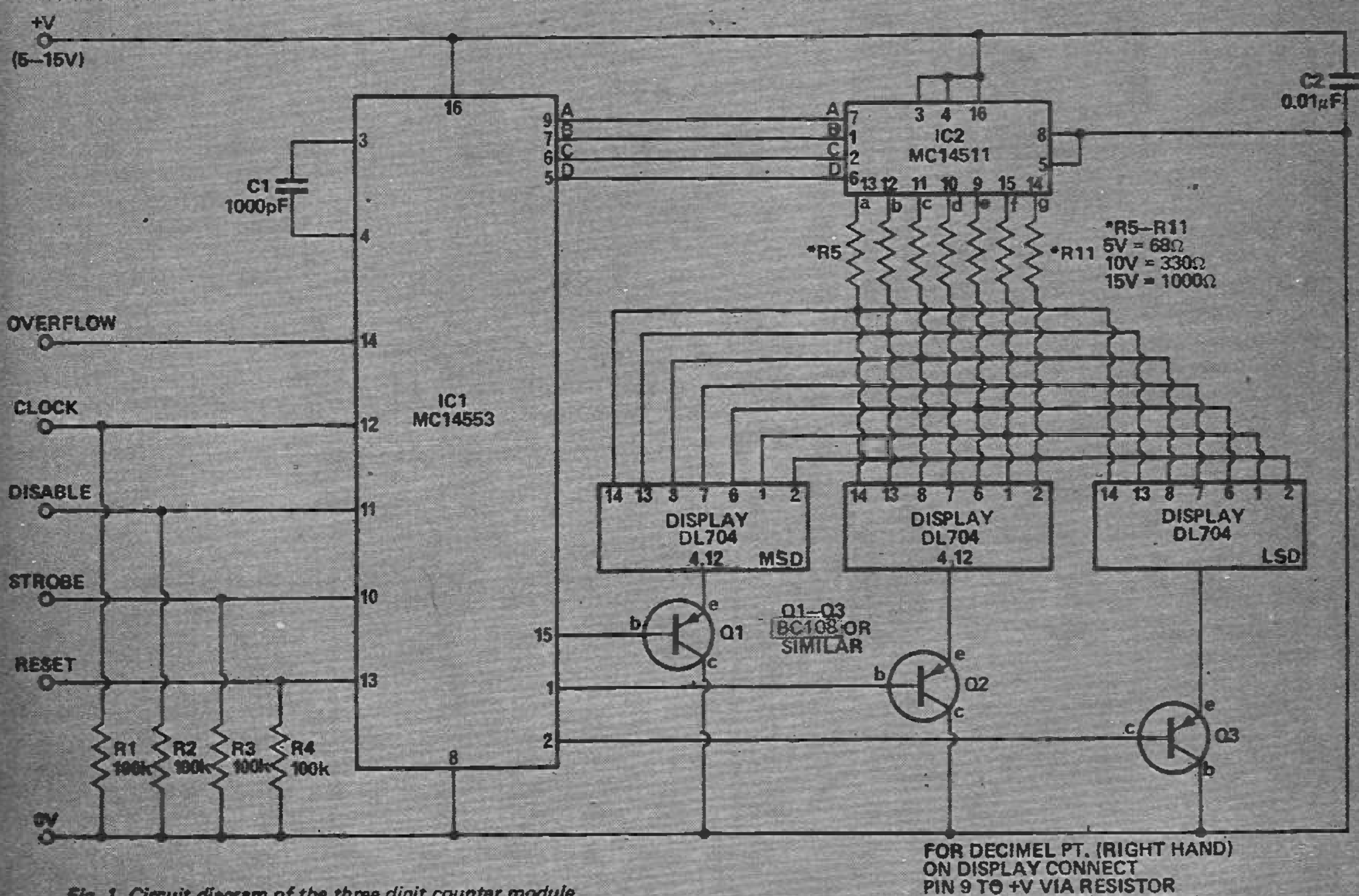


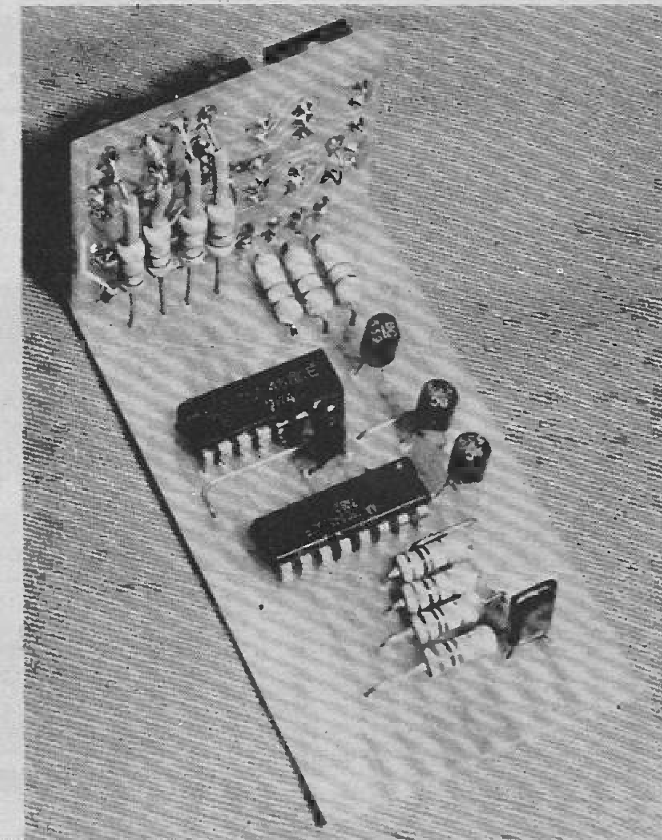
Fig. 1. Circuit diagram of the three digit counter module.

DIGITAL DISPLAY

4. Cost about same as TTL but rapidly decreasing.
5. Immunity to noise is greatly improved.

Disadvantages

Maximum frequency about 1 MHz compared to 15 MHz for TTL..



Rear view of the completed module. Note resistors and links at rear of display board.

CONSTRUCTION

Construction is quite straightforward especially if the printed circuit boards described are used. Since both ICs are CMOS devices, they can be easily damaged by static charges. Hence they should be handled as little as possible, fitted to the board after all other components and soldered using a minimum of heat.

Using the component overlay assemble the three DL704 displays to the display board (533B). Next solder the links onto the copper-side of the

PARTS LIST – ETI 533

R1,2, 3,4 Resistor	100 k	
R5-11	"	see text.
C1 Capacitor	0.001 μF Polyester	
C2 "	0.01 μF Polyester	
IC1 Integrated Circuit	MC 14553 (CMOS)	
IC2 " "	14511 or 4511 (CMOS)	
Q1,2,3 Transistor	BC108 or similar	
DISPLAYS	DL704 or similar three required	

PC boards ETI 533A and ETI 533 B
IC1 and IC2 are available from Marshall's

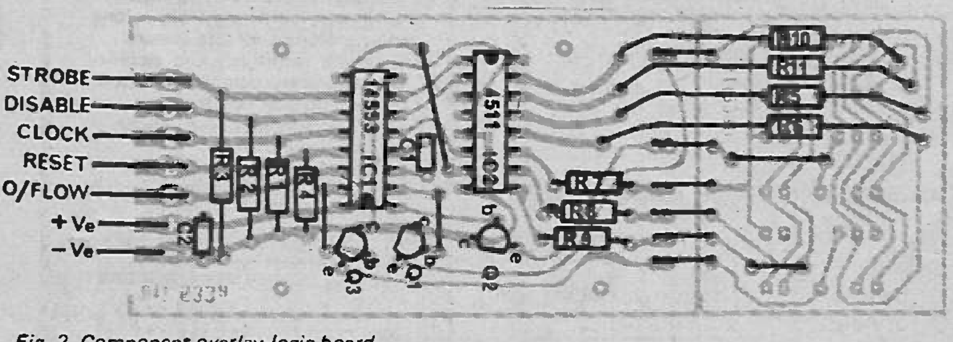


Fig. 2. Component overlay-logic board.

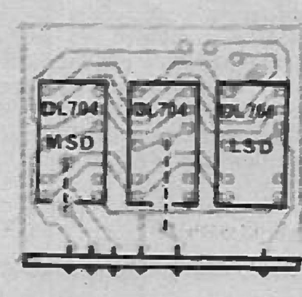


Fig. 3. Component overlay – display board.

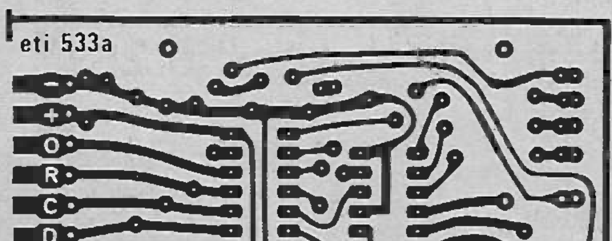


Fig.4. Printed circuit layout for logic board. Full size 80 x 42 mm.

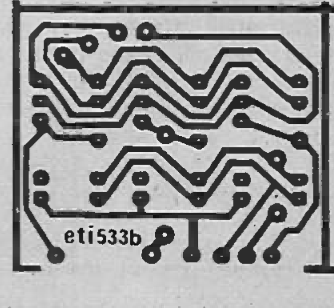


Fig. 5. Printed circuit layout for the display board. Full size 41 x 35 mm.

HOW IT WORKS – ETI533

The heart of the counter is ICI, this LSI CMOS chip contains a three-digit decade counter, three sets of latches, and a three-digit multiplexer with an internal oscillator. C1 is used to set the frequency of this oscillator.

The four input lines to IC1 are used to control the operation of the counter. Since IC1 is a CMOS device R1-4 are used to protect its inputs. Pulses to be counted are fed to the clock input and on a negative transition the value in the counter is increased by one. The schmitt-trigger action of the clock input allows any value of transition time of the input pulse.

The counter operates when there is a low at the disable input (pin 11).

To ensure accurate counting the clock should be low when the disable is brought from a high to a low level. The strobe input controls the loading of the latch. When it is low, data can be accepted for display. However the strobe input has no effect on the counter, i.e. even with the strobe input high, the counter can still be incrementing.

A high on the reset input clears the counters (to a 000 state) and stops the internal multiplexing oscillation of IC2, and so – blanks the display. Returning the reset to a low allows the internal oscillator to start up and all zeros to be displayed. This feature could be used in portable equipment to conserve power.

All inputs are standard CMOS inputs and require a minimum voltage change of from 30% to 70% of supply volts. However it is recommended that a swing from 0V to supply be used to give a satisfactory noise margin. Each input can be considered to be 100k shunted by 8-10 pF. Voltage swing below 0V and above supply are also to be avoided.

The one output available is the overflow (pin 14). This goes positive when the counter is 999 and the clock input is high. When the clock input goes low and advances the counter to all zeros the overflow goes low. This is a CMOS output and will swing between supply rails. It is not recommended that the overflow output be used to drive TTL directly.

The internal multiplexer of IC1 allows considerable saving in parts and board space. It allows a three-digit number to be transmitted over a single set of lines and it does this by leaving each digit on the output lines for a short length of time, before replacing it with the next digit. Then after presenting all the digits once, it starts over again and repeats the operation.

IC2 is a CMOS, latch BCD to seven-segment decoder and driver, however for this application the latch is not used. It converts the 4-bit BCD code into the seven-line code necessary to drive the display segments. It also provides sufficient current to drive the display. Although IC2 is coupled to all three displays, only one display is lit up at any one time. Thus when it is the turn of the most significent digit to be displayed, IC1 presents that number to IC2 which decodes the number and presents it to the three displays, but only Q1 is turned on, so only the left most display lights.

Note that IC1 controls which number is being presented and which transistor is turned on. This is called multiplexing. The switching between displays occurs so quickly that to our eyes the light appears continous.

Resistors R5 to R11 limit the current to each LED display to a safe level. Three different values have been given for these resistors. Select the value appropriate to the supply voltage that you decide to use, 68 ohms for 5 V, 330 ohms for 10 V and 1k for 15 V. Transistors Q1, Q2 and Q3 also act as current amps since only a limited amount of current can be taken from IC1.

Any voltage from 5 V to 15 V can be used to supply the counter, however, a supply voltage of 15 V allows the counter to operate at its highest speed.

display board and form them so that they are clear of other tracks by at least one millimeter.

Next fix lengths of tinned copper wire to each of the six holes on the bottom of the display board. Allow approximately 10 mm of wire to extend from either end of the holes. Bend each wire so that they lie parallel and flush to the surfaces of the display board – do not solder as yet.

On the main printed-circuit board (533A) fit resistors R7, 8, 9, 12, 3 and 4 and capacitors C1 and C2. Now mate the display board to the main board by inserting each of the previously bent wires into its corresponding pair of holes on the main board.

Apply gentle force to the display board until its bottom edge fits snugly against the main board. Solder each of the wires to both the supply and main boards to make a sound electrical and mechanical support for the display.

Fit R5, 10 and 11 and, taking care to orientate them correctly, fit Q1, 2 and 3 and IC1 and 2.

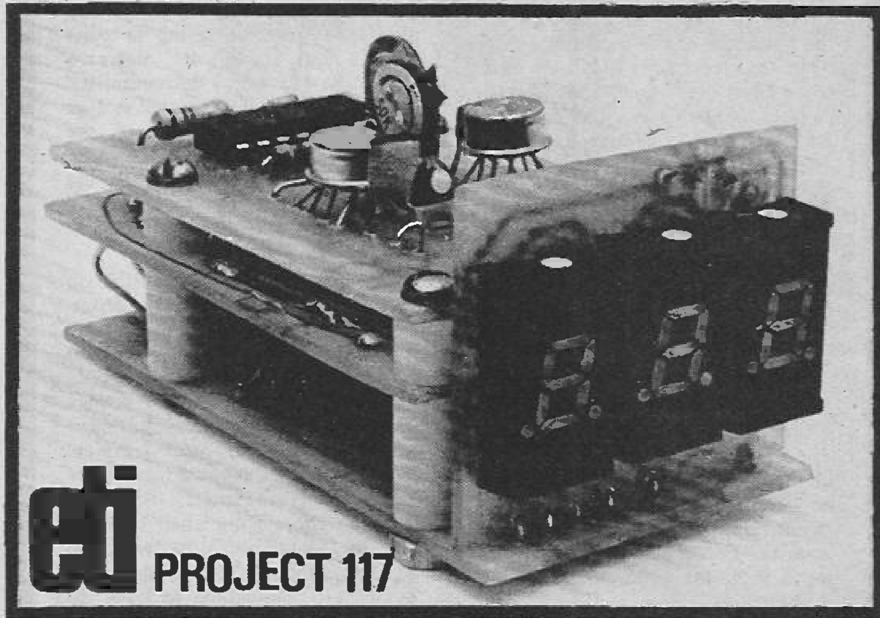
Lastly check that all components have been correctly fitted and all solder joints are good. If possible get someone else to check your final circuit as a final safeguard. ●

DIGITAL VOLTMETER

THE PREVIOUS ARTICLE details a simple, three-digit display module which is readily adaptable to a wide range of applications and is inexpensive to build. This month we provide details of the first of a series of modules specifically designed to interface with the ETI 533 display module.

The first of these modules is a simple, yet accurate, dc digital voltmeter. Fundamentally we have described it as a single range unit which is economical enough to be mounted within other equipment as a panel meter. However an input switch may be readily added to convert the instrument for use on ranges from one volt dc full scale to 1000 volts dc full scale.

We have not described the mounting of the unit in a cabinet or box as individual requirements will vary widely.



Inexpensive unit uses dual-slope technique

Fig.2. Circuit boards used for the converter.

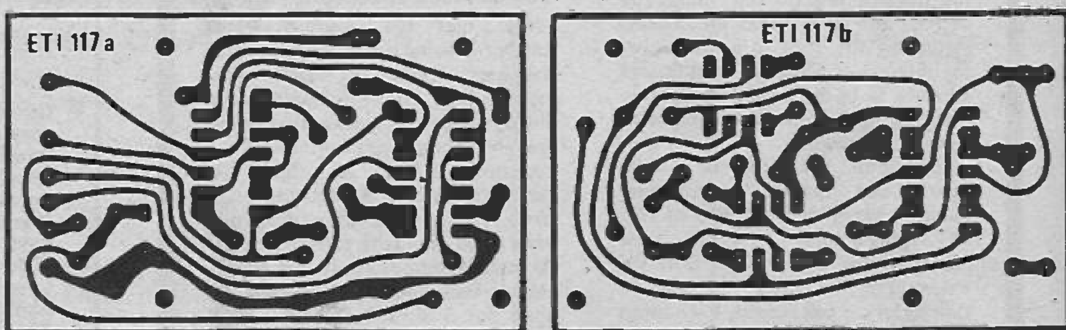


TABLE I

RANGE	VALUE OF R12	
1V	100k	5%*
10V	1M	5%*
100V	10M	5%*
1000V	100M (10 x 10M)	5%*

For multirange meters R12 must be 1% or adjustable.

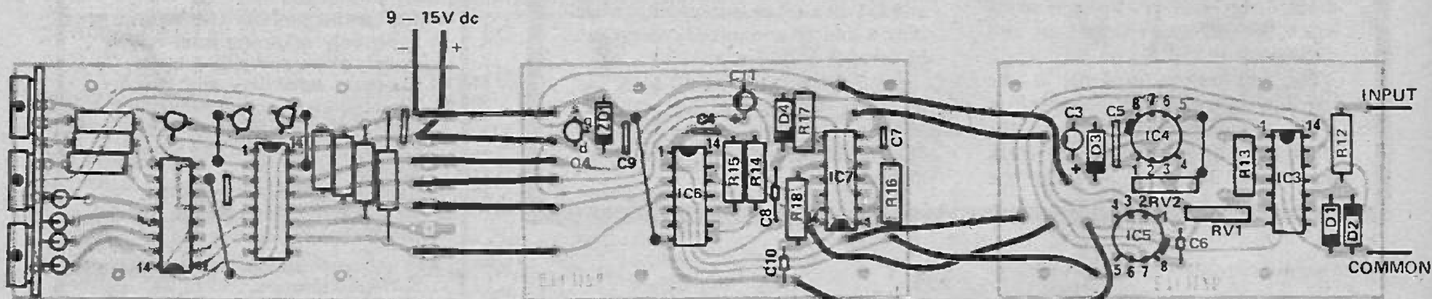


Fig.3. Component overlay of the complete voltmeter.

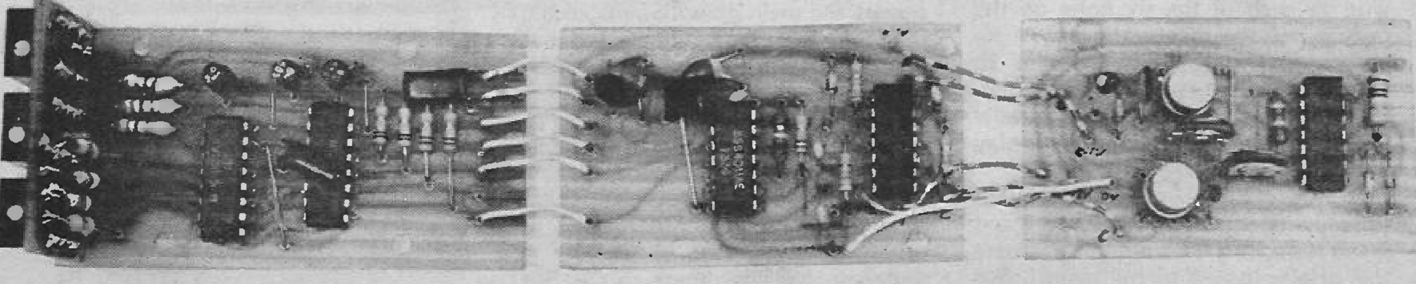


Fig.4. How the voltmeter appears before final assembly.

MEASURED PERFORMANCE OF PROTOTYPE

Number of digits	3	
Overrange	250% (no indication on first digit)	
Dual polarity	No	
Ranges	1, 10, 100 and 1000 V dc	
Accuracy	As adjusted	
Linearity	±1 digit	
Power supply	9-15 V dc at 120 mA isolated	
Input impedance	100 k/V	
Overrange Protection		
1 V range	100 V	limited by power
10 V range	500 V	dissipation and
100 V range	500 V	voltage rating of
100 V range	2500 V*	R12
	* input switch permitting	
Reference	5.1 volt zener at constant current.	

HOW IT WORKS

The method of analogue-to-digital conversion used is the popular dual-slope integration technique. A general explanation of this method was given last month in our multimeter survey and reference should be made to that article. We chose the dual-slope technique because it is relatively insensitive to component tolerances and gives very linear results with least amount of circuit complexity. The technique was developed by Weston and hence is covered by patents, however, there is nothing to stop individual constructors from using it, nor are there any royalties involved.

The circuit consists of an integrator (IC4 and C3), a comparator (IC5), an input selector (IC3), an oscillator (IC6/1,2,3) an RS flip flop (IC7/1,2), pulse generators for the reset and strobe outputs (IC6/4, IC7/3,4), a voltage reference (ZD1 and constant current source Q1), and (last month's) digital display module.

The 5 kHz output of the oscillator, which runs continuously, is connected directly to the clock input of the display module and the conversion proceeds as follows. Flip Flop IC7/2, drives IC3 such that it selects either the input voltage via R12 or the reference voltage via R13. The state of the flip flop is determined by the output state of the comparator IC5 (output high selects input voltage) and the overflow output from the display module (overflow selects reference voltage). If the input voltage is selected the output of the integrator will fall at a rate dependant on the input voltage, and, if the reference voltage is selected the input voltage will rise at a constant rate.

When the integrator output rises above 5.1 volts the comparator output goes high causing the output of IC6/4 to go low (as pin 5 of IC6/4 is also high). After about 10 µseconds delay, due to R16 and C7, the flip-flop changes state and the output of IC6/4 goes high again Thus a pulse is generated which is used as the strobe to transfer whatever number is in the decade counters into the store, and hence, to the display. The strobe pulse also triggers a 15 microsecond monostable, IC7/3, the output of which is delayed by 10 microseconds and inverted by IC7/4. This new pulse acts as a reset pulse for the counters setting them to zero.

As the flip flop has now reverted to its original state the input voltage is reselected and the integrator commences to ramp down again repeating the cycle.

Whilst the input voltage is selected clock pulses are gated into the counter and after about 200 milliseconds (1000 clock pulses each 0.2 mS) the counter will be full. The overflow thus generated from the display changes the state of the flip flop and the reference voltage is selected. The voltage across the integrator (referenced to 5.1 volts) at this instant will be proportional to the input voltage. With the reference supply connected the output of the integrator will rise at a predetermined rate and on crossing the 5.1 volt reference level the strobe and reset pulses are generated, the flip flop toggled and the process started again.

The time taken to bring the integrator back to the reference level is proportional to the input voltage and hence the number in the decade counter at that instant is the required reading of input voltage.

The only components which are required to have good stability, if accuracy is to be maintained, are R12, R13 and ZD1. All other components, provided their short-term stability is good, can be almost any tolerance. The integrator capacitor, for example, can have any value between 0.5 microfarad and 2.0 microfarads without affecting accuracy. However variations in the value of this capacitor will affect the over-range capability. The clock frequency may likewise be altered without affecting accuracy however, if the time of 1000 clock pulses is a multiple of 20 milliseconds the voltmeter will automatically reject 50 Hz ripple on the voltage being measured. This however was not considered of great enough importance to warrant special adjustment of the clock frequency which is preset by R15 and C4.

The reference supply is a 5.1 volt zener diode and a FET connected as a constant current source. The 5.1 volts is used as the common and hence, the 12 volt supply for the voltmeter must be left floating and must not be connected to ground or to any other equipment.

Due to the simplicity of the circuit there are some features of the instrument which are not desirable but do not greatly affect the operation of the instrument. Firstly there is no over-range indication and thus if 15 volts is applied to the 10 volt range the instrument will read 5 volts. The unit remains accurate (except for the first digit which is lost) until the integrator clips on its negative swing (about 250% of full scale). The other point is that if the input voltage is negative the comparator, IC5, will remain high and no further strobe or reset pulses will be generated. The effect of this is to freeze the display at the last number. This is not normally a problem as the display goes to zero if the input is disconnected.

CONSTRUCTION

The display-counter module ETI 533 should be built first using the instruction given on page 16.

Two additional boards are required to complete the voltmeter and the overlays and interconnections are given in Fig. 3. Check that all components, especially the metal case ICs are orientated correctly.

The interconnection wires should be long enough to allow the boards to fold together as shown above. The lower board ETI 533A has the components uppermost, the middle board ETI 117A has the components

DIGITAL VOLTMETER

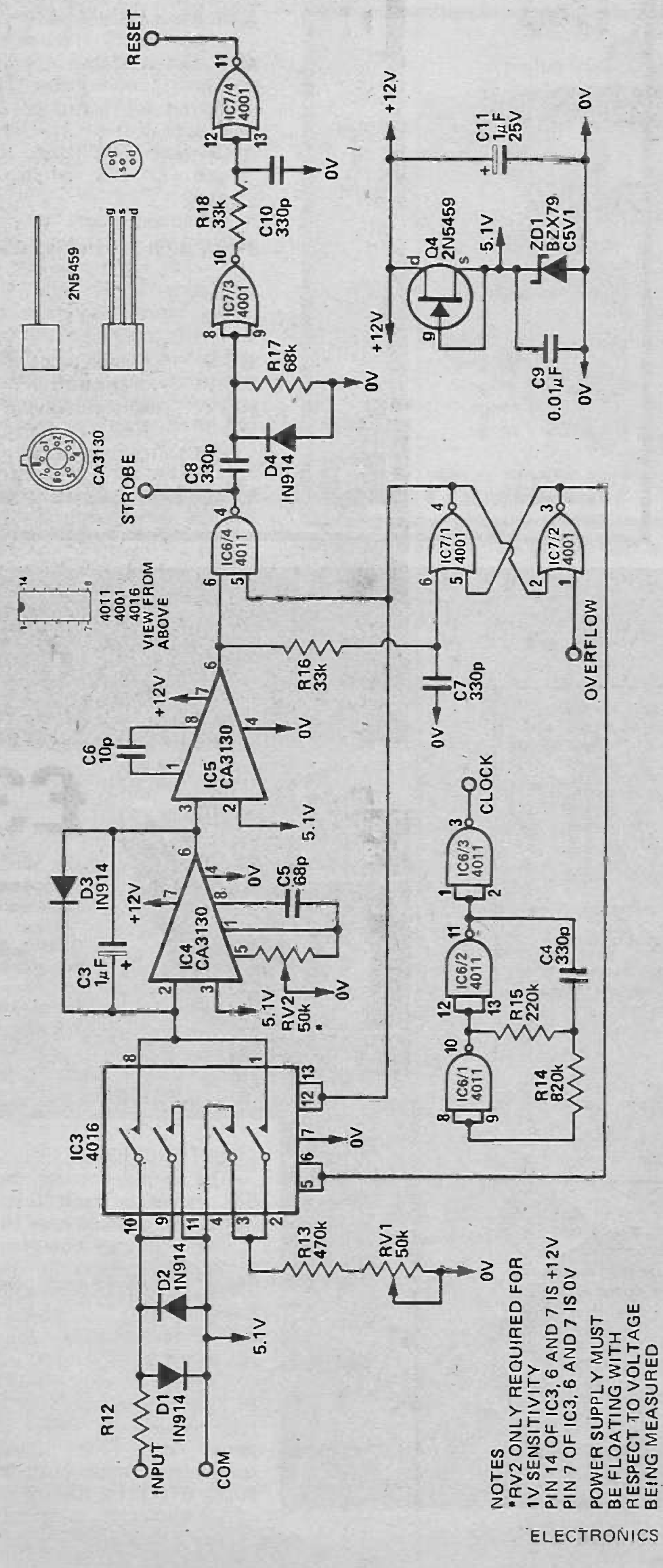


Fig. 1. Circuit diagram of the dual-slope analogue to digital converter. This circuit is used together with the ETI 533 display to make the complete voltmeter.

PARTS LIST

R16,18	Resistor	33k ¼w 5%
R17	"	68k " "
R15	"	220k " "
R13	"	470k " "
R14	"	820k " "
R12	"	See text
RV1,2	Potentiometer	50k Trim type
C6	Capacitor	10pF ceramic
C5	"	68pF
C4,7,8,10	"	330pF "
C9	"	0.01µF polyester
C3,11	"	1µF 25V Tantalum
D1,2,3	Diode	IN914 or similar
ZD1	Zener diode	5.1V, 400mW
Q1	Transistor	2N5459 or similar
IC3	Integrated circuit	4016 (CMOS)
IC6	" "	4011 (CMOS)
IC7	" "	4001 (CMOS)
IC4,5	" "	CA3130
PC Boards ETI 117A, ETI 117B		
Display Board Complete — Project ETI 533		

The CA3130 is being stocked by Marshall's for this project. The inclusive price for two devices is £1.70.

downwards while the top board ETI 117B again has the components uppermost. It may be necessary to juggle the components slightly on the lower two boards to allow them to fit together closely enough. These two boards are spaced apart with 12mm long spacers while the upper two boards are separated by 6mm insulated spacers. A piece of insulation material should be fitted between the top two boards to prevent the solder joints touching.

Power, 9-15 volts dc, is supplied to the lower board while the input connects to the upper board.

The unit can be either installed in a suitable box or within a piece of equipment. If range switches are required simply change the value of R12 as per Table 1.

CALIBRATION

Unfortunately to calibrate any voltmeter a known voltage reference or an accurate voltmeter is required for comparison. Two adjustments are provided, one for calibration and the other to compensate for the offset in the integrator IC. For input voltages of 10 V or more the offset potentiometer is not required as the error is within one digit.

This offset potentiometer should be adjusted first by applying a voltage of about one per cent (10 digits) of full scale and adjusting RV2 to give the correct reading. The calibration potentiometer RV1 can now be adjusted by applying an accurately known voltage near full scale.

The meter has a large overrange and voltages up to 250 per cent of full scale can be measured except that the first digit is lost and must be assumed, ie, if you are measuring a car battery on a 10 V range and it reads 3.52 V it is obviously 13.52 V.

TAPE BIAS

What does it really mean?

by Len Feldman

THE INCREASING popularity of tape recorders as a high-fidelity programme source is not difficult to understand. Unlike other programme sources, such as FM radio and gramophone records, tape offers the audio enthusiast the sense of involvement that makes the hobby all the more worthwhile. In addition, today's open-reel tape decks have performance which is often indistinguishable from that afforded by professional studio tape recorders, and the once looked down upon cassette deck has been transformed from a portable "dictating machine" to a high-fidelity component.

With such a wide interest in tape and tape recording, it is surprising how little most users of these products know about their operation. Unlike purely electronic products, such as amplifiers, tuners or receivers, tape decks involve an inter-relation of mechanical, magnetic and electronic systems.

Today, most audiophiles have a fairly clear understanding of what record equalization is all about. In essence the bass is attenuated and treble accentuated during recording — the opposite takes place during reproduction. The overall effect is to reduce groove amplitude and increase record playing time. It also improves signal/noise ratio. The record industry have an agreed standard for equalisation. This is called the RIAA curve (Fig. 1). The amplifier or preamplifier spec sheet has drummed home the idea that the closer an audio preamp adheres to the RIAA playback curve, (shown in Fig. 1), the better the product.

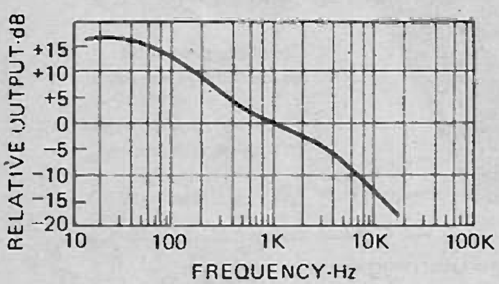


Fig. 1. Standard RIAA playback curve used for phono disc reproduction.

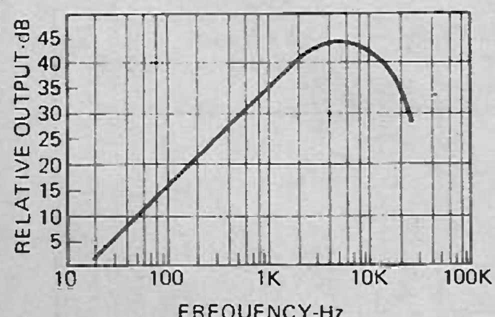


Fig. 2. Typical tape playback head output with constant-level signal recorded on tape.

Equalization is also required for tape recording. But there is no one standard here, each tape requires different equalization for optimum results. Why should this be so? Why cannot the industry "get together on a single, standard equalization" for tape recording and playback. Why, in fact, are better recorders (both open-reel and cassette) equipped with multiple equalization settings? And what about those multiple bias settings on some of those same recorders?

EQUALIZATION

To begin with, a tape recorder does not reproduce signals with a flat frequency response. A tape playback head, being sensitive to the rate of change of a magnetic field, produces a greater output as frequencies increase. (At higher frequencies, alternations of magnetic field become more rapid). Thus the output voltage increases with frequency as illustrated in Fig. 2. Eventually, the level ceases to increase with frequency and, in fact, begins to drop off fairly rapidly.

Two factors are responsible for this drop off. As the frequency to be recorded increases, the wavelength decreases. In addition, as magnetic variations increase in intensity, a point is reached where the tape begins to be saturated — it cannot accept greater and greater amounts of magnetization — and level begins to drop. The second of these factors is, to some degree, governed by the formulation of the tape itself, while the first is governed primarily by tape speed and the gap length of the tape head. Figure 3 illustrates how the linearly increasing voltage output varies with popular tape speeds for a given tape head gap (4 microns), while Fig. 4 shows how linear output can be extended to higher frequencies at a given tape speed by decreasing the tape head gap.

Obviously, none of the curves of Figs, 2, 3 or 4 would be acceptable for high-fidelity reproduction. The process used to restore "flat" response in tape recording and playback is called *equalization*. Equalization can be applied both during the record operation and during playback. Referring again to Fig. 2, if during playback the response curve of Fig. 5 is used, the resulting overall record/playback response will be as shown in Fig. 6. Note that there is still some roll-off at low and high frequencies.

RECORD EQUALIZATION

In order to realize optimum high-frequency response, equalization is used in the record process, too. Record equalization can offset high-frequency roll-off to some degree, but if too much high-frequency pre-emphasis is used, the tape will become saturated at lower nominal recording levels and distortion and roll-off will occur anyway. Playback equalization can in theory, be used to extend high-frequency response but if highs are boosted too much during playback, increased tape hiss will be heard. The record and playback curves must therefore strike a balance to minimize problems of each.

In professional recording work,

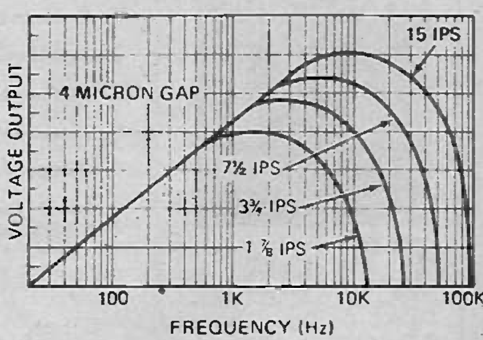


Fig. 3. Linear increase in output voltage extends to higher frequencies at increased tape speed.

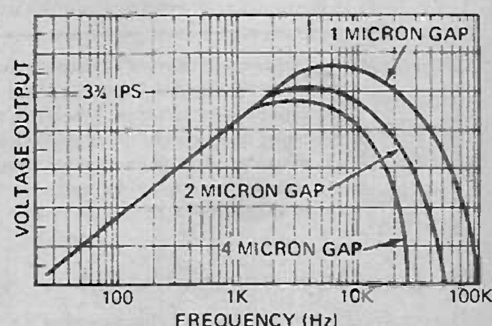


Fig. 4. Reducing playback head gap while maintaining constant tape speed will extend the high-frequency response.

standards of record and playback equalization were developed by the U.S. NAB (National Association of Broadcasters) and the German Standards organization known as DIN. These standardized curves are plotted in Fig. 7. The DIN or CCIR curves tend to strive for higher frequency response. By using a bit less record equalization, tape saturation is not reached as soon. But this requires more playback equalization which results in higher tape hiss.

In the consumer audio field, manufacturers often change their equalization curves to offer "extended response" which seems to be the sole criterion by which many audiophiles judge tape deck performance. With a given tape speed and a given head gap, however, such "improvements" are invariably accompanied by either reduced level of recordings or increased tape hiss or combinations of both.

In general, frequency response curves for tape equipment are plotted not at 0 dB level on the record level meters but at a level of −10 dB or even −20 dB in the case of open-reel machines and at −20 dB or even −30 dB in the case of slower-speed cassette decks (which require greater high-frequency boosting during recording to compensate for reduced tape speed.)

Some years ago, the industry introduced chromium dioxide tape. It delivers somewhat higher frequency before saturation drop-off occurs. This characteristic produces a slight increase in high-frequency response or for improved signal-to-noise ratio (reduced tape hiss) or a combination of both.

Today, there are a great many different tape formulations, each of which requires a different record and playback equalization. Multiple switch positions are provided on many open-reel and cassette decks which adjust equalization to suit the various popular formulations. Actually, professional machines used in recording studios are often adjusted to work best with one and only one brand and type of recording tape. Conscientious studio engineers may even re-calibrate or adjust equalization when different production batches of the same brand and type of tape are used. The very least that a home user can do to ensure optimum results with an open-reel recorder or better cassette unit is to follow the manufacturer's recommended equalization settings for the type of tape being used. Most owner's manuals list a variety of tapes and their appropriate settings for machines equipped with more than one equalization switch position.

BIAS

Assuming that both recording and playback equalization have been optimized with respect to each other in a given recorder, one would expect that the magnetic pattern recorded on the tape will now correspond exactly to the strength of magnetic fields generated by the record head. Unfortunately, magnetic tape is basically a non-linear medium. The magnetic pattern left on the tape is not always proportional to the instantaneous current in the recording head. The greatest amount of non-linearity occurs as the audio waveform passes through the zero axis, as shown diagramatically in Fig. 8. Hysteresis effect, a sort of magnetic inertia, acts upon the particle as magnetization begins. After this initial reaction, the particle responds linearly to the applied field. If nothing were done to offset this effect, a sine wave recorded onto tape as shown in Fig. 8a would take on the appearance of Fig. 8b when played back. Obviously, this is a form of distortion and, what is worse, it is a very annoying form of distortion containing high order harmonics. Furthermore, it is a form of distortion that actually is more disturbing at low recording levels than at high signal levels, since the distortion components remain constant and therefore constitute a higher percentage of the total signal at lower recording levels.

High-frequency bias current is used in all modern recorders to overcome this problem. Generally, this super-audible frequency should be at least four times the frequency of the highest audio signal to be recorded,

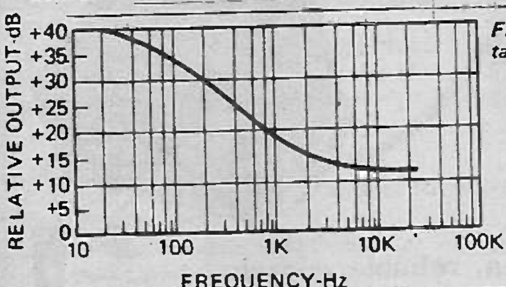


Fig. 5. Typical playback equalization in tape deck preamp circuitry.

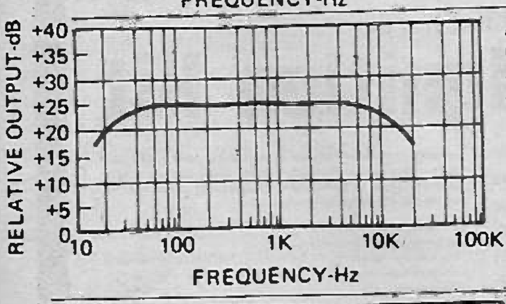


Fig. 6. Combining recording response (Fig.2) with equalized playback response (Fig.5) results in overall record/play response shown.

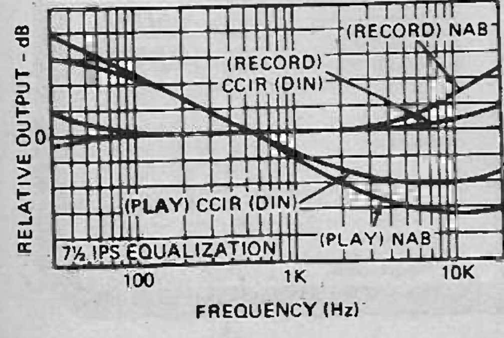


Fig. 7. Record and playback equalization standards adopted by the NAB and European standards organizations.

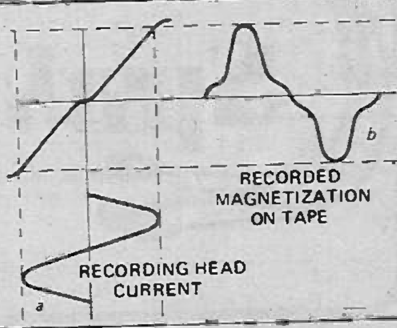


Fig. 8. Distortion caused by non-linear magnetization characteristics of tape is similar to crossover distortion encountered in improperly biased Class B audio amplifiers.

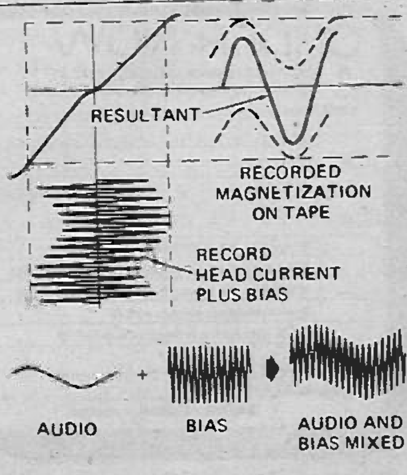


Fig. 9. Combining high-frequency bias with desired audio signals during recording shifts audio magnetization of tape to its linear undistorted region.

TAPE BIAS

but open-reel recorders will often employ bias frequencies of the order of 100 kHz to 125 kHz while modern high-quality cassette units use frequencies in the range from about 80 kHz to 105 kHz.

The combined action of the desired audio signal and inaudible bias signal can best be understood by referring to Fig. 9. The bias current magnetizes the oxide particles through the non-linear segment of the curve. Then the audio signal actually demagnetizes the

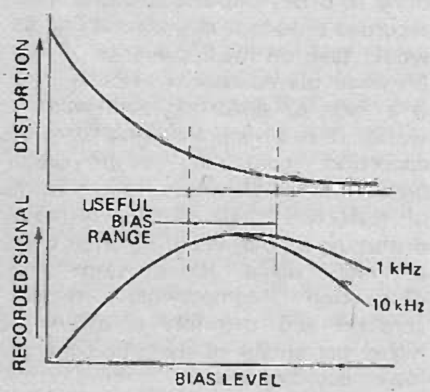


Fig. 10. Increasing bias level reduces distortion, but overbiasing will reduce high-frequency response.

particles to a level which is proportional to the signal.

Bias level changes will affect distortion level. Generally, as bias level is increased (starting from no bias) distortion will decrease rapidly at first. With further increase of bias level, distortion decreases more slowly. If bias is increased much beyond this desired point, high-frequency response will get poorer. Ideally, bias should be set as high as possible without causing severe high-frequency losses in the recorded tape. The action of bias in relation to distortion and high frequency response is shown in the general curves of Fig. 10.

Audiophiles who learn of bias for the first time often wonder why the high-frequency bias signal is not recovered as part of the playback signal. In fact, the bias signal does record a series of magnetic fields of its own, but their wavelength is so short that no playback head, however narrow its gap, can significantly response to these high frequencies. Some small high-frequency energy is picked up by the playback head (however many dB down it may be compared to desired audio signals) and is one of the reasons why higher than necessary frequencies are now used for bias.

Much home recording is done of stereo FM programmes and stereo composite signals contain varying amounts of 38 kHz signals in their output. If, for example, 45 kHz were used as a bias frequency in tape decks, a distinct 7 kHz "whistle" might be heard when playing back such recorded stereo FM programmes, resulting from the beat or difference between the two otherwise inaudible high-frequency signals.

Since oxide formulations vary greatly from one tape type to another, each requires a different bias level. For this reason, home tape recorders now come equipped with separate bias switches to match the various bias requirements of different tapes. In the case of professional machines, bias adjustment is usually continuously variable and professionals will often apply a slight amount of excess bias. This practice can reduce recording drop outs that sometimes occur because of poor or non-uniform dispersion of oxide particles on the tape surface. Again, the professional recording engineer will often choose a slight reduction of high-frequency response if that choice means reduced overall distortion and the elimination of other bias related problems. ●

Reproduced by arrangement from Radio Electronic's May 1975*

ETI HELPING HAND COMPETITION

ETI have arranged some very attractive competitions in the past, the ETI / Doram Design Competition open until the end of October with prizes totalling £500 is one example. Helping Hand is a different type of competition - we are not asking people to enter for what they can get out of it, rather, for what readers can contribute to a less fortunate section of the community - the deaf.

Helping Hand is being organised by ETI with the complete co-operation of the Royal National Institute for the Deaf. We hope that all types of readers will enter - individuals, schools, colleges, apprentice groups and even companies. Although the problems are challenging, we feel that the ingenuity of ETI readers will probably come up with at least one solution which will make life more secure or easy for the deaf.

The Prizes

Helping Hand is to find solutions to three specific problems. There are three prizes, one for the best solution in each category. This will be a specially designed engraved trophy. The main prize winner will be the RNID however. At the close of the competition, ETI will hand over the prize winning ideas to the RNID together with a cheque for £250 to help with the cost of developing the idea into production. There is a £1.00 entrance charge and all money received in this manner will also be passed onto the RNID for the same purpose.

How to Enter

The problems, listed here, are put in very general terms. We do not wish to place any restrictions on how these problems are to be solved - the solution will probably be electronic, but need not be. Solutions do already exist for these problems but high cost and impracticality lead us to believe that better solutions, or inexpensive ones can be found.

Helping Hand is open until March 31st 1976 but entrants are asked to send in their entries before that date if possible

A fair amount of background information has been prepared by ETI and the RNID , readers intending to enter are asked to send a large stamped self-addressed envelope for this and the entry form. This should be sent to Helping Hand, Electronics Today International, 36 Ebury Street, London, SW1W OLW.

An entrance fee of £1.00 is being made: the cheques or postal orders for this should be made payable to the Royal National Institute for the Deaf, not ETI.

The judging will be carried out by representatives from the RNID and ETI, details will be published nearer the closing date

The Rules

1, There are no restrictions on who enters; individuals, groups, clubs, colleges, schools and companies are eligible.

2 The ideas need not be new but should not already have been declined as impractical.

3 Entrants may submit patented designs or may apply for patents before submission. It is, however, a condition of entry that any patented design is made available to the RNID free of royalty and entrants will be asked to declare this on their entry form.

4 The judges reserve the right to award the prizes to the three best entries, irrespective of category, if entries for other categories are not considered worthy.

5 All entries should reach ETI by 31st March 1976, accompanied by £1.00 (payable to the RNID) and a completed entry form.

6 ETI reserve the right to publish details of any entry after the closing date.

The Problems

1 A sick person is being looked after by a deaf person. The deaf person has no useful hearing and requires to know whether the sick person is all right and above all needs to know if the sick person is in a state of distress anywhere in the sick room.

2 A hard of hearing person is attending a College of Further Education and has considerable difficulty in understanding what the lecturer says due to his distance from the lecturer and to the background noise in the room. A device is required to enable him to make the the best possible use of his hearing.

Note: The inductive loop system is widely used in this country to help overcome these difficulties but has the problem that it has to be installed. Radio microphones systems are also used but again have the disadvantage of being very costly and cumbarsome to use.

3 Many deaf people have great difficulty in using the telephone and in fact many of them can not use the telephone at all. The development of a writing tablet which would allow them to write a message on a small pad and for this to be communicated over the telephone line to a pad at the other end would have many advantages. In addition the communication should be two way so that the person can receive a message or an indication that the message has been received.

INTERNATIONAL

PART 1

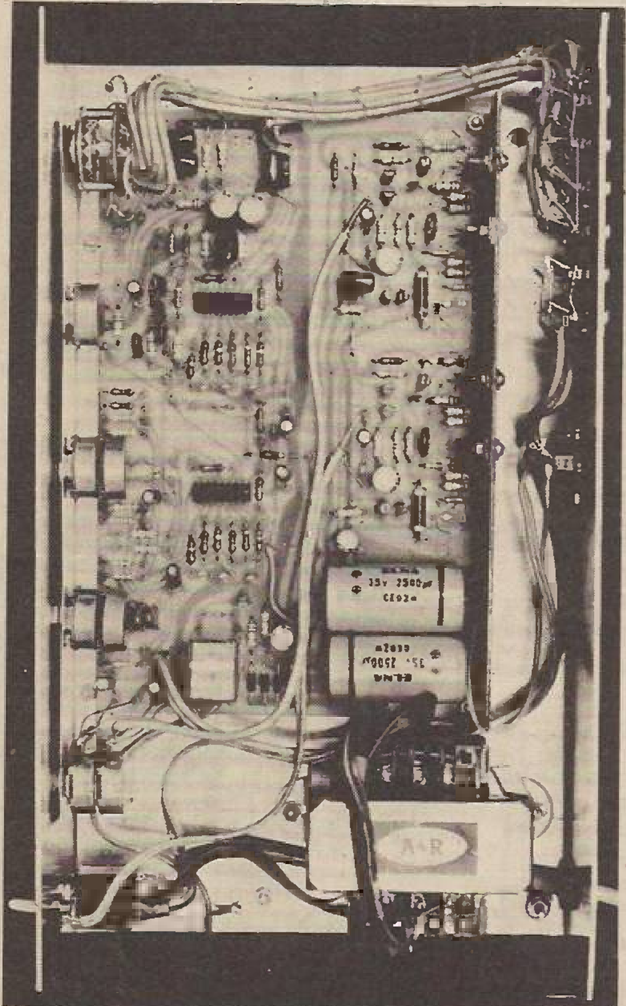


Fig. 1. Internal view of the INTERNATIONAL·25

MEASURED PERFORMANCE OF THE INTERNATIONAL·25			
POWER OUTPUT		25 + 25 watts into 8 ohms	
FREQUENCY RESPONSE		+0 −0.5 dB	15Hz–30kHz
		+0 −3 dB	6 Hz – 80 kHz
CHANNEL SEPARATION		1 kHz – 46 dB	
HUM AND NOISE (with respect to 25W)			
Phono (10 mV)		67 dB (unweighted)	
Other inputs		68 dB (unweighted)	
INPUT SENSITIVITY			
Phono		2.5 mV	47k
Other inputs		200 mV	47k

TOTAL HARMONIC DISTORTION

Power	Frequency	One channel	Both channels
12.5W	100 Hz	0.1%	0.13%
	1 kHz	0.08%	0.16%
	10 kHz	0.12%	0.17%
20W	100 Hz	0.14%	0.5%
	1 kHz	0.12%	0.6%
	10 kHz	0.17%	0.8%
25W	100 Hz	0.5%	5.2%
	1 kHz	0.6%	4.8%
	10 kHz	0.7%	4.3%

TONE CONTROLS	
Bass	12 dB boost at 50 Hz
	12 dB cut at 50 Hz
Treble	9 dB boost at 10 kHz
	9 dB cut at 10 kHz
DIMENSIONS	340 x 88 x 210 mm

THE INTERNATIONAL·25 is a twenty-five watt per channel, high quality audio amplifier which is so easy to build that it is likely to set a standard for the amateur constructor which will remain unbeaten for years to come. ETI's top design team used some of the latest devices on the market to achieve this breakthrough.

WHEN designing this amplifier considerable effort was made to achieve several, generally incompatible, aims. These were to design an amplifier that gave high performance, was simple enough for the beginner to build BUT, was low in cost.

Since a high percentage of the cost of an amplifier is in the hardware, (e.g. chassis, potentiometers, switches etc) and this cost does not vary greatly relative to amplifier power output, we aimed at the highest possible power for reasonable cost. Thus the amplifier gives 25 watts RMS per channel which is about as much as can be obtained without component costs increasing dramatically.

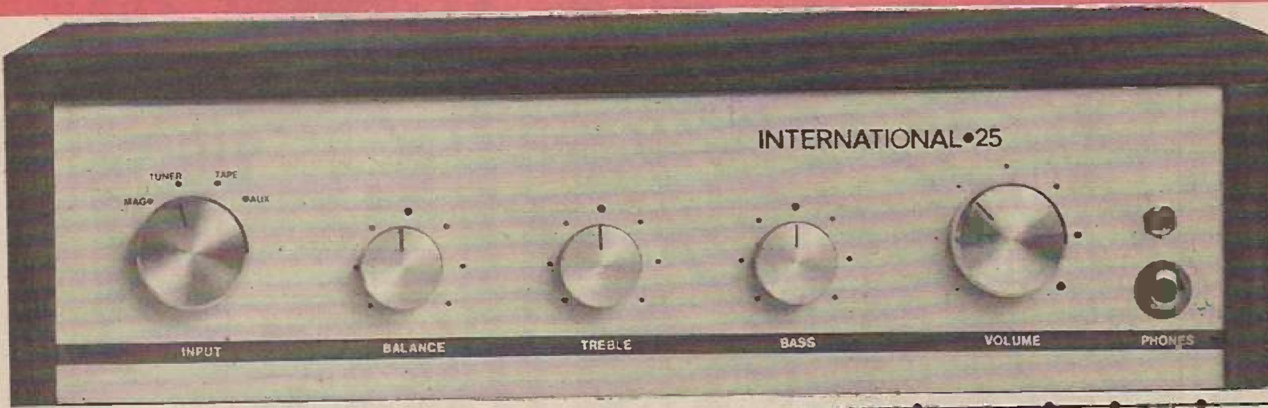
To gain the required simplicity we used a single printed circuit board, to hold as much as possible of the electronics, thus keeping external wiring down to a minimum.

The result is a 25 watt-per-channel amplifier which is extremely easy to build and set up, which has a distortion of around 0.1% and costs about the same as a 12 watt per channel kit at present on the market that is much more difficult to build.

The single printed-circuit board

25 STEREO AMPLIFIER

eti project



COMPONENT SUPPLY

Some of the components used in this amplifier are so new that most of the local component shops won't have them. In fact they probably will have never heard of some of them.

We have, however, made arrangements with Doram Electronics for the supply of components used in the amp. Doram also can supply the case, the metal work, the pcb, etc.

A complete kit of parts is available for £29.95 (plus £4.05 VAT) including P and P from DORAM ELECTRONICS LTD, P.O. Box TR8, Wellington Road Industrial Estate, Wellington Bridge, Leeds, LS12 2UF.

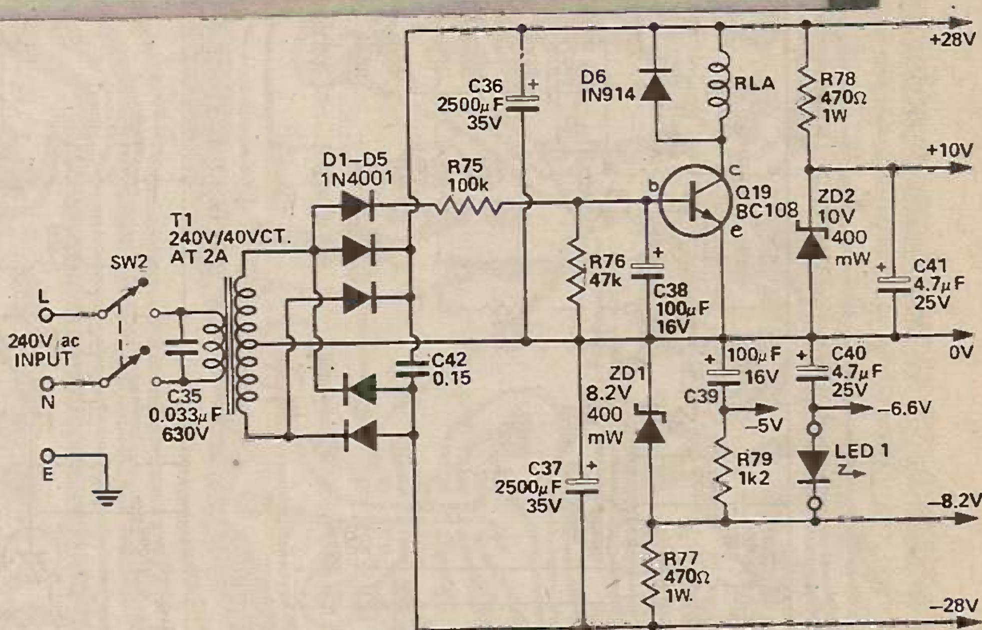


Fig. 2. Power supply of the INTERNATIONAL·25

construction greatly simplifies things for the beginner. A heatsink is attached to the rear of the board to hold the power transistors, and a bracket at the front holds the potentiometers. Before attaching these brackets assemble the components to the printed circuit board according to the component overlay, which we will print next month.

In this first part we give you the circuit, pcb design and parts list so that you can get the components together. However we do not recommend you to start building until you have read the final part of the article next

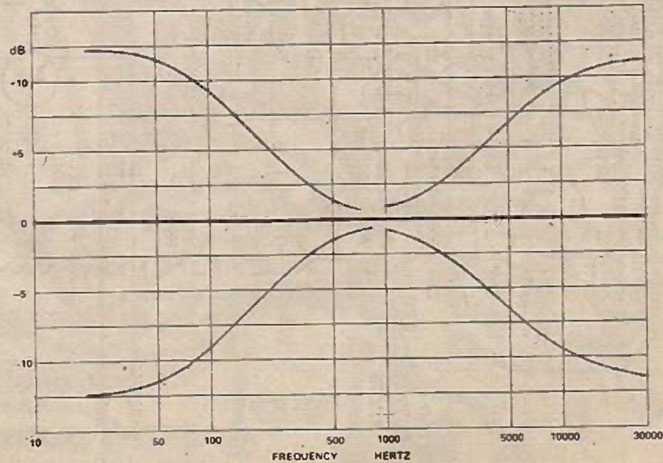


Fig. 3. Tone control characteristics.

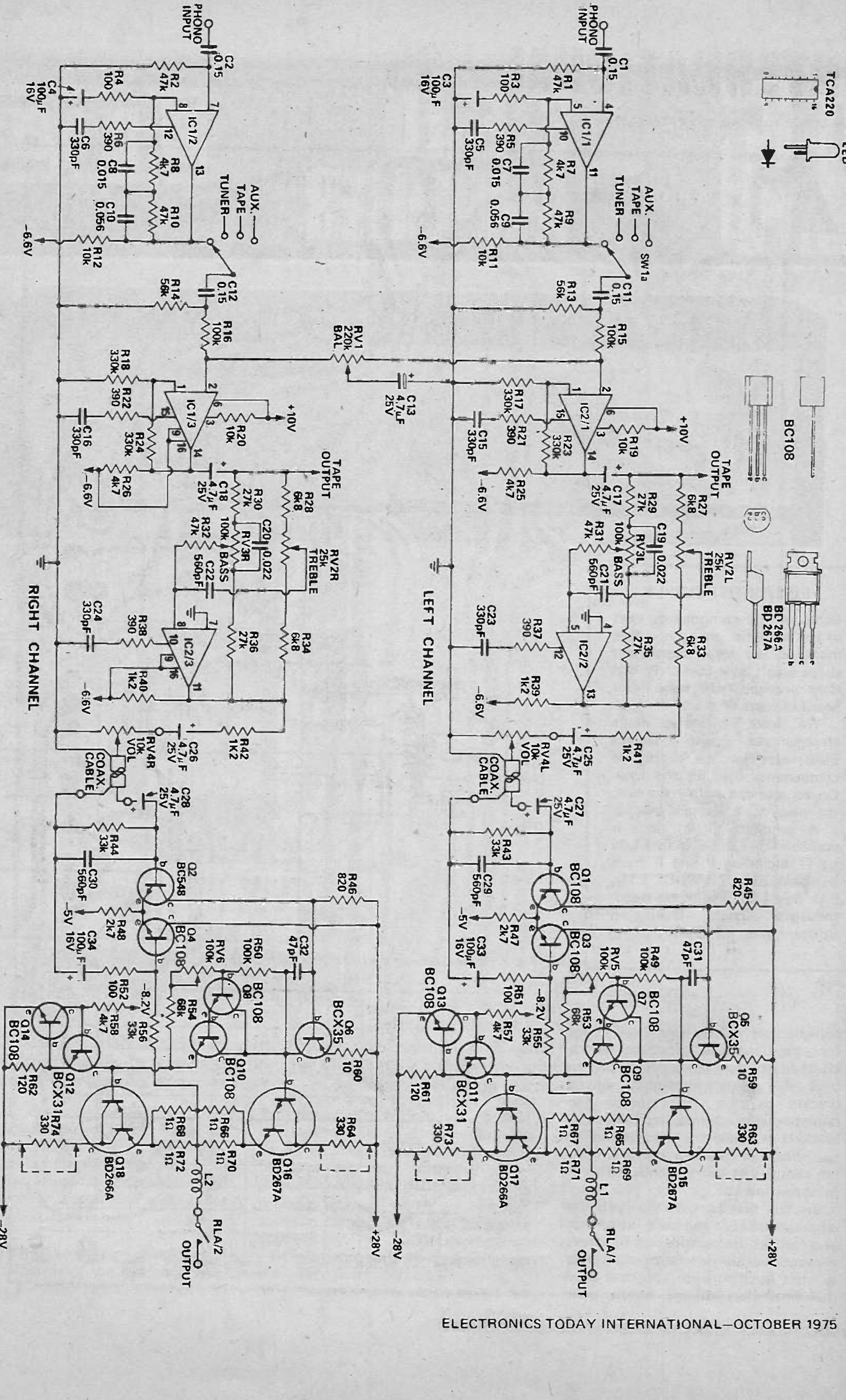
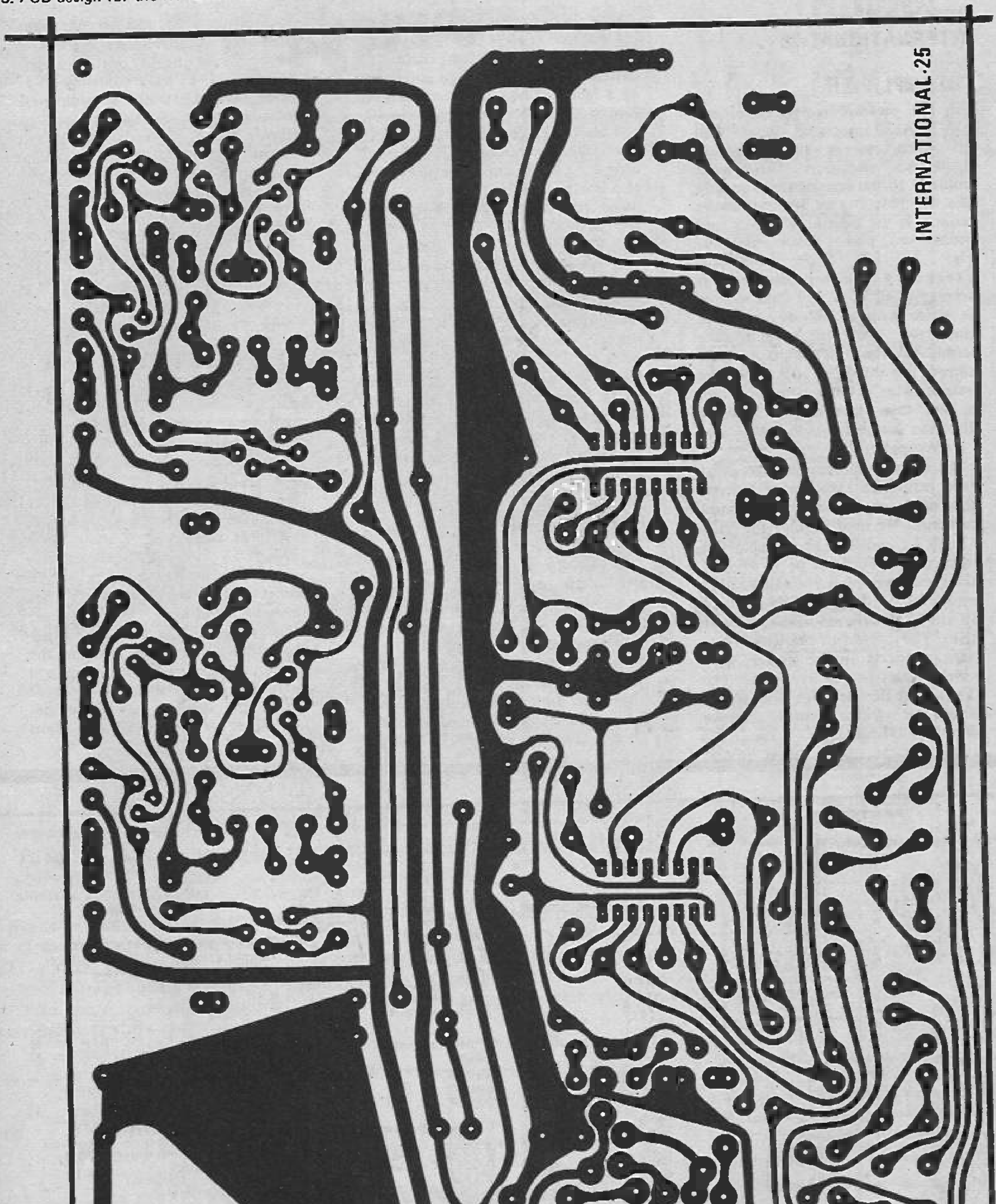


Fig. 4. Circuit diagram of the INTERNATIONAL-25.

 Main text continues on page 30....

Fig. 5. PCB design for the INTERNATIONAL-25.



HOW IT WORKS – INTERNATIONAL-25

PREAMPLIFIER

In the preamplifier we have used two TCA220 integrated circuits each of which contain three identical operational amplifiers. These work similarly to the conventional op amp like the 709, 741 or 301 except the output is an emitter follower and needs a pull down resistor. Fig. 1. for those interested. Frequency compensation is accomplished by a 390 ohm resistor in series with a 330 pF capacitor connected to the appropriate terminal. The maximum voltage allowed on this IC is 18V. Since the output swing in the positive direction is less than that in the negative direction we have used +10V and −6.6V supplies.

The magnetic pickup used on most good turntables has a low output and also needs equalization to perform correctly. We used part of the TCA 220 (ICI-1 and ICI-2) to amplify this signal (about 60 times or 35 dB at 1 kHz) and to provide the equalization required (+13 dB at 100 Hz and −14 dB at 10 kHz referred to the gain at 1 kHz). The output of this amplifying stage connects to the switch SW1 which selects the desired input. The signal from the cartridge is amplified before the selector switch to improve the signal-to-noise ratio.

After the selector switch we have the balance control (RV1) which attenuates either left or right channel as desired. The signal is then amplified, by a factor of two, to recover what is lost in the balance-control network and also to buffer the signal to give a low impedance output. The output drives the tone-control network and also the tape-output sockets.

The tone-control section uses the last sections of the TCA220 (IC2/2, IC2/3) with the bass and treble controls in the feedback network. These controls provide about 10 dB of boost and cut of both bass and treble. Resistors R27 and R33 set the limit of the treble boost and cut, while C21 controls the actual frequency where the treble control starts. Resistors R29 and R35 control the bass limits while C19 sets the frequency. The output of the stage is connected to the volume-control potentiometer RV4.

POWER AMPLIFIER

The power amplifier is of conventional design using a differential pair Q1 and Q3 followed by a common-emitter amplifier stage, Q5, working at a constant current (5 mA) supplied by Q11 and Q13. The output of Q5 is buffered by the output transistors Q15 and Q17. These are darlington transistors and have a current gain (Hfe) of over 750 at 3A. These transistors are biased on slightly (10 mA) to remove cross-over distortion and the bias is set by measuring the voltage across R63 or 73 (3V) while adjusting RV5. After bias adjustment is completed these resistors are shorted out to allow full power capability. Transistors Q7 and Q9 are physically joined onto Q15 and Q17 to provide accurate temperature indication and to ensure thermal stability.

The gain of the power amplifier stage is 100 and is set by the ratio of R55/R51. The earth reference for the power-amplifier input stage is supplied via the coax cables connecting to the preamplifier.

POWER SUPPLY

The power supply is a full wave rectifier with a centre-tapped transformer supplying ± 28V to the main amplifiers. The supplies for the preamplifier are obtained from a 10 V zener ZD2 and a 8.2V zener ZD1. The actual negative supply to the preamplifier comes via the LED on the front panel and is about −6.6 volts (1.6V across LED). A smooth −5V is also derived from the −8.2V and is used for the differential pair in the main amplifier.

The relay RLA is used to prevent the switch on transient reaching the speakers. After switch on there is a delay due to C38 of about 4 seconds before the speakers are connected. On switch off the delay is only about 1 second.

PARTS LIST

R65, 66	Resistor	1Ω	½W	5%
R67,68	"	1Ω	"	"
R69,70	"	1Ω	"	"
R71,72	"	1Ω	"	"
R59,60	"	10Ω	"	"
R3, 4	"	100Ω	"	"
R51,52	"	100Ω	"	"
R61,62	"	120Ω	"	"
R80,81	"	220Ω	1W	"
R63,64	"	330Ω	½W	"
R73,74	"	330Ω	"	"
R5,6,21	"	390Ω	"	"
R22,37,38	"	390Ω	"	"
R77,78	"	470Ω	1W	"
R45,46	"	820Ω	½W	"
R39,40,41	"	1k2	"	"
R42,79	"	1k2	"	"
R47,48	"	2k7	"	"
R7,8,25	"	4k7	"	"
R26,57,58	"	4k7	"	"
R27,28	"	6k8	"	"
R33,34	"	6k8	"	"
R11,12	"	10k	"	"
R19,20	"	10k	"	"
R29,30	"	27k	"	"
R35,36	"	27k	"	"
R43,44	"	33k	"	"
R55,56	"	33k	"	"
R1,2,9,10	"	47k	"	"
R31,32,76	"	47k	"	"
R13,14	"	56k	"	"
R53,54	"	68k	"	"
R15,16,49	"	100k	"	"
R50,75	"	100k	"	"
R17,18	"	330k	"	"
R23,24	"	330k	"	"

RV1	Potentiometer	220k lin single gang rotary
RV2	"	25k lin dual gang rotary
RV3	"	100k lin dual gang rotary
RV4	"	10k log dual gang rotary
RV5,6	"	100k trim pot
C31,32	Capacitor	47pF ceramic
C5,6,15	"	330pF "
C16,23,24	"	330pF "
C21,22	"	560pF "
C29,30	"	560pF "
C7,8	"	0.015μF polyester
C19,20	"	0.022μF "
C35	"	0.033μF 630 V
C9,10	"	0.056μF polyester
C1,2	"	0.15μF "
C11,12,42	"	0.15μF "
C13,17,18	"	4.7μF 25V electro
C25,26,27	"	4.7μF 25V "
C28,40,41	"	4.7μF 25V "
C3,4,33	"	100μF 16V "
C34,38,39	"	100μF 16V "
C36,37	"	2500μF 35V "

L1,2	Choke	25 Turns 0.4mm Cu Wire on a 10Ω 1W Resistor
D1 — D5	Diode	1N4001 or similar
D6	"	IN914 " "
LED1		
ZD1	Zener Diode	8.2V, 400mW
ZD2	Zener Diode	10V, 400mW
Q1,2,3	Transistor	BC108
Q4,13,14,19	"	or ZTX108
Q7,8,9,10	"	"
Q5,6	"	BCX35
Q11,12	"	BCX31
*Q15,16	"	BD267A or B
*Q17,18	"	BD266A or B

*insulation washers needed

IC1,2 Integrated Circuit TCA220

RLA Relay 2c/o contacts 1250Ω coil
T1 Transformer 40V cT @ 2A
SW1 Switch Rotary 2 pole 4 position
SW2 Switch miniature toggle 240V
Stereo Phone Socket
Two 6 way phono sockets
Two 2pin DIN sockets
CHASSIS
HEAT SINK
POT SUPPORT BRACKET
COVER
3 small knobs — 2 large knobs — 4 rubber feet — 2 9.6mm spacers — 3 core flex & plug rubber grommets.

month. Transistors Q7 and Q9 are glued to the power transistors to ensure thermal stability.

Readers may have difficulty in obtaining the triple op-amp, TCA220. This has been ordered from Mullard by Doram (see the box on page 27) and any component supply problems should be referred to them.

To be continued next month.

WIN A FREE SUBSCRIPTION

'Patience, you haven't a leg to stand on till Egor gets hold of that copy of ETI I missed!'

Take out a subscription this month and you could get your money back. All you have to do is write an amusing caption for the cartoon above — it must relate to ETI and be decent (we thought of several very funny but dubious ones ourselves!). If your entry is the best we will send your money back!

You can also ensure a regular copy of ETI by placing an order with your newsagent.

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ETI MAGAZINE,
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My caption for the cartoon is: . . . .

. . . .

Competition closes 31st October 1975.

INTERNATIONAL-FM

STEREO TUNER — eti project — PART TWO

This high quality stereo tuner was designed to match the INTERNATIONAL-25 stereo amp (see page 26). Last month we gave details of circuit and we now finish the article with some notes on construction and alignment.

THE METAL WORK

The chassis is the same size as the INTERNATIONAL-25: 335mm x 190 mm x 84mm. We decided to mount the controls and meters on a support bracket to leave the front panel looking neat. In fact the only components mounted directly onto the front panel are the frequency meter and the LED, both of which are push-fit. Figure 1 shows how we cut the front panel.

Because of difficulties in bending the aluminium and in fixing the components we made the support bracket in two sections. These are bolted together after the slider pot has been mounted into the top section (see photo 2). Figures 3 and 4 give details of the major cutting required in these sections. Because the meters are push-fit mounting types it is best to cut their holes a bit on the small side.

Figure 5 shows how to fix the cursor onto the slider pot. The cursor itself is made from 3mm perspex cut to 50 x 28mm. Any scratches can be cleaned off with metal polish. The knob should be removed from the slider pot and the slider cut back so that it protrudes 8mm from the slot. If the cursor and slider are carefully drilled they can be screwed and glued together (don't forget to scribe a line on to the back of the cursor).

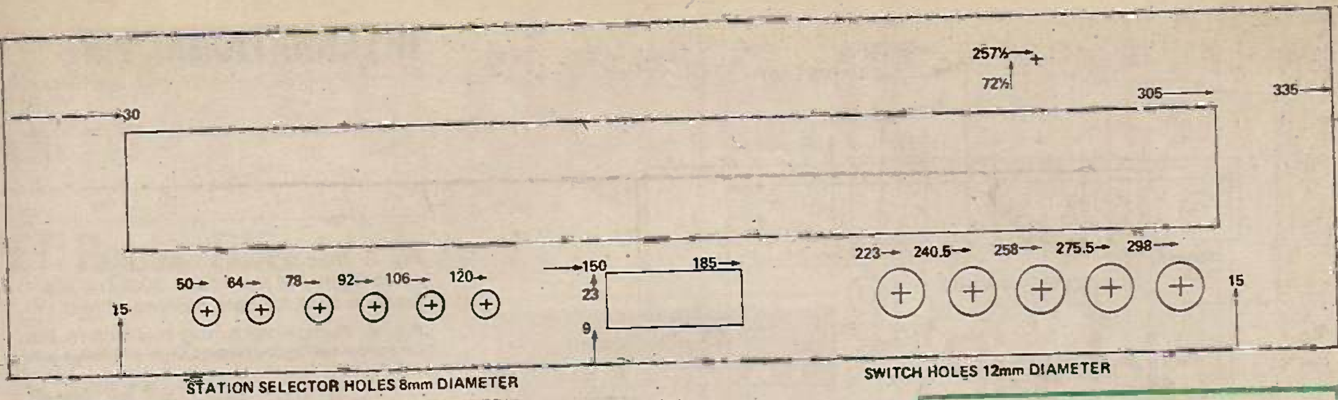


Fig. 1. The metalwork required on the front panel. Dimensions in millimeters.

> **THE METALWORK**
>
> **The three pieces of aluminium, cut to size and bent to our design, are available from H.L. Smith of 287 Edgware Road, London NW2. Send £1.82, which covers VAT and postage.**

Photo 2: This shows the support bracket and pcb are mounted.

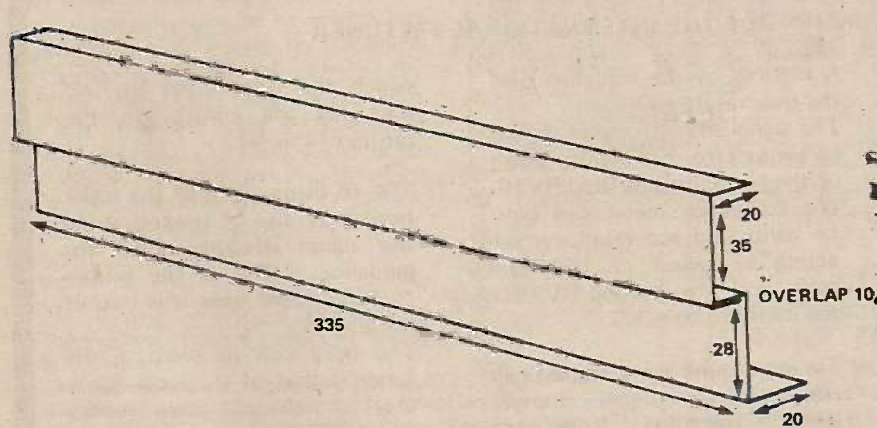


Fig. 2. This shows how the support bracket is constructed in two sections. The top section holds the slider pot and two meters. The bottom section mounts the switches and selectors and the frequency meter.

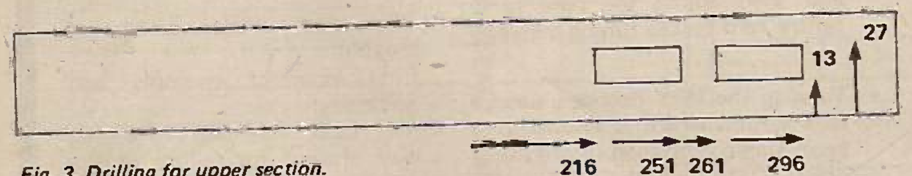


Fig. 3. Drilling for upper section.

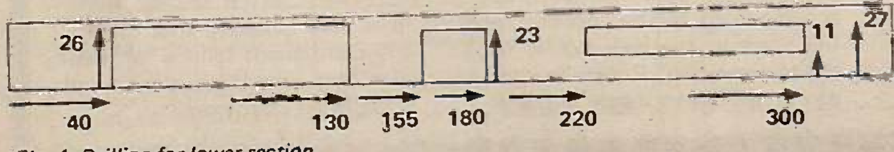


Fig. 4. Drilling for lower section.

Mounting the slider pot itself requires removing the black plastic end covers so that the case of the pot fits flush with the support bracket. It will be necessary to drill a couple of holes in the case so that the pot can be mounted from beneath. We prepared the frequency scale by sticking down some dark green plastic and gluing strips of white paper to this.

The pcb is mounted, as shown in photo 2, with the tuner head to the rear of the chassis. Figure 6 shows how the board is wired up to the rest of the tuner. The only wiring not shown in Fig. 6 is the mains wiring to the transformer via the on/off switch and the wiring to the meter lights.

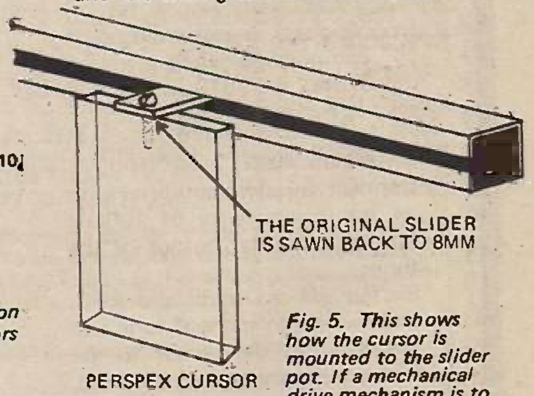


Fig. 5. This shows how the cursor is mounted to the slider pot. If a mechanical drive mechanism is to be used the drive cords can be attached to a tag under the screw.

A simple 300Ω antenna can be constructed as shown in Fig. 7 and then you are ready to try the tuner according to the test procedure. If you find that there is a gentle hum this can be cured by decoupling the base of Q_2 with a 10μF (10V) capacitor (see Fig. 8). There is sufficient room on the pcb to fit this component easily.

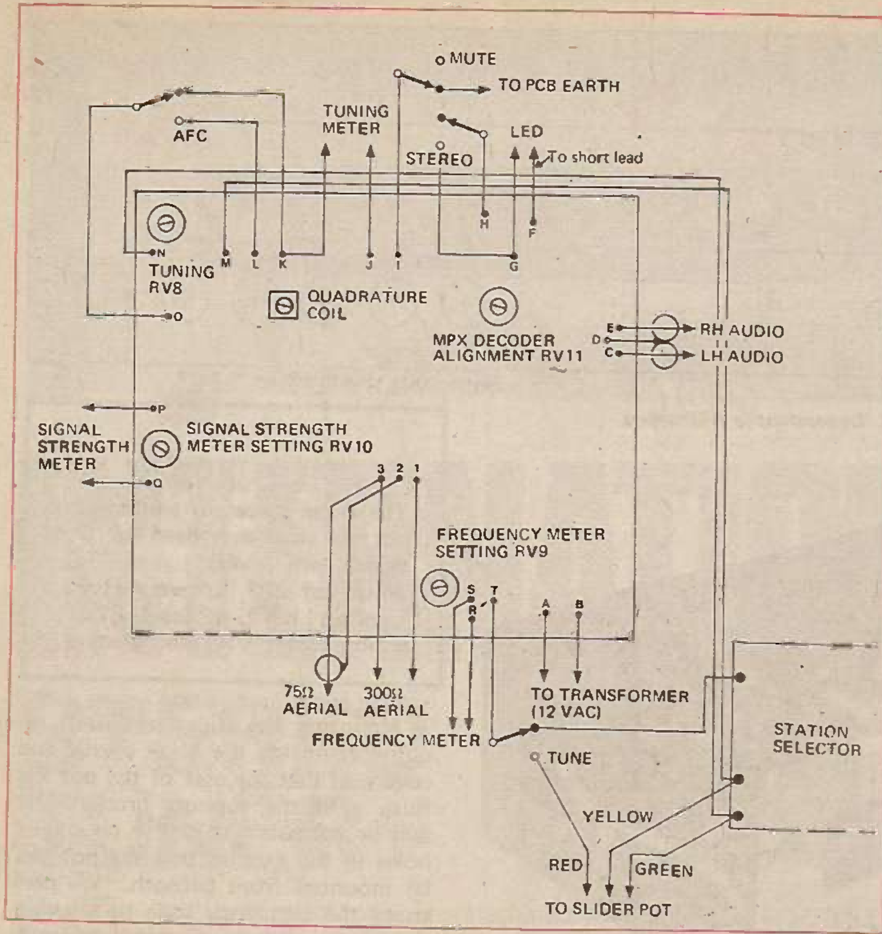


Fig. 6. Wiring up the board to rest of the tuner.

INTERNATIONAL·FM

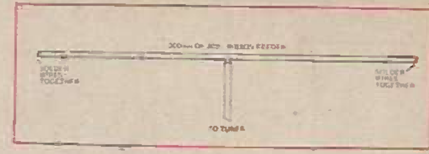
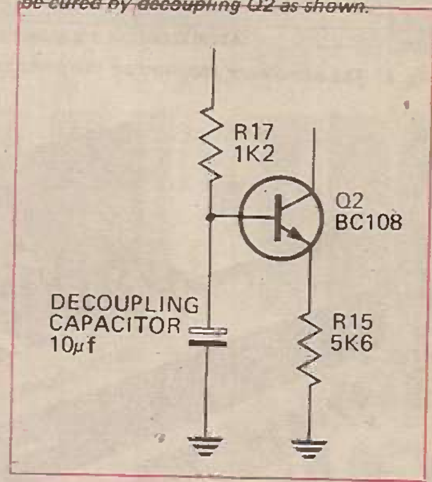


Fig. 7. How to make a folded dipole antenna for FM reception. 300Ω ribbon feeder is used for both dipole and feed.

Fig. 8. Hum in the tuning bias circuits can be cured by decoupling Q2 as shown.



On the p.c.b. pattern last month a short connection between two holes was not shown. This is under RV8 from the slider to pin N.

C10 is also shown with wrong polarity in both circuit and layout. •

TEST AND ALIGNMENT OF THE INTERNATIONAL-FM TUNER

1. Make certain all connections are sound, and that solder does not overlap any of the PCB tracks.

2. Double check the orientation of all components such as ICs, diodes and the 7812, where it is easy to make a mistake.

3. Switch on check:
   Connect an audio amplifier with an input sensitivity of 100mV (approx.) to the output of the tuner.
   Switch off the mute and AFC, and switch to manual tune and stereo. Set the cursor to the high frequency end of the scale.

a) Switch on the mains, and check the PSU voltage to be 12V. Some hiss should be audible at the output.

b) Peak this noise by adjustment of the quadrature coil (an RS type trimmer tool should be used to avoid damaging the core).

c) Now check the meter functions: the centre zero should be roughly centred by the adjustment of the quadrature coil.
The signal strength meter should be set at zero in a blank section of the band, by adjusting RV10.
The frequency meter can only be calibrated accurately by selecting a station on the main scale, and then setting RV9 for the meter to coincide.

d) Tuning around for a station will result in the signal strength meter travelling from the end stop. To finely set the quadrature coil tune the signal strength meter for maximum and then adjust the core for centre zero on the tuning meter.

e) To align the MPX decoder, tune to a station which is known to be in stereo, and then rotate the preset RV11 until the LED beacon lights. This will also be accompanied by an increase in the noise in the background of the transmission. Rotate the pot across the entire range through which the lamp stays lit, and then set the control to the centre of this arc.

f) The IF output coil of the tuner head may also be peaked, using the signal strength meter for guidance. This is the purple coloured core near the output termination.
The only coil to avoid in the tuner is that of the local oscillator. You will soon realize which this is, since a very minor adjustment will cause the station to disappear.

4. The most likely causes of trouble:
   First incorrect assembly and soldering
   -the LED may be the wrong way around for failure of the stereo.
   -incorrect switch wiring.
   -it is very unlikely that there is any component failure for manufacturer identified devices of established 'pedigree'.

We've done it again!

ETI Reader Offer

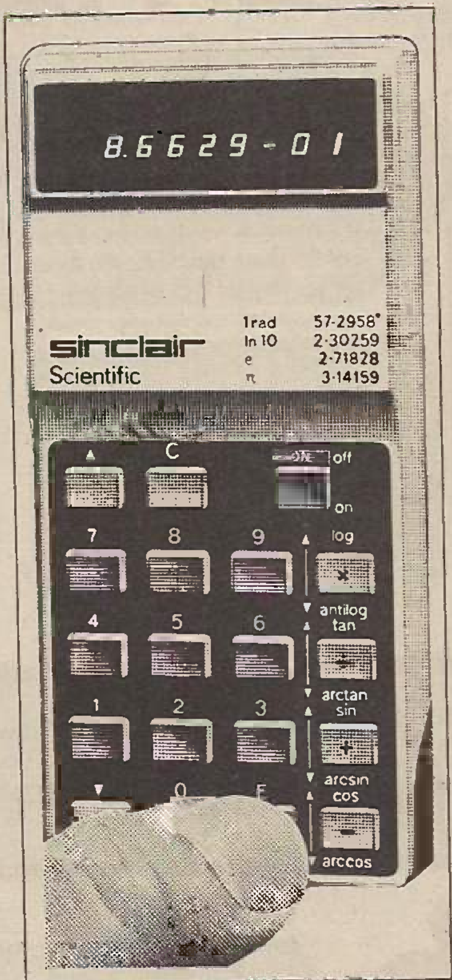
Sinclair Scientific Calculator Kit £11.95

Including VAT and P&P

In the October 1974 issue we organised with Sinclair an offer that has become a legend - nearly one in three readers sent for it - ten times the expected response.

In the last year ETI, has forged ahead in sales and many new readers may wish to own one of these calculators - the only one to have won two Queen's Awards - one for technical innovation, the other for export sales.

This, the second time we are running this offer, the price is £3.00 lower than a year ago and we are also offering the built version at only £1.00 more.



Sinclair Scientific — Actual Size

Sinclair Scientific Calculator Built £12.95

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Sinclair Scientific Facilities

The low price and simple construction of the Scientific belie its calculating power.

The detailed instruction booklet supplied describes fully the method of usage. With the Sinclair Scientific you can handle directly:

Log 10, Antilog 10, Sine and Arcsine, Cosine and Arcosine, Tan and Arctan, Automatic Squaring, Automatic Doubling, X^y (any power) $\sqrt[y]{x}$ (any root) Addition, Subtraction, Division and Multiplication.

Of course these functions can be used together giving you a fabulous number of facilities.

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Please find enclosed a cheque / PO for £11.95 payable to Electronics Today International for a Sinclair Scientific Calculator KIT. (For acknowledgement of order, please include a stamped addressed envelope)

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Offer closes October 31st. This offer is strictly limited to one calculator per coupon. Please allow 28 days for delivery.

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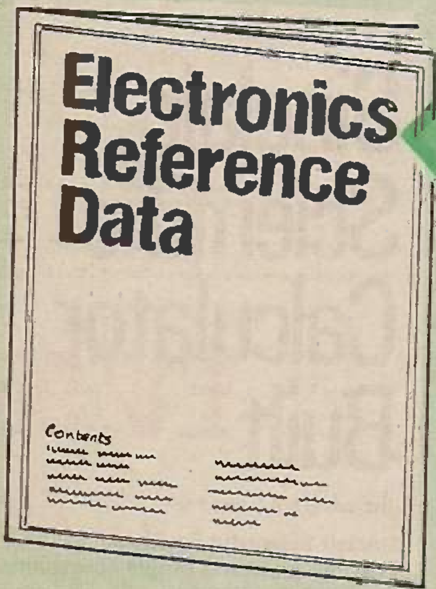
ON SALE OCTOBER 3rd

NOVEMBER ETI



FREE WITH NOVEMBER'S ETI

An 8 page pull out, crammed with useful electronics reference data...... .....those formulae you're always forgetting, common transistor data, definitions and conversions.... ... and much more. You'll want to keep this - be sure not to miss it.

TIC-TAC RADIO

An ultra minature AM radio which is built in a Tic-Tac mints box—uses ZN414 and one transistor.

AUTO-CORRELATORS

Auto-Correlation is a technique in which an audio signal is multiplied by a time delayed version of itself giving a considerable reduction in noise.

AN EXTRA 16 PAGES

Unlike some of our competitors — your next copy of ETI will still be 30p — and there are 16 extra pages in the November issue.

READER OFFER

Weller SOLDER GUN

TODAYS RETAIL PRICE £9.80

ETI OFFER PRICE £6.50

DIGITAL FREQUENCY METERS

Using the ETI digital display module, this inexpensive circuit displays directly all frequencies up to 1MHz with 0.01% accuracy accuracy — and it can be battery powered.

200W GUITAR AMPLIFIERS

How to couple two of the ETI 100W guitar amps (Details in Project Book 1, still available from ETI for 85p inc.) to give 200W into 8Ω.

electronics today international

ETI DATA SHEET

NEW SERIES

The new series of ETI Data Sheets are arranged so that they can easily be removed from the magazine if required. It is planned to give details of between two and four devices each month, the emphasis being strictly on maximum information in the available space on I.C.'s and other semiconductors.

ETI Data Sheets are intended as an introduction to the devices, not as complete information though applications circuits will occasionally be modified to make it easier to build them up. All semiconductor manufacturers produce their own excellent data sheets but the majority of the information is not relevent to the enthusiast: we are concentrating on the data that is.

Internal circuits of I.C.'s will only be shown if it is felt that this will lead to a better understanding of the operation.

Please refer to the notes on page 39.

μA 7800 SERIES: POSITIVE VOLTAGE REGULATORS

FAIRCHILD

The 7800 series of 3-terminal voltage regulators give excellent regulation and ripple rejection, have internal current limiting and automatic thermal shut-down making them almost indestructible. With adequate heat-sinking, they can deliver over 1A.

No additional components are necessary for use as voltage or current regulators but a few extra components will enable adjustable output voltages to be achieved.

The third and fourth number in the coding gives the voltage: 7805 is 5V, 7812 is 12V, 7824 is 24V. Other voltages in the range include: 6V, 8V, 15V and 18V.

The letter U after the number denotes T0-220 package, K denotes T0-3 package. Second letter C denotes consumer specification.

Closely related is the 7900 series, similar but with *negative* voltage regulation. Other types includes device with 100mA, 200mA and 500mA ratings in other packages.

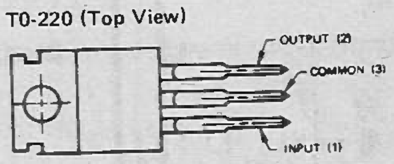
SPECIFICATION

	7805	7812	7824
Input voltage (max)	35V	35V	40V
Line regulation (typ)	3mV	10mV	18mV
Quiescent current (max)	8mA	8mA	8mA
Ripple rejection (typ)	78dB	71dB	66dB
Short-circuit current (typ)	750mA	350mA	150mA
Peak output current (typ)	2.2A	2.2A	2.1A

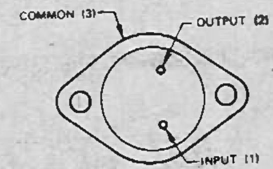
Typical Advertised Price (UC type) £1.60 inc. VAT
Main data supplied by Fairchild Semiconductor.

PACKAGES

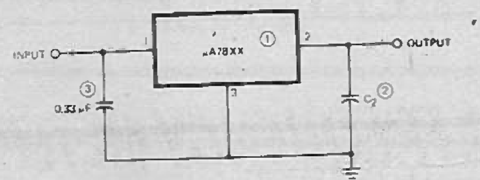
T0-220 (Top View)



T03 (Top View)

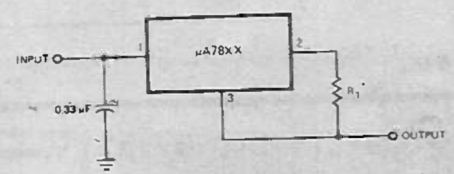


FIXED OUTPUT REGULATOR



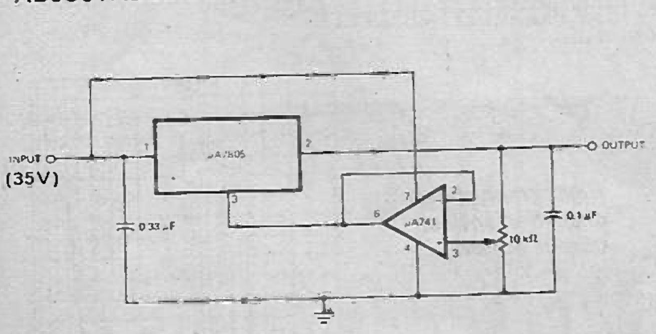
NOTES:
(1) To specify an output voltage, substitute voltage value for "XX".
(2) Although no output capacitor is needed for stability, it does improve transient response.
(3) Required if regulator is located an appreciable distance from power supply filter.

CURRENT REGULATOR

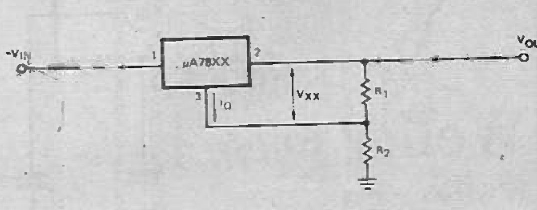


$$\text{Output Current} = \frac{V_{OUT}}{R_1}$$

ADJUSTABLE OUTPUT REGULATOR, 7 to 30 VOLTS



CIRCUIT FOR INCREASING OUTPUT VOLTAGE



$$V_{OUT} = V_{XX}\left(1 + \frac{R_2}{R_1}\right) + I_Q R_2$$

TBA810S/AS 7W AUDIO AMPLIFIER

SGS-ATES

The TBA810S is a 12-lead quad in-line I.C. designed for use as a class B audio amplifier.

The device will give 7W at 16V into a 4Ω load, 6W at 14.4V, 2.5W at 9V and 1W at 6V but will work with a supply as low as 4V or as high as 20V. It gives up to 2.5A output current and has high efficiency (75% at 6W) together with low harmonic and cross-over distortion.

The TBA810S is provided with a thermal limiting circuit which means that the device will suffer no damage even if overheated due to an inadequate heatsink — all that happens is that output power is reduced.

The TBA810AS is identical except for minor differences in the arrangement of the cooling tabs.

The cooling tabs should be connected to a heatsink. With the TBA810S this can be an area of the p.c.b. itself of about 1 square inch for each side of the cooling tab.

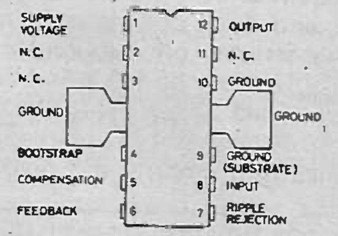
SPECIFICATION

Figures are typical and for V_S=14.4V unless shown.

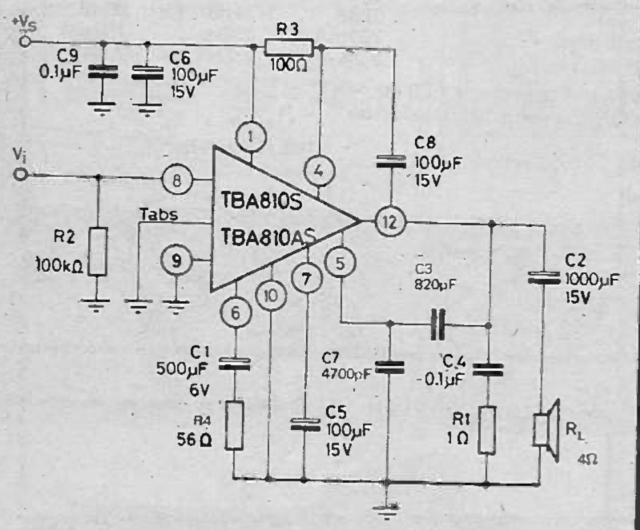
Supply Voltage	4–20V (max)
Quiescent Current	12mA
Power Output (16V)	7W
(14.4V)	6W
(9V)	2.5W
(6V)	1W
Input Sensitivity (R4 56Ω)	80mV
(R4 22Ω)	35mV
Frequency Response (–3dB)	40–20000Hz
Distortion (50mW–3W)	0.3%

Typical Advertised Price £1.25 inc. VAT
Data supplied by SGS–Ates

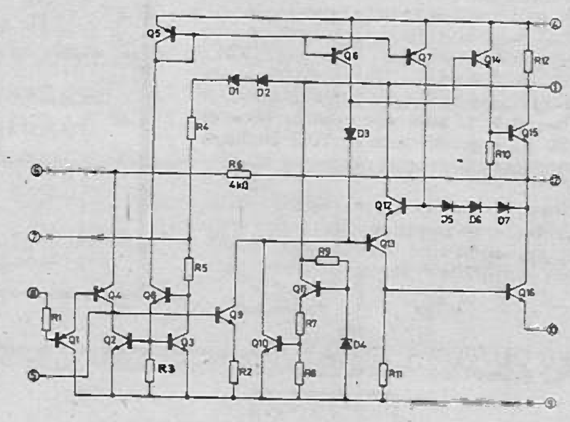
LEAD CONNECTIONS



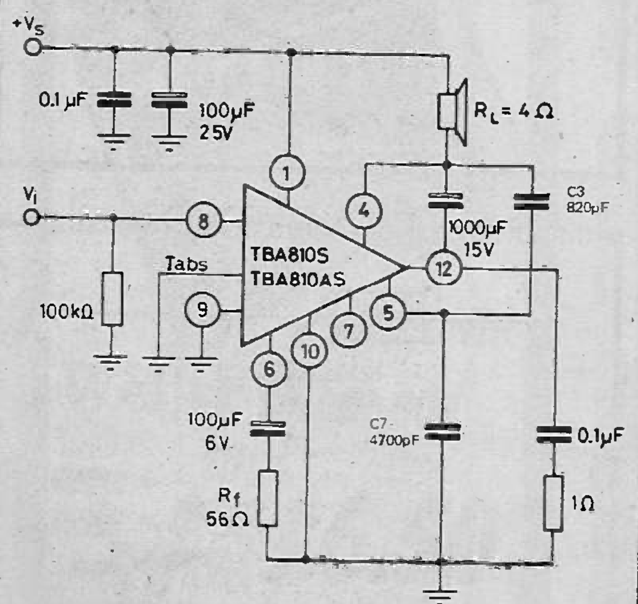
APPLICATION CIRCUIT

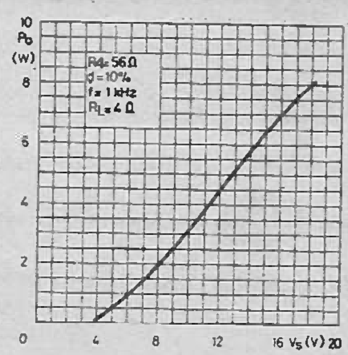


INTERNAL CIRCUIT

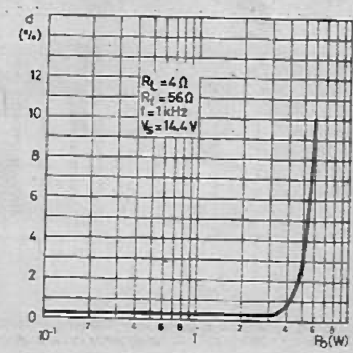


APPLICATION CCT WITH SPEAKER AT V_S





Left graph shows output against supply voltage



Right graph shows distortion against output power.

The TDA 1054 contains four distinct circuits: 1. Low Noise Preamplifier, 2. Automatic Level Control System (ALC), 3. High Gain Equalisation amplifier, 4. Supply Voltage Rejection Facilty (SVRF).

It is designed for use as a preamplifier in tape and cassette recorders and players, dictaphones, compressor and expander in telephonic equipment and in Hi-Fi preamplifiers.

Applications circuits are shown here for a complete tape recorder using other SGS–ATES I.C.'s, TCA 900 motor speed control and audio amplifier TBA 820. The second circuit is for a Hi-Fi preamp in which the ALC facility is not used.

SPECIFICATION

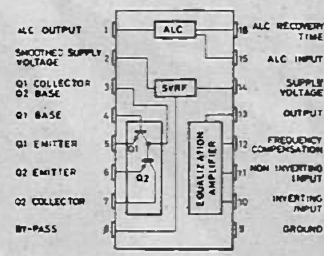
Figures are typical and for 9V supply except where shown.

Supply Voltage	4–20V
Quiescent Current	6mA
ALC Range (for 3dB change at O/P)	54dB
S/N Ratio with ALC	56dB
Supply Voltage Ripple Rejection	30dB
Voltage Gain (open-loop)	110dB
Distortion (playback)	0.1%
Distortion (record with ALC)	0.4%
Output Voltage before Clipping (with ALC)	900mV

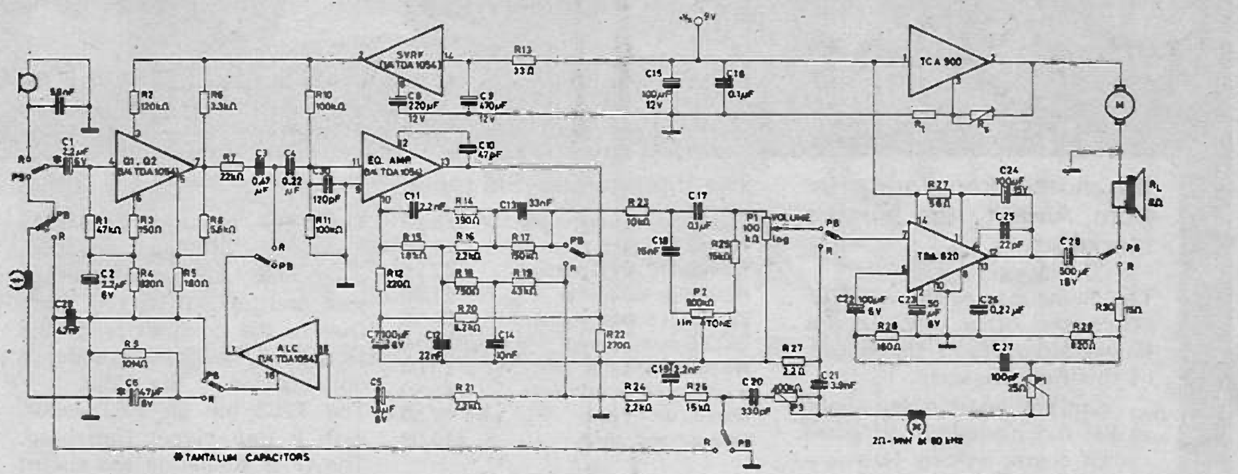
Typical Advertised Price £1.50 inc. VAT
Data supplied by SGS-Ates.

LEAD CONNECTIONS

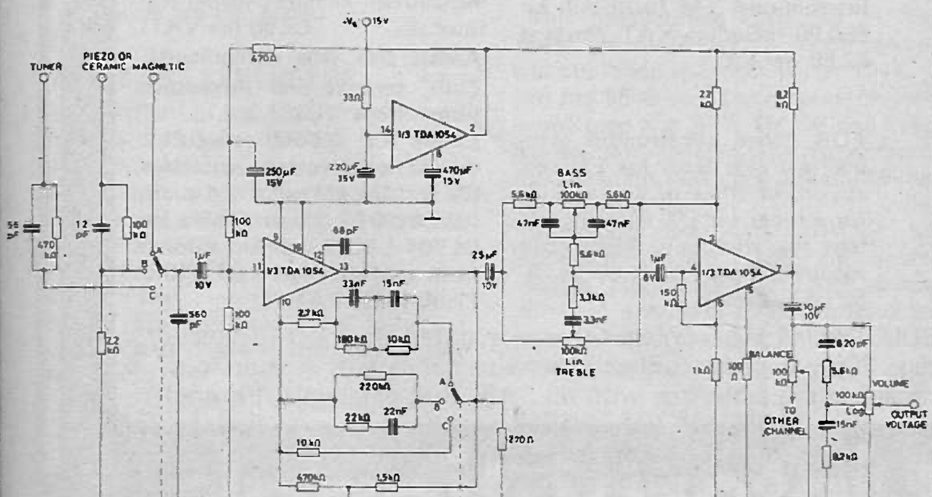
Package 16-pin DIL



COMPLETE CASSETTE RECORDER



HI-FI PREAMP



ETI DATA SHEET

The information in this section is based on the manufacturers data and is intended as a guide to the experimenter. Devices are not normally available direct from the manufacturers but all devices included in this section are currently, or have recently been, advertised in ETI and/or other electronics magazines. It is regretted that ETI cannot answer queries arising from Data Sheet including availability, modifications, availability of further data, layout or construction.

INTERNATIONAL 3600 SYNTHESIZER

ETI project

Constructing the case; and inter-unit wiring.

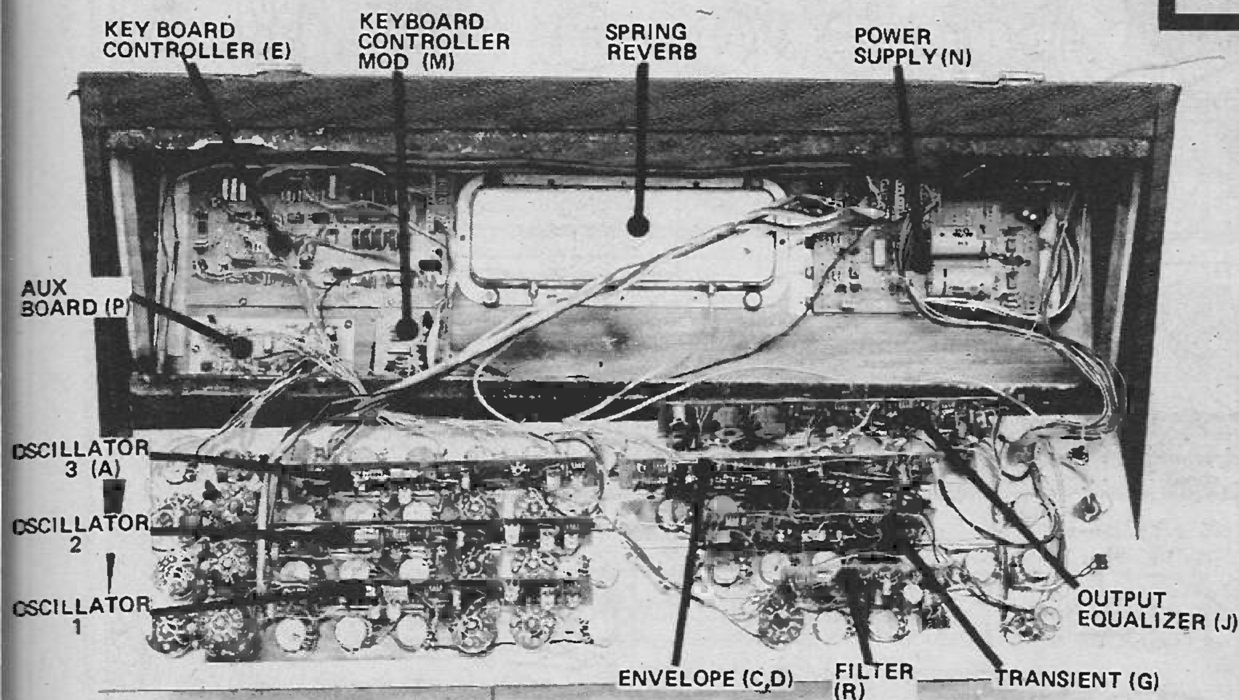


Fig. 1. Assembly of the modules within the box.

WE CONTINUE this month with details of the final four modules to be constructed. Details of cabinet assembly and interwiring of the synthesizer are also given.

TRANSIENT GENERATOR

Full details of the transient generator can be found in the May '74 issue of Electronics Today International. Note that a modification, published in September of 1974 reduced the value of R21 to 100k.

In the 3600 synthesizer the exponential converter and the external trigger are not used. The following components are therefore not required.

R1, 2, 3, 5, 6, 9, 10 and 14.
Q1, Q3, D2, IC2.
C5, C6, RV3, RV4, SW1 and SW3.

Link points 13 and 14 together and take the trigger from the keyboard to point 5. It will be found that triggering reliability is improved by increasing C3 to 0.0068 μF.

The mounting bracket will need to be trimmed slightly in order to clear the level potentiometer of oscillator 2.

ENVELOPE CONTROL

This module was described in the April '74 issue and a modification was published in September of 1974.

In the 3600 unit the external trigger is not used and R17, 18, Q3 and SW2 are therefore deleted. The trigger from the keyboard now goes directly to the hole number 13.

Increasing the value of C7 to 0.0068 μF makes triggering more reliable. The mounting bracket of this unit will also have to be trimmed in order to clear the level potentiometer of oscillator 3.

OUTPUT-EQUALIZER

This module was described in the July 1974 issue. In the 3600 unit the joystick and exponential converter are not used and the following components are therefore deleted.

IC7-10, Q1, Q2, RV10-15.
R23-32 and C18-22.

Note that the positions of front panel controls have been changed and connection details are now given in Fig 2 & 3. A different mounting bracket is also used being now the same as that used for the envelope control.

POWER SUPPLY

This module was described in the March 1974 issue and modifications were published in the April and September '74 issues. For the 3600 unit only nine outlets are required.

KEYBOARD

The keyboard described for the 4600 cannot be used in the 3600 because of lack of space. A Kimber Allen keyboard was used in our prototype.

CONSTRUCTION

The general assembly of the box can be seen from the photographs and from Fig. 7. The individual pieces are shown in Fig. 8. Note that the

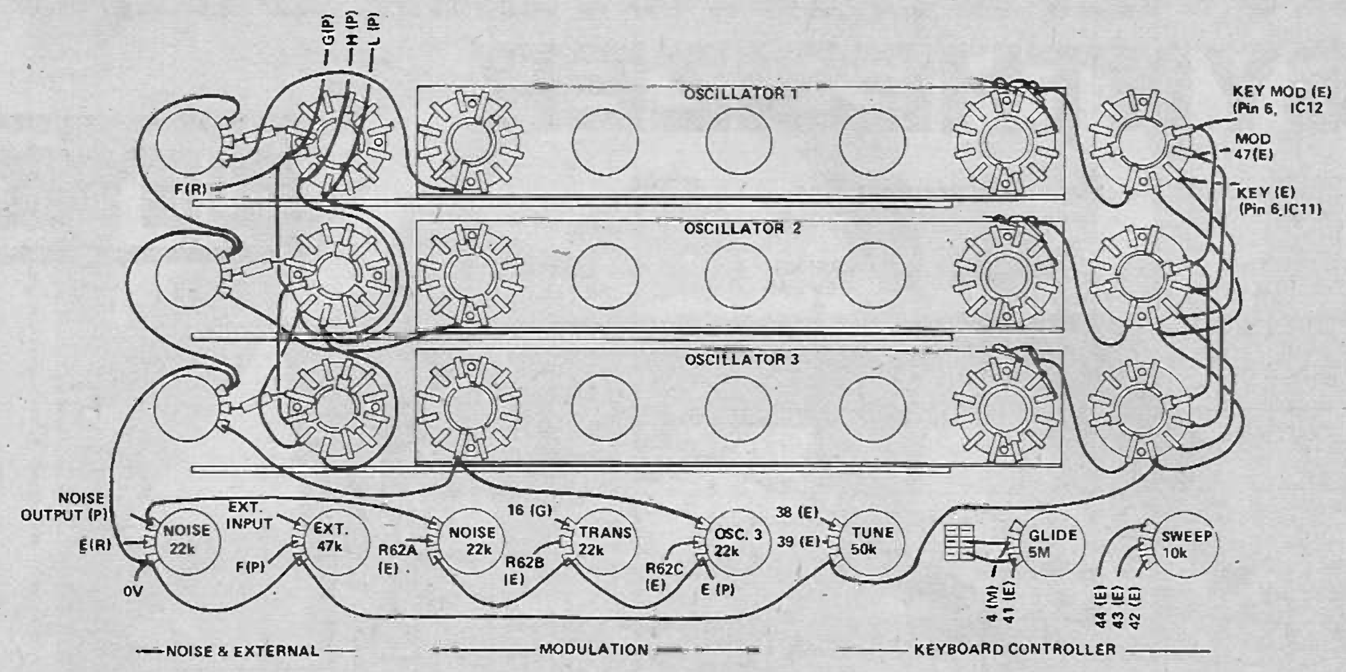


Fig. 2. Front panel interconnections — oscillator section.

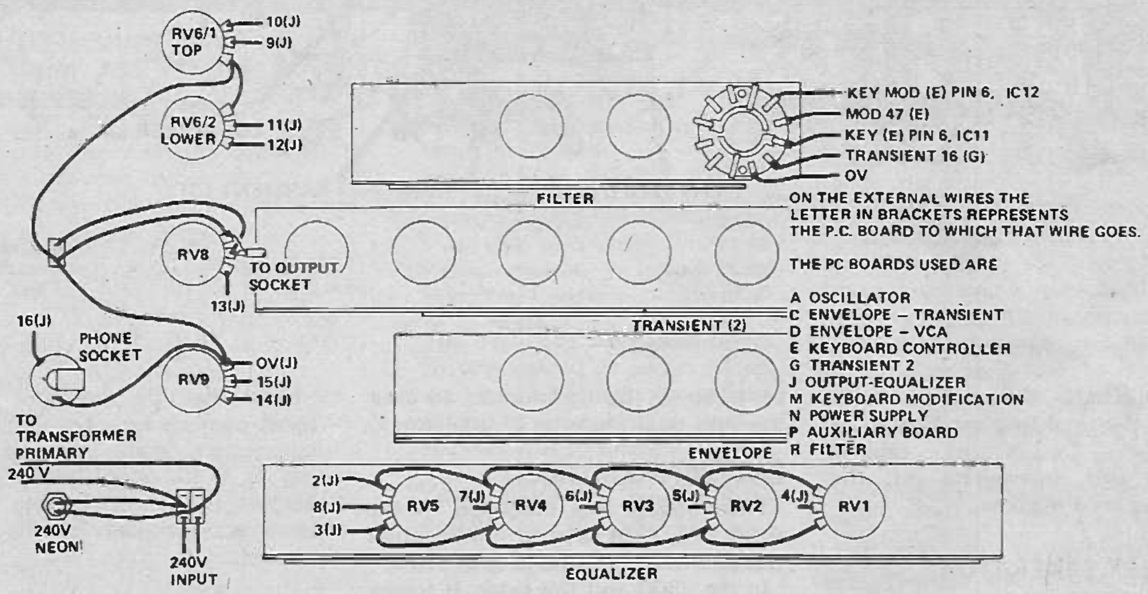
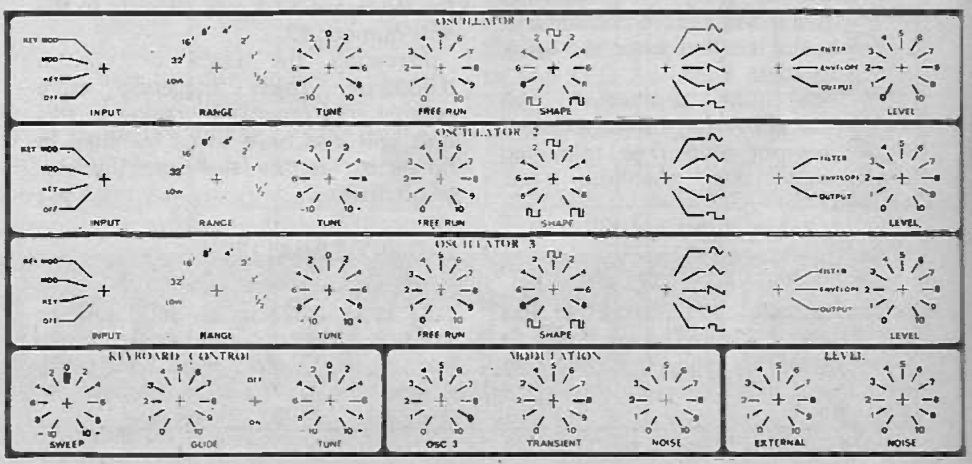


Fig. 3. Front panel interconnections — filter section.

dimensions given are for a timber thickness of 12 mm and for construction using all butt joints. Allowances will have to be made if other timber thicknesses or mitred joints are used. It is advisable to use small pieces of wood to strengthen corners.

We hinged the lid using dismountable hinges, so that the lid could be detached, and used suitcase-type catches on each side, towards the front, to hold the box closed. A handle is mounted on the front for carrying the unit. It is recommended that a strip of foam plastic be glued onto the lid to ensure a dust-proof seal when the unit



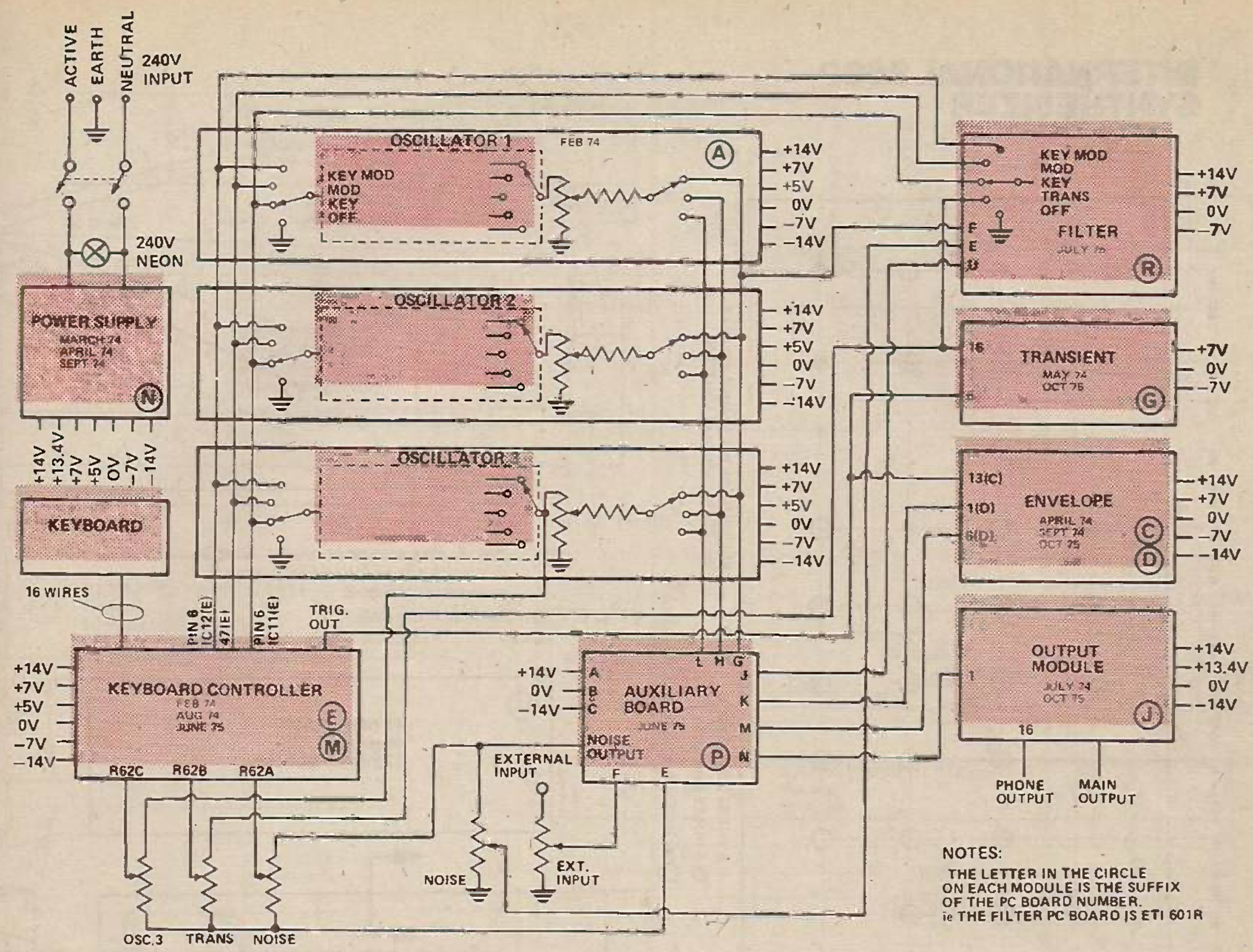


Fig. 4. Overall interconnection diagram.

is closed. The box may be covered with vinyl or veneered as required. Note however that the keyboard should be installed before the keyboard panels (pieces 7 and 8) are covered.

The small panel containing the mains-cord socket, the external-input socket and the output-socket can now be assembled, wired and mounted in place. Note that the wires to the input and output sockets should be in shielded cable.

The keyboard may now be wired up and installed as follows. The aluminium frame of the Kimber Allen keyboard extends beyond the ends of the keys. Use this portion to mount the keyboard by placing two pieces of wood on top of the ends of the frame. These pieces of wood should be of such thickness that the keyboard is held at the correct height when finally assembled. The keyboard is held in position by long self tapping screws which pass through the keyboard panels (7 and 8), through the pieces of packing wood and screw into the end frame. After checking alignment, and that the keyboard functions correctly, the keyboard panels may be covered or veneered as for the rest of the box.

The power supply, keyboard controller, auxiliary board and the spring reverb are all mounted inside the box on the base. The photo shows the relative positions of these modules. They should be installed fitted with wires that are long enough to reach their destination. The other modules and their associated potentiometers and switches can now be mounted on the front panel. Interconnections can now be made using the diagrams in Figures 2,3 and 4 as a guide.

A solid earth is required if noise is to be minimized. This is easiest done by earthing each module to the front panel. Solder the earth wire onto the back of a potentiometer (after filing off the plating). A solid-earth wire between the auxiliary board and the front panel is also necessary.

Finally, due to the size of the range switch on oscillator 1, it will probably be necessary to cut a section out of the front panel upper-support to provide clearance. ●

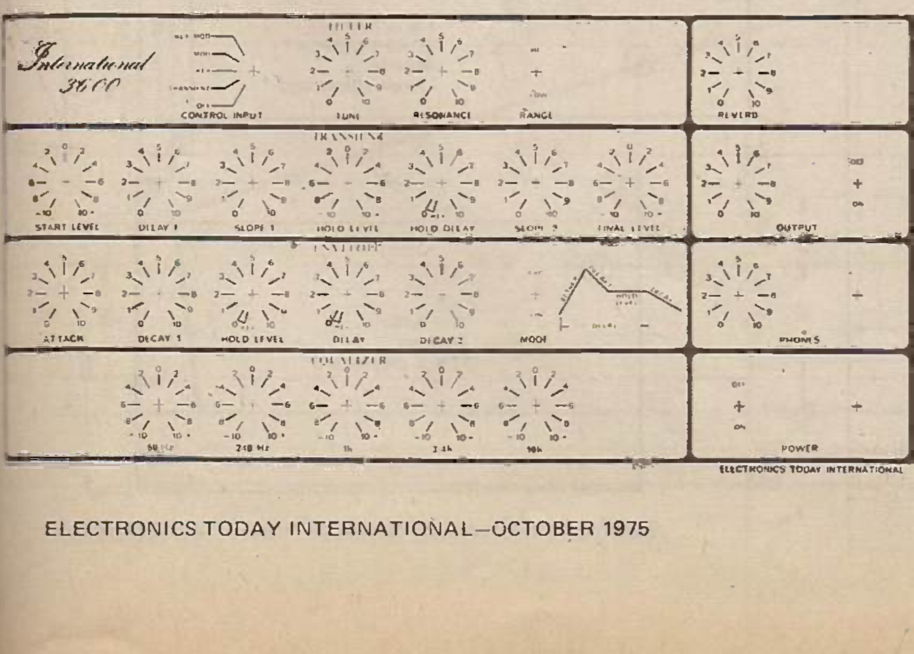
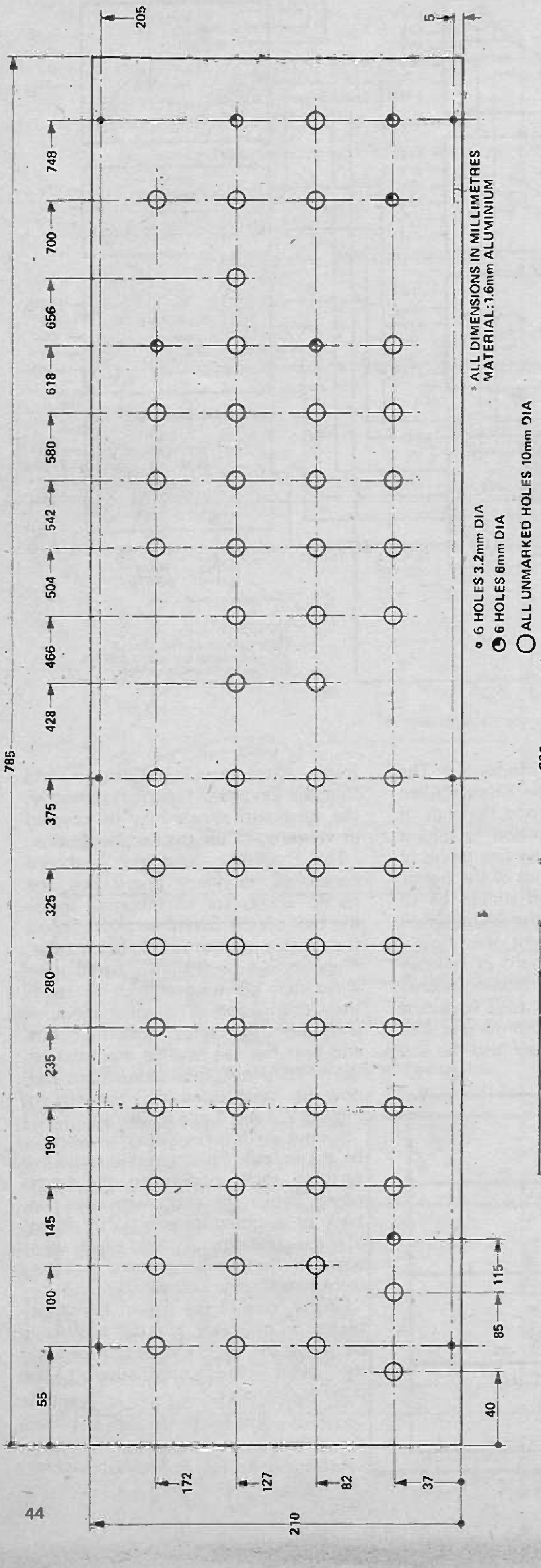


Fig. 5. Front panel artwork.



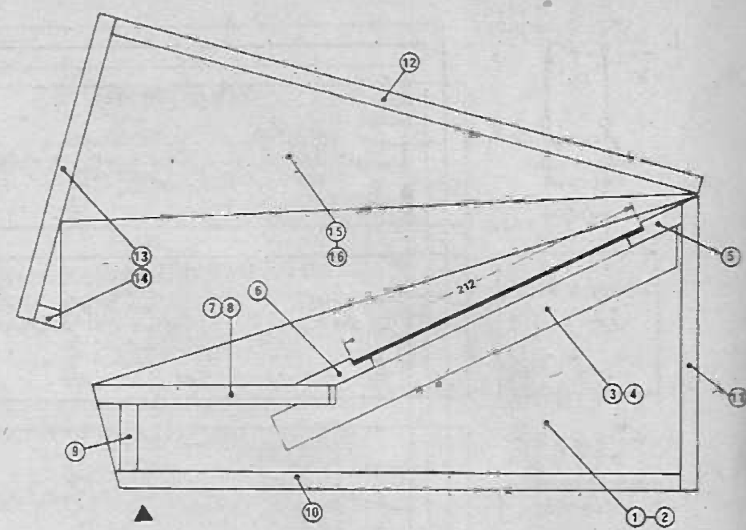
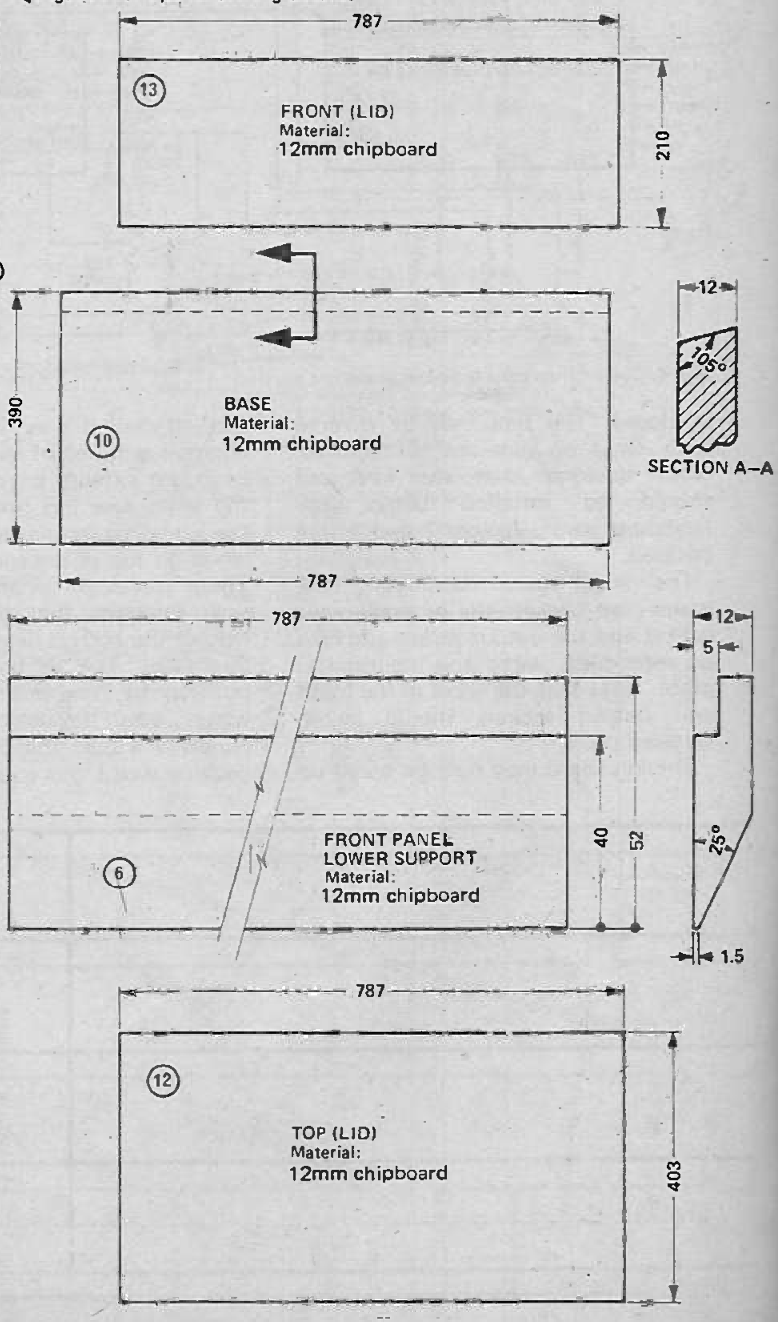


Fig. 7. Box assembly details. Numbers in circles are of individual pieces as numbered in Fig. 8.

◀ Fig. 6. Front panel drilling details.



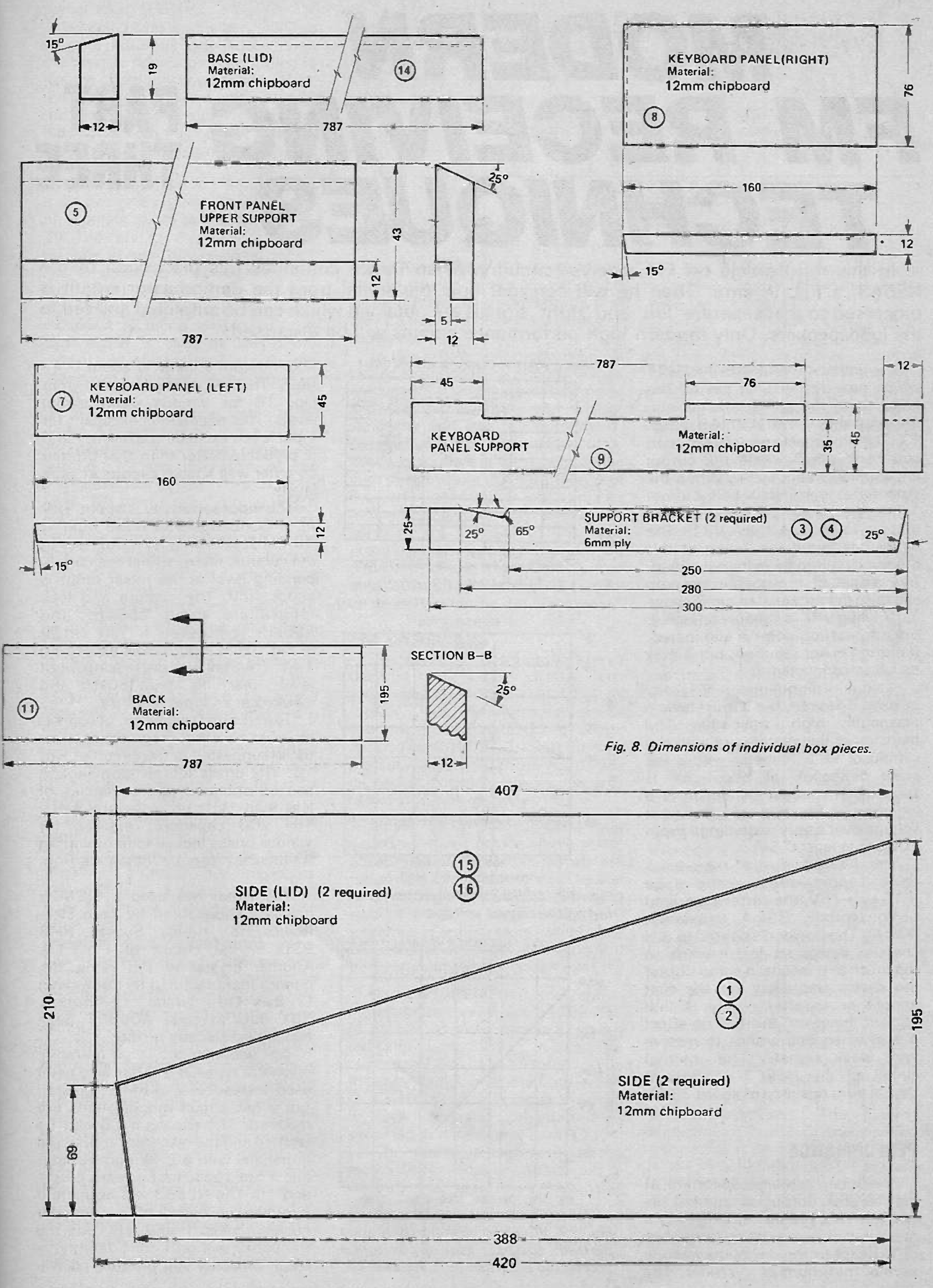


Fig. 8. Dimensions of individual box pieces.

MODERN FM RECEIVING TECHNIQUES

PART THREE

In this third article on FM receiver circuitry, Brian Dance continues this discussion of the NE563, a PLL IF amp. Then he will consider how the signal from the demodulator circuit is processed so that separate 'left' and 'right' signals are obtained which can be amplified and fed to the loudspeakers. Only modern high performance circuits will be discussed.

The limiter circuit feeds the stage which provides AGC at pin 4. The variation of the pin 4 voltage with the input signal level is shown in Fig. 17. The limiter also provides muting current to pin 8 where the output impedance is about 20k. When the potential at this pin falls below about 1.1V, the circuit is muted. The muting level is set by VR1. The writer has found the action of this muting circuit to be extremely good. Any signal of reasonable strength will raise the potential of pin 8 above 1.1V when VR1 is suitably adjusted, but inter-station noise is eliminated. If muting is not required, pin 8 may be left unconnected.

A signal strength meter, M1, may be used if desired, but it must have a reasonably high impedance. The readings of this meter vary with the setting of VR1. A meter with a full scale deflection of about 5V is suitable. The meter deflection is a logarithmic function of the input voltage over a very wide range (from 10uV to at least 0.5V).

The NE563 device requires a power supply voltage in the range +10 to +15V, the current required being typically 38mA (maximum 42mA). The power dissipated in this complex device renders it warm to the touch and results in some drift of the centre frequency for the first minute or so after power is first applied; however, this has no effect except when one wishes to receive very weak signals. The internal circuit of the NE563 provides a typical hum rejection of about 33dB.

PERFORMANCE

The total harmonic distortion at the NE563 output is quoted as 0.4%. This value having been measured at a modulating frequency of 1kHz when the deviation was the normal maximum of ±75kHz. The audio output voltage is about 0.4V RMS. The AM rejection is shown in Fig. 18 for various input signal levels. This rejection is excellent for input levels exceeding a few mV and is probably better than that offered by other well known circuits at such levels.

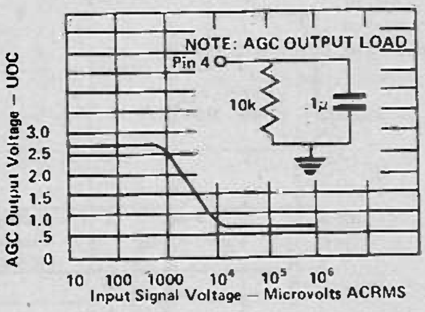


Fig. 17. Typical NE563 AGC characteristic.

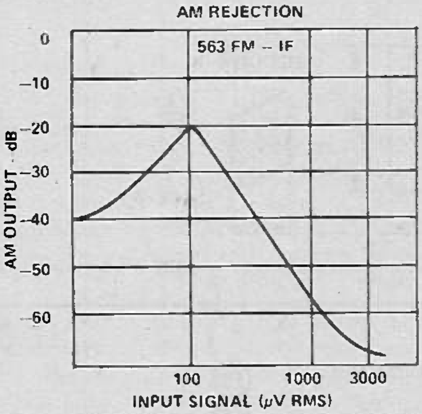


Fig. 18. NE563 AM rejection plotted against input voltage.

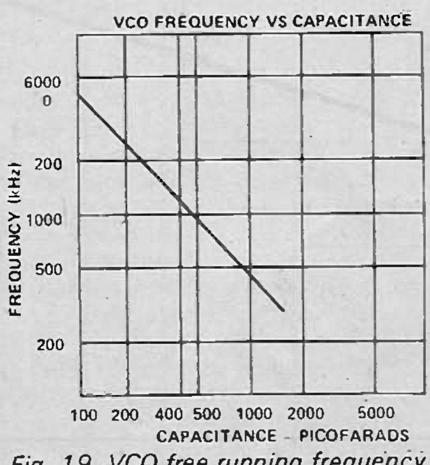


Fig. 19. VCO free running frequency plotted against the capacitance connected between pins 11 and 12.

The input sensitivity is about 9μV for a 30dB signal to noise ratio at 10.7MHz (allowing for a 6dB loss in the ceramic filter), whilst the corresponding level at the mixer input is about 1mV. The capture and lock ranges are about 250kHz and 290kHz respectively for the circuit of Fig. 16 at input levels exceeding 1mV. They fall with decreasing input levels, reaching about 80kHz and 140kHz at an input of 10μV.

The NE563 device can, of course, be used at other frequencies than those suggested in the circuit of Fig. 16. The phase locked loop section can be operated at frequencies of less than 1kHz up to several MHz. The VCO capacitor required for various phase locked loop operating frequencies can be obtained from Fig. 19.

The writer has used a 9.8MHz crystal manufactured by Aero Electronics Ltd., Horley, Sussex, RH6 9SU in the circuit of Fig. 16. Another crystal of the same frequency manufactured by Cathodeon Crystals Ltd., Linton, Cambridge, CB1 6JU to code A04851 gave equally satisfactory results.

An economical Taiyo ceramic resonator type CR-9.8 has also been used instead of a 9.8MHz crystal, but a few circuit modifications are required. The capacitor C8 can be omitted and the resonator connected in parallel with a 2.2k ohm resistor and a 5pF capacitor between pins 1 and 16. The NE563 will oscillate if one merely connects a capacitor between pins 1 and 16, but the frequency will drift considerably. A 22pF capacitor will produce oscillation at about 9.8MHz.

A crystal oscillator is less likely to produce spurious oscillations than the ceramic resonator. Although one has the additional cost of the crystal, the circuit is very simple and ideal for the amateur constructor. Problems may occur with this type of circuit if the input contains spurious frequencies.

The demodulated signal is a multiplex one containing a number of separate parts as shown in Fig. 20. They are:

(1) The normal audio signal which has a waveform representing the sum of the signals in the left and right hand channels. If monaural reception is being employed, this sum signal is used as the audio output. As shown in Fig. 20, the maximum frequency of this signal is 5kHz.

(2) A low level19kHz 'pilot tone' which is synchronised with a 38kHz sub-carrier. This pilot tone is required for the operation of the stereo decoder circuit.

(3) A 'left minus right' signal which is modulated onto a 38kHz sub-carrier. This signal is proportional to the sound amplitude in the left channel minus that in the right channel, the maximum frequency in each channel being 15kHz. Thus the modulated left minus right signal occupies a frequency band of 38+15kHz, that is from 23kHz to 53kHz as shown in Fig. 20. There is a small gap in this signal at 38kHz, since no audio frequencies below about 30Hz are transmitted.

(4; The 38kHz sub-carrier itself is suppressed at the transmitter to a level of not more than one per cent of the total signal.

It can be seen from Fig. 20 that a stereo signal requires a much greater bandwidth than a simple monaural signal. This inevitably means that at a given input level from the aerial the signal to noise ratio will be worse for stereo reception than for monaural reception — actually about 20dB worse.

The pilot tone is normally switched off at the transmitter when a monaural signal of more than a few minutes duration is being transmitted. This automatically ensures that the stereo decoder in the receiver is switched to the monaural state for the optimum signal to noise ratio.

A number of types of stereo decoder circuit have been published. For example, in the switching type the 19kHz pilot tone is obtained from the multiplex signal by means of a tuned circuit and is doubled in frequency to re-generate the 38kHz suppressed sub-carrier; the latter is used to switch the multiplexed input signal. Apart from the necessity of setting up the tuned circuit, such systems have the disadvantage that they do not provide the best channel separation.

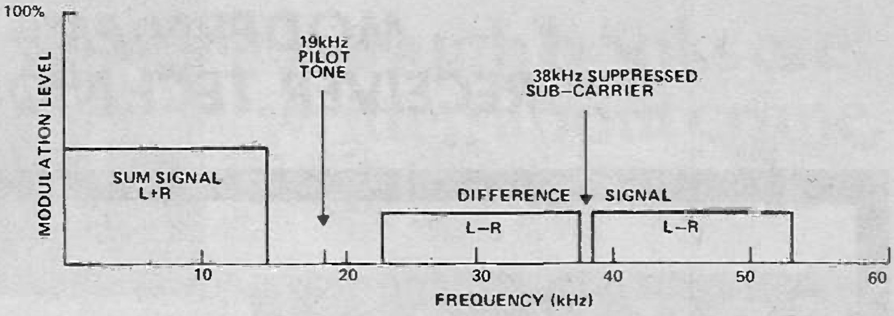


Fig. 20. The frequency spectrum of a stereo multiplex signal.

In this article only modern phase locked loop decoding circuits will be discussed, since they provide optimum performance with circuit simplicity and ease of adjustment. The frequency of the loop automatically locks onto a harmonic of the pilot tone and any normal changes of the component values with time or temperature will not affect the performance. Circuits of this type provide excellent channel separation (typically better than 40dB) and employ an integrated circuit designed especially for the application.

The CA3090AQ

The CA3090 is a unique stereo decoder integrated circuit first introduced by RCA in mid-1971 as the CA 3090Q. An improved version was made available in 1973 under the coding CA309AQ. Both devices are encapsulate in 16pin quad-in-line packages which require a supply of about 22mA at 12V.

Unlike other phase locked loop decoders, these devices have voltage controlled oscillators which are tuned by a 2mH inductance. The use of an inductance tuned oscillator is said to result in better stability at extremes of temperature (which may be useful in car radio receivers) and better stability as the circuit ages.

The CA3090AQ has the following advantages over the CA3090Q:

(i) It can drive directly a stereo indicator lamp which requires a current of up to 100mA. (The indicator lamp is illuminated when th 19kHz pilot tone causes the loop to lock, showing the circuit is switched to the 'stereo' mode).

(ii) The steady voltage level at the stereo defeat/enable contact (pin 4) controls the operating mode, this voltage level being independent of the pilot tone level provided that the latter is above a certain minimum level.

(iii) The CA3090AQ is capable of providing rather lower distortion than the CA3090Q.

Circuit

The fairly complex internal circuit of the CA3090AQ is shown in block form in Fig. 21 together with a typical external circuit. The demodulated multiplex signal from the receiver detector is applied to pin 1 of the CA3090AQ where the input impedance is about 50k. The low distortion pre-amplifier stage feeds the signal to both the 19kHz and the 38kHz synchronous detectors.

The voltage controlled oscillator generates a 76kHz signal which is divided in frequency to produce a 38kHz signal and two 19kHz signals in phase quadrature. The 19kHz pilot tone from the demodulator circuit is compared with the locally generated 19kHz signal. An error signal is generated which is used to control the voltage controlled oscillator frequency so that it remains locked with a harmonic of the pilot tone.

A second synchronous detector compares the locally generated 19kHz signal with the 19kHz pilot tone. If the amplitude of the latter exceeds a certain value set by an externally adjustable threshold voltage, a Schmitt trigger circuit is energised. The signal from the Schmitt trigger operates thelamp driver circuit which switches the stereo indicator lamp on or off. It also switches the circuit from monaural to stereo operation.

The output signal from the 38kHz detector and the multiplex signal from the pre-amplifier are applied to a matrix circuit which produces the left and right hand audio signals; the latter are applied to their respective internal amplifiers. The external capacitors C7 and C8 provide the normal 50μs de-emphasis.

A light emitting diode D1 in series with the resistor R4 is shown in Fig. 21. LEDs consume much less current than tungsten filament lamps and are more reliable. However, D1 and R4 may be

MODERN FM RECEIVER TECHNIQUES

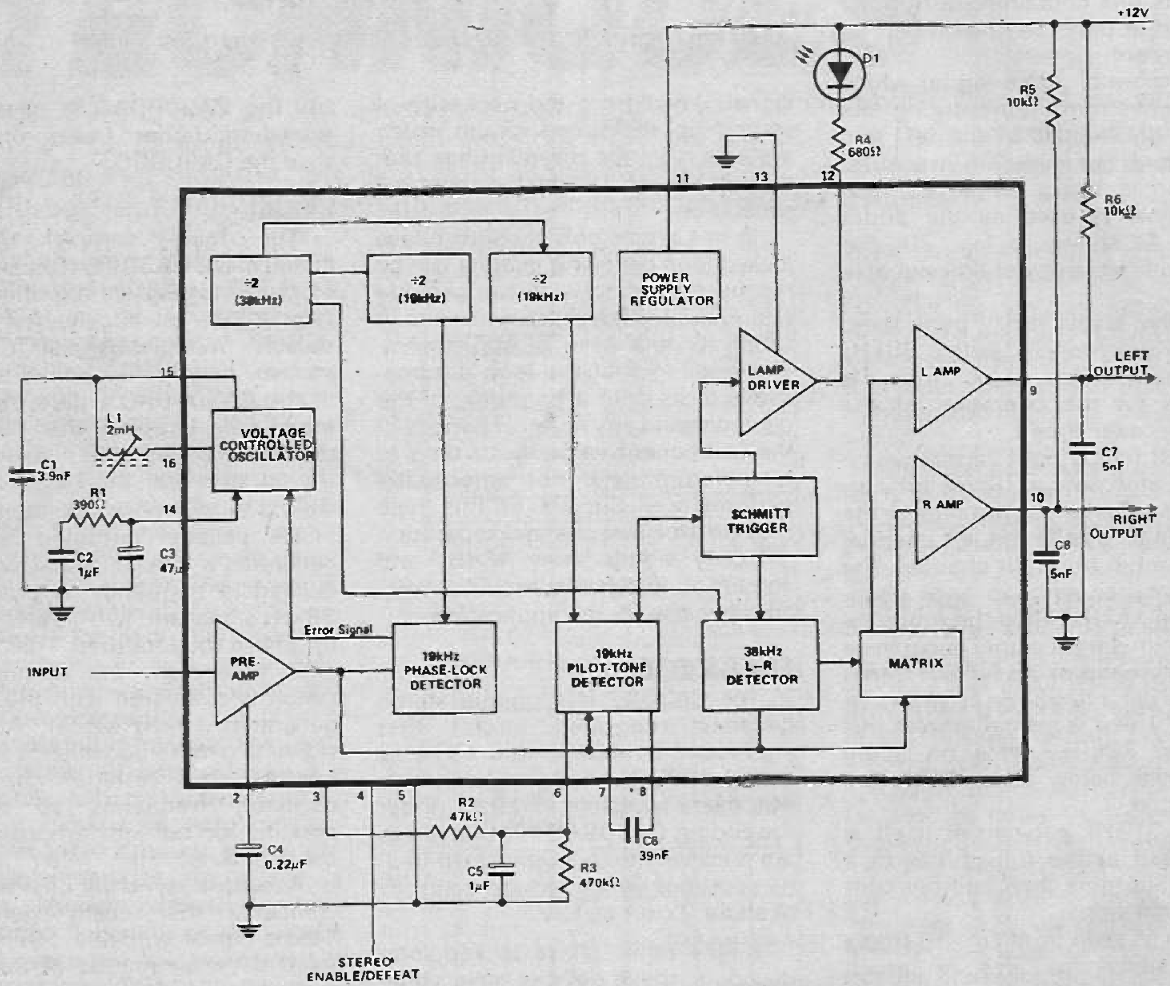


Fig. 21. The circuit used with the CA3090AQ with the internal circuit shown in block form.

replaced by a small lamp consuming not more than 100mA if desired.

The core of the inductance L1 should be set half way between the points at which the indicator lamp just switches as the core adjustment is changed. The centre frequency of the voltage controlled oscillator is then very close to 76kHz. The capture range of the loop is typically ±10% of the centre frequency.

A 2mH coil especially designed for use with the CA3090 device is the Toko type YXNS 30450NK which has its adjuster colour coded blue. It employs 270 turns on a ferrite core which provides a Q factor of about 118. The connections are made to the two pins on the opposite side to the row of three pins on the base of this coil.

If the voltage applied to pin 4 of the CA3090AQ exceeds about 1.2V, the device is switched to the stereo mode. At lower voltages it is switched to the monaural mode. The tolerance range of the pin 4 voltage is 0.9V and 1.6V. The CA3090AQ may be used without the stereo defeat and enable function if a suitable control voltage is not readily available; in this case pin 14 should be directly grounded.

The CA3090AQ provides a typical 2nd harmonic distortion level at the outputs of 0.2%, whilst the 3rd, 4th and 5th harmonic distortion is typically less than 0.1%. The channel separation is typically 40dB (minimum 25dB).

To be continued next month....

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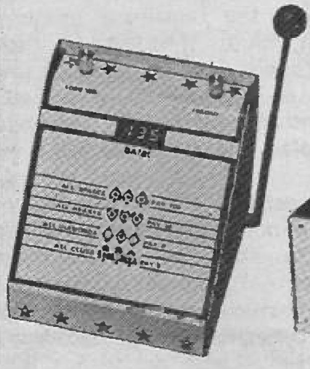

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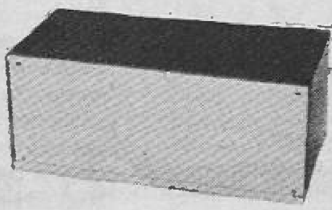

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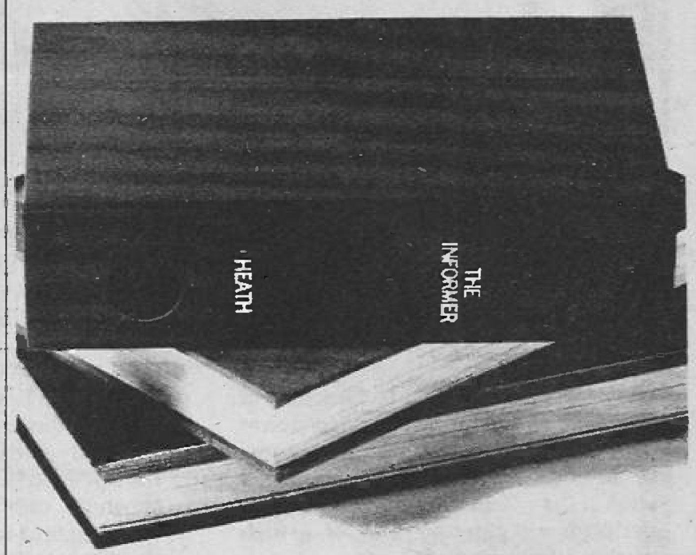

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UNDERSTANDING COLOUR TV

Picture quality adjustments

by Caleb Bradley BSc.

A PAL colour television with conventional shadowmask display tube is capable of giving an astonishingly 'true to life' colour picture but this depends on correct setting of a large number of preset adjustments. Since a very large proportion of the colour serviceman's (expensive) time is spent on these adjustments, which for best results should be rechecked at intervals, an electronics-minded viewer can find it worthwhile to tackle some or all of them himself. With unhurried work he can bring his set's performance close to that of a high quality studio monitor.

CONTROLS COMMON TO MONOCHROME SETS

The following adjustments, the first few of which are accessible to the viewer, need no explanation since they are familiar from monochrome receivers:

ON/OFF — VOLUME
BRIGHTNESS
CONTRAST
VERTICAL (FRAME) HOLD
HORIZONTAL (LINE) HOLD

(Because of the critical timing functions of the colour receiver line-output stage this control must be set more carefully to the centre of its 'flywheel' lock-in range than is necessary on monochrome sets.)

VERTICAL SHIFT
HORIZONTAL SHIFT
HEIGHT (FRAME AMPLITUDE)
VERTICAL LINEARITY
FOCUS
WIDTH (LINE AMPLITUDE)
AND/OR E.H.T. VOLTAGE

(This control should only be adjusted with reference to the manufacturer's data which generally calls for use of a special e.h.t. meter to ensure that the tube third anode supply never exceeds a specified voltage, typically 22-25 kV.)

SPECIAL CONTROLS FOR COLOUR

Surprisingly the majority of these are best assessed and set up on *monochrome* pictures although they all contribute to the colour picture. They arise from the basic shadowmask tube principle of creating a picture by combining three 'primary-coloured images on the same screen. The images are produced by three separate electron guns whose beams are made to scan by a common deflection coil assembly over three separate arrays of phosphor dots. This process depends for its success on precise positioning of the three beams relative to the shadowmasked screen and the adjustments to achieve this are grouped under the titles PURITY and CONVERGENCE. Some are electrical adjustments and some are mechanical; the mechanical adjustments on the tube neck are identified in Fig. 47.

This subject was dealt with in Part 7. To summarize, the shadowmask is only able to direct the three electron beams correctly to their corresponding phosphor dots over the whole screen area if the effective beam deflection centres are correctly located. The 'purity' adjustments available to achieve this are two flat ring magnets on the neck of the tube and a fore-and-aft sliding movement of the scan coils.

The state of purity of a receiver is best checked by switching off two of the three beams by means of the first anode cutoff switches provided and inspecting the remaining image for uniform colour. It is best to inspect the red image since any spurious tinges of blue or green are easily spotted. If the contrast can be fully reduced to give a plain red raster the job is even easier.

An uncritical viewer is unlikely to notice minor purity errors. Here is a guide to their effect on normal programme pictures. Colours of objects (which should be constant) vary — depending on their position on the screen. Large areas of uniform colour which occur occasionally in programmes (such as expanses of blue sky or backgrounds to captions) will show up any areas of impurity. On a monochrome picture a serious purity error shows as a large stationary blemish of *different* colour tinge from the rest of the picture and is the same for all pictures.

Having detected some purity error, heed a note of caution: if the purity adjustments are touched the convergence adjustments described later will certainly need to be retrimmed as well.

If you decide to forge ahead, set up a red raster, preferably plain, as

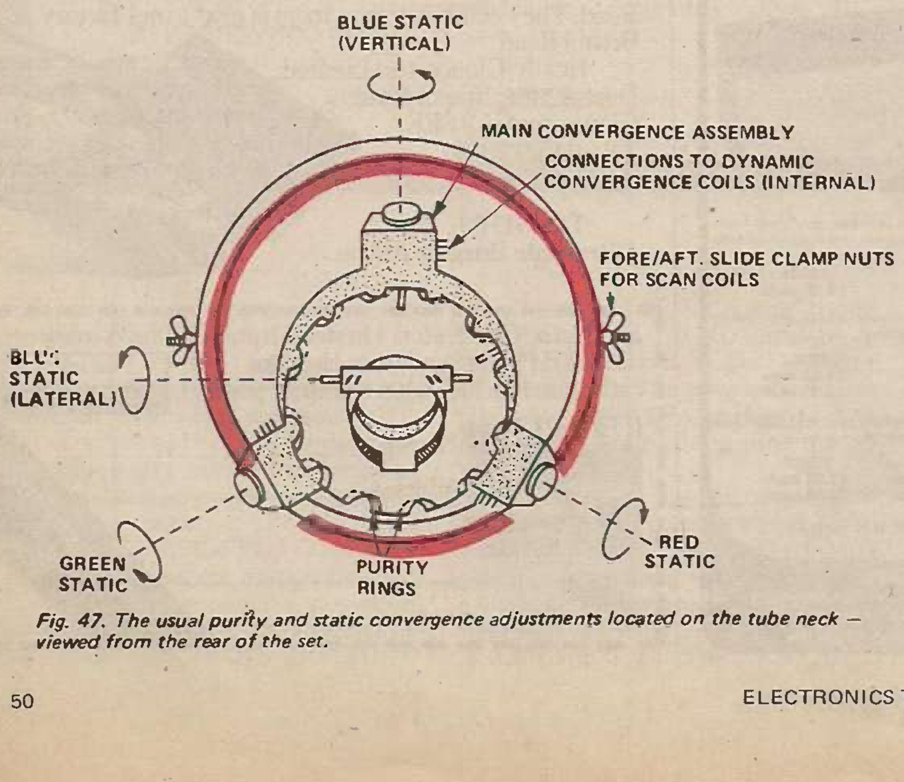
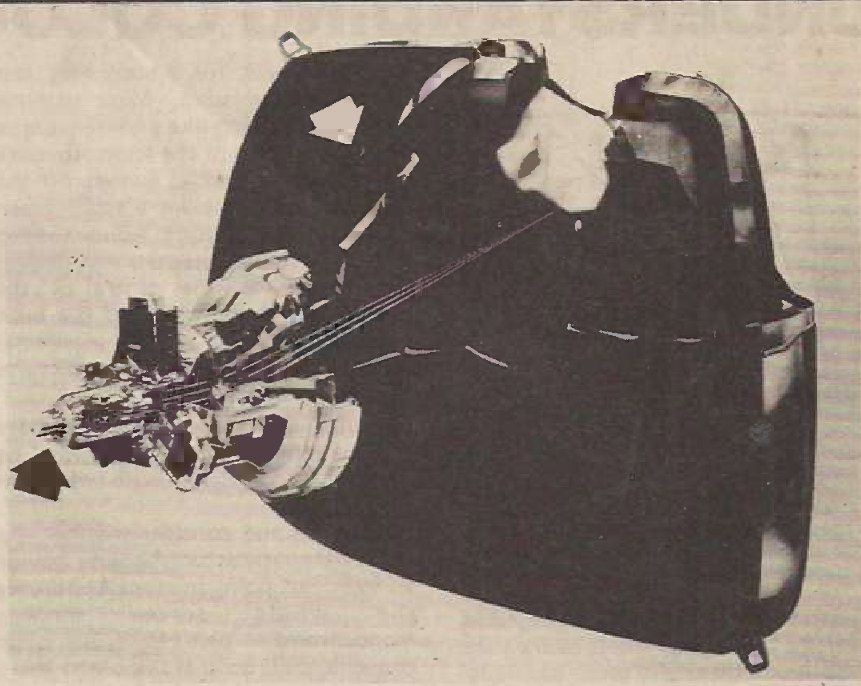


Fig. 47. The usual purity and static convergence adjustments located on the tube neck — viewed from the rear of the set.

CAUTION

Very high voltages — up to 25 kV — are common in colour TV receivers. Do not attempt to undertake the adjustments described in this article unless you are very experienced in handling equipment that operates at such potentials.

The main danger areas are indicated by the two arrows shown on the picture tube (right).



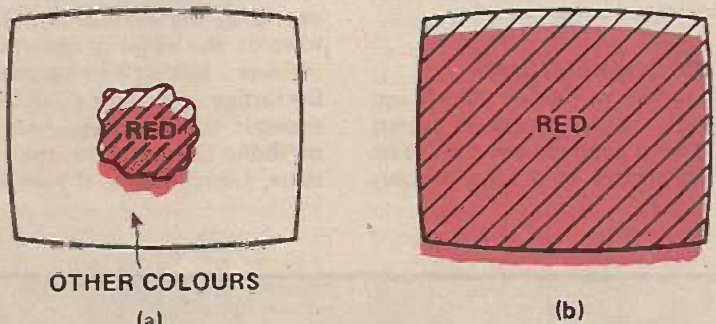


Fig. 48. Purity adjustment is done with the red gun only working. With the scan coils pushed fully forward, the purity rings are used to position the beam deflection-centre horizontally and vertically, to obtain central red spot as in (a). The scan coils are then brought backwards sufficiently to obtain a pure raster as in (b).

described. Note the positions of the purity rings (Fig. 47) — they always have identifying tabs or slots. Experimentally rotate them together and singly, noting the effect on the red raster. With large sets a mirror makes this much easier. Probably the red raster can be 'purified' in this way; if not follow the full procedure involving the scan coils as follows.

Loosen the clamp wingnuts and push the coils fully forward so they hit the tube flare. Then adjust the purity rings for pure red at the *centre* of the screen — Fig. 48. Overall red cannot be obtained at this stage. Then gradually pull the coils backward. The red area should expand to fill the whole screen. If the coils are brought back too far the purity worsens again. The 'perfect' position should not be hard to find and the rings can be retrimmed if necessary. Having purified red, check the blue and green rasters separately. These should also be pure.

If purity absolutely cannot be obtained the shadowmask may somehow have become magnetised. Check that the set's automatic degaussing (Part 7) really works; if so, treatment with a portable degaussing coil may be needed.

CONVERGENCE

This aspect of the adjustments can also be called registration since it is concerned with superimposing exactly the three colour images. In practice it is rare for a colour set to show no registration errors at all. They are most evident on monochrome pictures. Inspect the outlines of sharply defined objects in these pictures. Convergence errors cause black-to-white edges to have coloured fringes . If there is error over the whole screen, do the relatively simple STATIC adjustments (see below) which may be sufficient; if the errors occur in some parts of the picture more than others the more demanding DYNAMIC adjustments need attention.

STATIC CONVERGENCE

The static convergence adjustors are rotatable magnets mounted on the tube neck by which the three pictures can be individually shifted to achieve registration. There are three radial

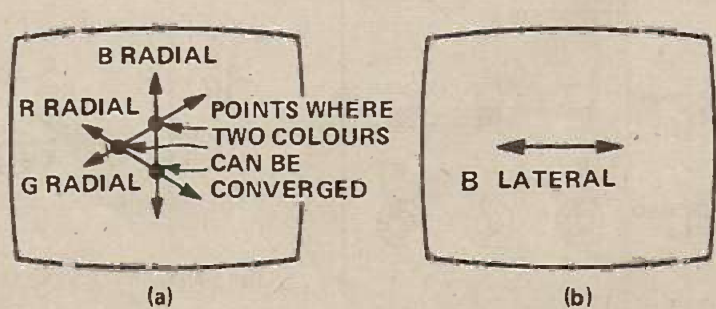


Fig. 49 (a). The R, G and B picture shifts produced by the radial static adjustors (on the main convergence assembly).
(b). The shift given by the blue lateral static adjustor which is necessary for complete convergence of R, G and B.

UNDERSTANDING COLOUR TV

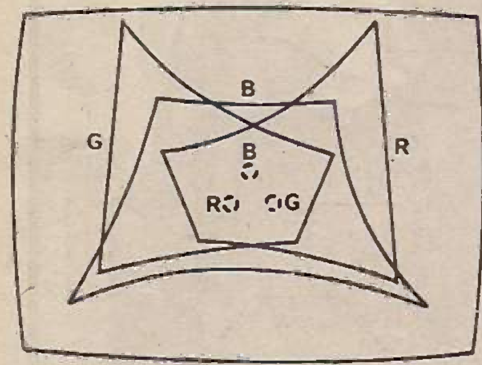


Fig. 50 As the three guns are not mounted on the tube axis, and the length of the beam paths alter over the screen area, the rasters are distorted as shown (exaggerated).

adjustors (Fig. 47) whose magnetic fields are brought to the tube by pole pieces inside the convergence assembly and focused on the electron beams by ferrous plates inside the tube. Their effects on each image are shown in Fig. 49a; alone they enable any two images to be converged, but not all three. To achieve this a fourth adjuster on one beam, conventionally a blue lateral adjuster is needed — Fig. 49b).

It is very hard to do static convergence on moving pictures and it is best to wait for a stationery test pattern transmission. Most patterns include something like a white cross or dot at the centre of the screen to make this adjustment easy. Switch off the blue gun which leaves a red + green (equals yellow) picture. Adjust the red and green radial magnets for perfect convergence at the centre of the screen. Switch on blue and use both the blue radial and blue lateral adjusters to bring all three pictures together at the centre.

Purity and static convergence are slightly interdependent so it may be necessary to retrim both of them again.

Sit back and consider whether the results are satisfactory because now is an excellent point to stop! Look over the whole screen showing monochrome pictures. Although convergence is good at the centre there may be errors elsewhere. Their cure involves the dynamic convergence adjustments whose purpose should be well understood before tackling.

DYNAMIC CONVERGENCE

In a simple world the screen and shadowmask would be shaped as part of a sphere centred on the beam deflection centre. In practice viewers demand near-flat screens and with colour there are three deflection centres at slightly different positions. The result is that the rasters which should be rectangular are distorted as shown in Fig. 50. Dynamic convergence is an electronic process of 'counter distorting' each raster back to rectangular shape, without which overall convergence is obviously impossible. It is achieved by circuits which feed special current waveforms — mixtures of sawtooth and parabolic currents at both line and field frequencies — through coils wound on the internal pole pieces of all four static adjusters in Fig. 47. Thus the magnetic field applied to each beam comprises both a steady flux contributed by the static magnet and a complex alternating component.

The distortion of each raster in Fig. 50 is a combination of two effects. The first is pure 'pincushion' distortion caused by the flatness of the screen. Looked at another way it is caused by the increase in beam length towards the edges of the raster. This increase follows a parabolic law. Correction is possible by supplying the dynamic convergence coils with a parabolic current in the opposite sense. Correction in the vertical sense

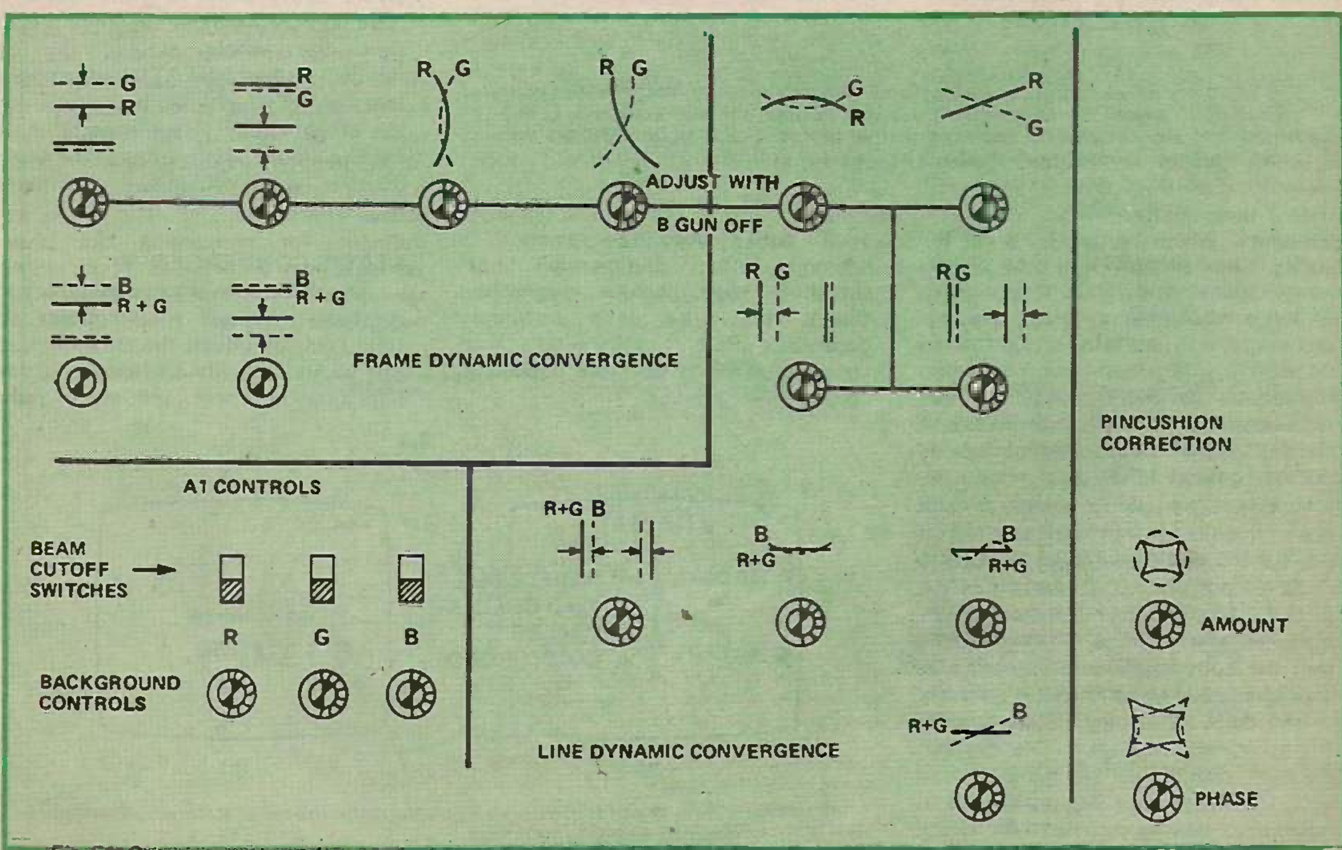


Fig. 51: Convergence control panel of a typical domestic receiver. This also includes pincushion and A1 (first anode) controls.

requires a parabolic current at field frequency and correction in the horizontal sense requires a parabolic current at line frequency.

The second distortion is asymmetry caused by the unavoidable displacement of each gun from the tube axis. This is countered by sawtooth currents, again at both line and field frequencies.

Dynamic convergence circuits therefore consist of networks of resistors, capacitors and inductors which derive from the main line and field scan waveforms (sawtooth shaped) the necessary mixtures of sawtooth and parabolic waveforms for each dynamic coil. The parabolic waveforms are obtainable by integrating sawteeth.

Most of the components are variable presets to enable the optimum convergence to be set up and the total number of controls may be more than a dozen. Circuits vary greatly between manufacturers and it is not really necessary to understand them in detail because the function of each control should be clearly marked. A typical arrangement is shown in Fig. 51.

CROSSHATCH PATTERN

It is hopeless trying to adjust the dynamic controls on a normal programme picture. What is needed is a stationary monochrome pattern designed to show up any convergence errors. Transmitted test patterns are usually far from ideal. The perfect pattern is a crosshatch of thin vertical and horizontal lines as shown in Fig. 52. Until lately this could only be obtained from expensive workshop equipment (any colour service workshop should be equipped with generators for this pattern and the colour bars pattern for decoder alignment) which provides an r.f. signal suitable for feeding to the aerial sockets of receivers. A low-priced crosshatch generator project will be featured in a near future issue of ETI. This unit enables any owner to bring his colour set to ideal convergence.

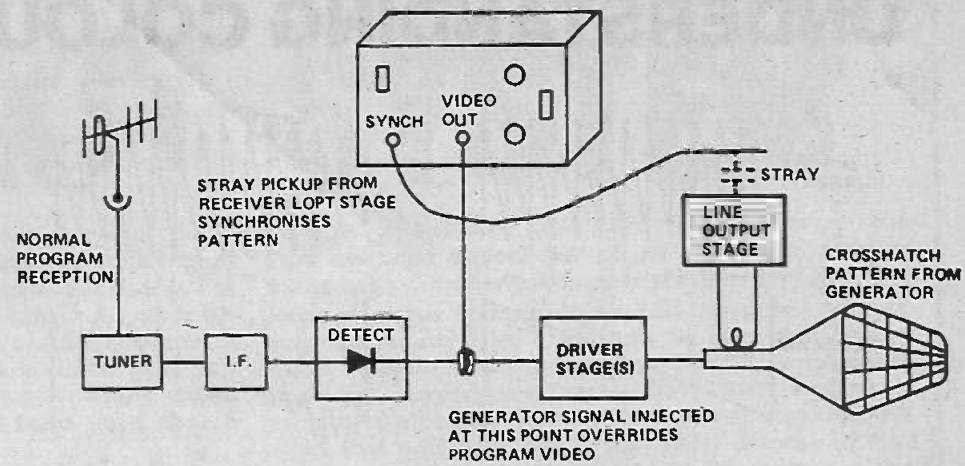


Fig. 53. Connection of direct-injection crosshatch generator to a receiver.

ADJUSTMENT

Having obtained a crosshatch pattern on the screen the dynamic errors can be investigated and compared with the markings on the convergence controls. These will be found concealed somewhere on the set, often lurking behind a 'secret' panel. The correct procedure is to switch off the blue gun and concentrate on converging red and green, the aim being a yellow crosshatch without red or green fringes. Do not turn controls at random; instead make a mental note of what each control actually does e.g. 'bends red verticals to the left' or 'contracts red horizontals at bottom'. Then plan each new adjustment before making it. Soon you will find which controls are interdependent and which errors cannot be completely eliminated, only 'traded off' against errors in other parts of the picture.

Switch on blue and use the blue controls to approach the ideal white fringe-free crosshatch. The static magnets can be trimmed at any time if necessary.

SECRETS OF GOOD CONVERGENCE

There is a degree of skill in converging which becomes second nature after one has converged two or three sets. The following adjustments affect convergence in varying degrees and should be finalized *before* convergence adjustment: Height, Width, Linearity, Focus, EHT Voltage, Purity. However the controls for contrast, brightness, grey scale (to be described), tuning and decoder adjustment have no effect on convergence so can be moved at any time.

During adjustment keep a clear view of the entire screen at all times – it is so easy to over-concentrate on removing an error in one part at the expense of the rest. Go through the interdependent adjusters several times moving each control slightly *less* than seems necessary. If the variable inductor for converging the blue verticals goes to one end of its range the wires to the blue lateral coil may need interchanging. Every dynamic

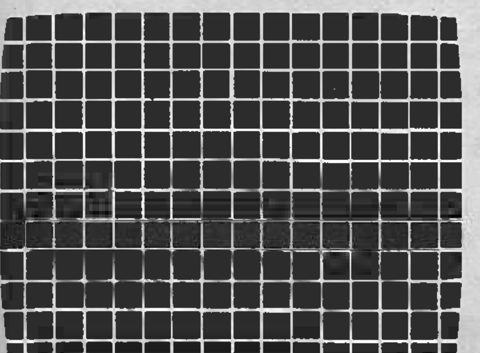
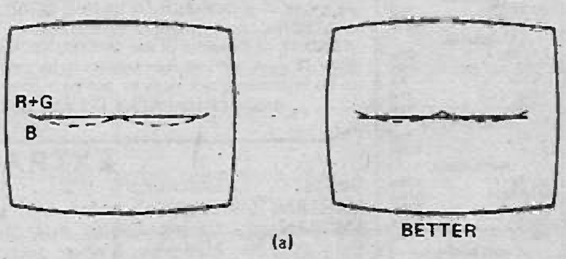


Fig. 52. The crosshatch pattern of white lines on a black background which is virtually essential for dynamic convergence adjustment. It enables any error to be related to the typical control set-up shown in Fig. 51.



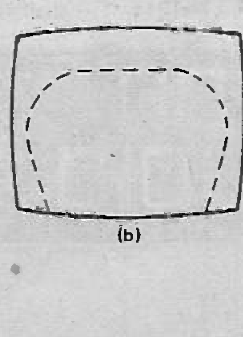


Fig. 54. Tips for good convergence.
(a) If two colours cannot be perfectly converged it is better to distribute the residual errors, with less attention to the edge of the screen, than to insist on perfect convergence at the centre.
(b) The viewer is more likely to notice convergence errors inside the area shown. Thus small corner errors can usually be tolerated.

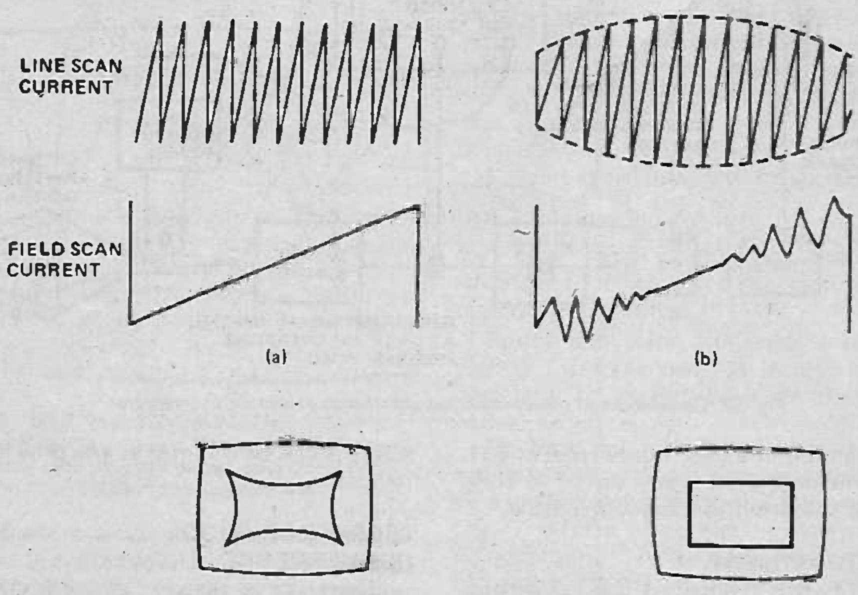


Fig. 55 (a). Line and field scan currents without pincushion correction.
(b). Pincushion correction obtained by cross modulation in transductor — see text.

control should have a visible and progressive effect on the crosshatch pattern and failure to do this suggests a fault in the convergence circuit. If a wirewound potentiometer has an abrupt effect at one point of its travel it may have burnt out — regrettably these components are often over-run.

It is rarely possible to achieve perfect convergence over the whole screen including the corners and the real skill lies in distributing the residual errors so they are not noticeable to the viewer. Fig. 54 should be helpful here. Once converged as finely as possible a colour set should ideally not be moved since merely rotating it through 90° relative to the earth's magnetic field can have a minute upsetting effect.

GENERAL RASTER CORRECTION

A certain amount of pincushion distortion is common to all three rasters and is usually corrected by a special transformer called a transductor. This consists of three windings on the limbs of an E-shaped Ferroxcube core. The two outside windings are in series and are connected in shunt with the line scan coils; the middle winding is connected in series with the field scan coils. The transductor causes a degree of cross modulation between the line and field scan amplitudes due to progressive saturation of the E-shaped core with increasing flux. The effect is shown in Fig. 55. Usually there are one or two controls associated with the transductor to allow the form of correction to be varied to obtain a truly rectangular raster. ●

ELECTRONICS -it's easy! PART 20

Generating non-sinusoidal waveforms.

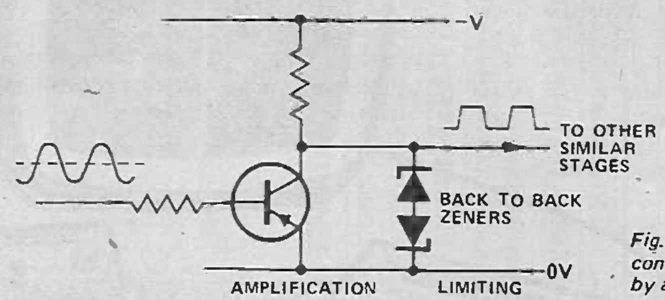


Fig. 1. A sinewave may be converted to a squarewave by amplifying and clipping.

SQUARE WAVES

Square and rectangular waves are most important in digital circuitry because they have signal levels that can be only one of two definite states. (the transition times being considered negligible). They also are used as the starting point for generating pulse trains in which the signal consists of narrow pulses. Three main methods are used to generate square waves. Two start with sinewaves, converting them to square waves, the other generates the square wave directly from a dc voltage.

If a sinewave of the same frequency as the squarewave needed is greatly amplified, the slopes of the sinewave at the zero crossing point are raised more toward the vertical. Also if the amplifier is overdriven the upper and lower limits of the original sinewave will be clipped. A crude square wave results. A more positive clipping process uses two oppositely connected zener diodes placed across the output, as is shown schematically in Fig. 1. If the process is repeated two or three times a quite reasonable square wave results with fast rise-times and clean tops.

A second way, originating from a sinewave, uses a special circuit called a Schmitt trigger. In this circuit, another of the basic family of digital circuits, the output is either low or high depending upon whether the input-voltage level is above or below (respectively) a preset input level. Although the input can exist at any analogue level the output will always be only in one of two states. To produce square waves a sine-wave is fed into the Schmitt trigger which is set to trigger at the point where the symmetrical sinewave passes through zero. The result is a square wave, if the trigger level is exactly at zero, or rectangular if above or below. The advantage of this method is that very low-frequency square waves can be generated.

A typical Schmitt trigger circuit (Schmitt first described this two-state circuit in 1938) is given in Fig. 2. For the values given the output swings from its high value of 12 V to a low value of 1.0 V when the input passes through 1.8 V on the way up. The output swings back again as the input goes through 1.0 V on the way down. The difference between the up and down trigger levels is known as hysteresis (or backlash). Design methods exist that enable the trigger level, backlash and output swing to be set as required. To produce symmetrical square waves from a sine-wave source, with this circuit, the sine-wave would have to have its dc zero placed at 1.5 V. The 150 pF capacitor is added to reduce the impedance of the 1.8 k resistor at high frequencies, that is, whilst the circuit is switching. It is called a "speed-up" capacitor.

As well as being a convenient way to produce square waves, the Schmitt trigger also provides a mechanism whereby a hesitant effect is made positive. Take for example the case where daylight is used to operate a street lamp. As the light falls to around the operating point a relay-switch would chatter on and off with minor changes, until the average light level had fallen below the critical region. By adding a trigger circuit with reasonable amount of backlash, the relay is made to switch on the first time the light falls below the preset level. The relay cannot again change state without a significant rise occurring in light level.

The third way to produce square waves is to generate them using another digital circuit building-block, the free-running multi-vibrator or astable as it is also called.

There are three main types of multi-vibrator — astable, monostable and bistable. The astable automatically switches continuously between two states, thereby producing a square or rectangular wave signal. The monostable is normally in one state, and is triggered by an input signal into its second state. It stays there for a predetermined time before automatically toggling back again thus producing a fixed-length, single, square pulse. The bistable (or flip-flop),

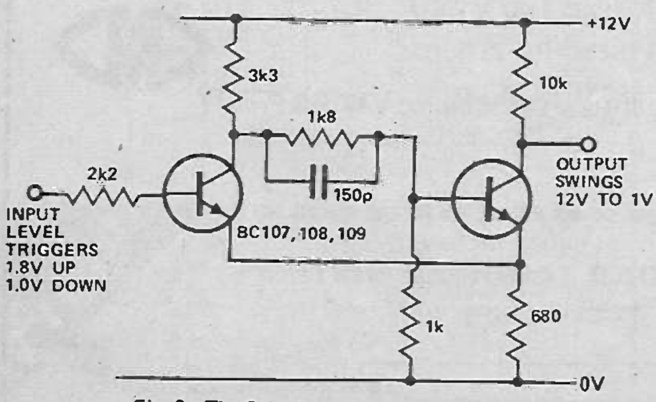


Fig. 2. The Schmitt trigger circuit.

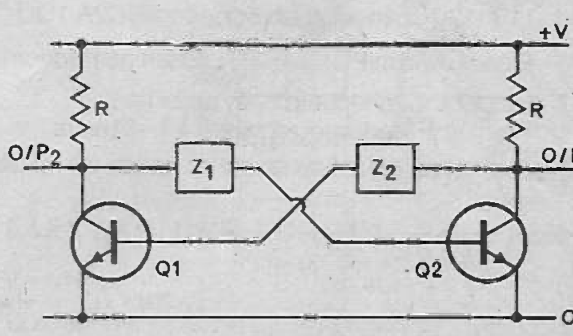


Fig. 3. The basic arrangement of the multivibrator family of circuits.

toggles from one state to the other with each successive input control pulse. It thus gives one output pulse for every two input pulses.

Each type can be used to produce "square" wave signals — the astable as a free running source, the monostable and the bistable as sources initiated by a train of pulses or changing levels.

Basically each type of multi-vibrator is formed from two common-emitter stages that are coupled together with impedances as shown in Fig. 3. This provides positive feedback from one stage to the other causing the device to always be in one state or the other — never between states for any length of time. This kind of impedance — resistors, capacitors or a mixture — determines the kind of positive feedback applied, and hence which of the three functions is generated.

Free-running astable — here the impedances are identical in both sides and are capacitors. Bias, or charging, resistors are added to each base as shown in Fig. 3. A suitable circuit for generating a 1 kHz square wave signal is given in Fig. 4a, Figure 4b is another circuit that will flash a small lamp at 1 Hz. Astable design is reasonably easy and is fully explained in numerous books, especially those devoted to digital circuitry. The period of the square wave produced is given approximately by T = 1.4RC (refer Fig. 4a) from which the frequency f = 0.7/RC. The other main requirements needed is to ensure that the transistors are capable of handling the current demands of R_L when switched on. The output can be taken from either collector — the two are said to be complementary, that is, when one is high the other is low. Alternately the load can be wired directly into the collector circuit as shown in Fig. 4b.

If the base resistors are fed from an independent source the frequency can be varied by external means. This produces a voltage-to-frequency convertor, or, voltage-controlled oscillator VCO. Referring to the approximate period

$$T = 2RC \ln\left(\frac{1 + V_{cc}}{V_{bb}}\right)$$

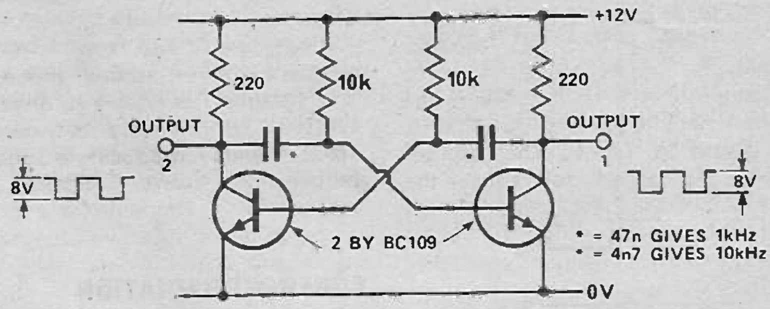
If the VCO is fed with a sawtooth signal the frequency output sweeps in synchronism — the well-known police siren sound.

Monostable or one-shot — if the requirement is for a train of pulses of uniform envelope height and width yet of variable repetition rate, then a monostable driven by a pulse train of the required frequency is the answer. A monostable has one transistor base connected as the astable above, the other is resistance coupled. Figure 6 shows a monostable set to provide a 20 μs wide pulse for a very wide variety of pulse inputs. Monostables are often used to reshape pulses back to a standard shape; they also serve to introduce a finite time delay because the initial input pulse can be regenerated later in time from the trailing edge of the monostable pulse. Thus the input pulse is delayed by the time duration of the monostable pulse width. An approximate value for the pulse duration is given by T = 0.7RC.

The circuit given in Fig. 6 features a second voltage rail. This ensures that the off-state transistor, which ever it is at any one time, is adequately switched off. It is, however, possible to design monostables that operate between only two lines — this has been the trend with semiconductor designs.

Bistable or flip-flop — this is the basic element used in digital computer counting as it produces an output pulse for every second input pulse, thereby dividing the input frequency by two. These have the two stages connected with resistors in both sides. Initially the circuit will start in either state — a set voltage is applied to the SET or RESET input thus conditioning the circuit to the initial plate required. Input pulses or step voltages applied to both sides will cause the unit to change state at each input pulse. Figure 7 shows a typical simple design of flip-flop. The need for a negative voltage rail has been avoided by adding an emitter resistor. Triggering inputs, not shown, can be arranged to drive into the base, emitter or collector in order to provide the toggle action.

Designs come in two varieties — those in which the on-stable holds the transistor well into saturation, and those in which the transistor is never saturated. The latter are capable of faster switching times but need much more careful design. We omit the design of the bistable for that is also well described in texts. It is a rare event, these days, for one to design flip-flops because they are now marketed in IC forms using over 10 transistors to achieve a much more stable and versatile unit at a price less



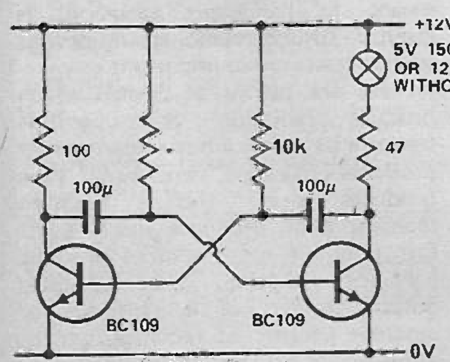


Fig. 4. Free running astable circuits. (a) 1 kHz signal source. (b) Circuit for flashing an indicator lamp.

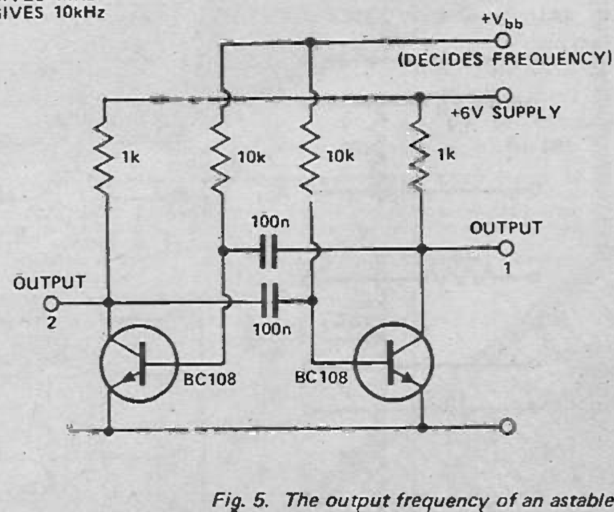


Fig. 5. The output frequency of an astable can be varied by altering V_{bb} — it becomes a voltage-controlled oscillator VCO.

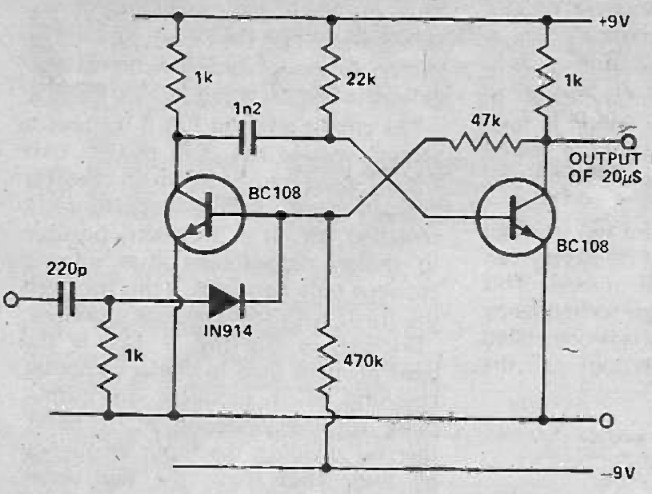


Fig. 6. Simple form of monostable — it produces a 20 microsecond wide pulse for each positive going input pulse.

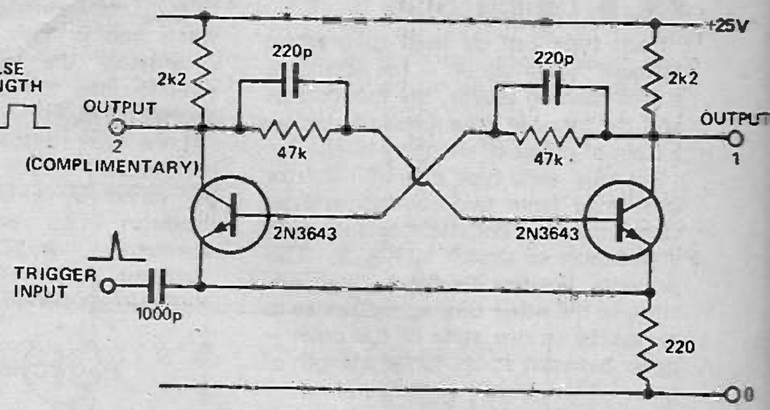


Fig. 7. Basic flip-flop or bistable circuit.

than that of the two discrete transistors needed for the circuit shown in Fig. 7. Monostables and Schmitt triggers are also available in IC form. The latter effect can also be obtained using a linear op-amp with suitable connections.

PULSES

The logical follow on from square-wave generation is that of pulse generation. In Part 8 we described how LR and (more usually) CR networks could produce pulses by differentiating the square wave. The circuits for doing this are shown in Fig. 8. Figure 8d shows the standard differentiation circuit used. It produces signals, as shown in Fig. 17.7, in voltage form from (a) square-wave input waveform. The technique applies equally well for a single pulse requirement. Pulses produced this way alternate in sign. If both pulses are needed it is usually easier to produce two separate trains from anti-phase square waves selecting and combining the pulse polarities needed. This is easier in practice than attempting to invert every second pulse generated by a single differentiator circuit.

GENERATING EXTREMELY HIGH FREQUENCIES

The upper frequency limit for transistor operation is at present just approaching the gigahertz region (10^9 Hz); beyond this quite different techniques are employed. These techniques use devices such as magnetrons and klystrons, millimetre travelling wave tubes, masers and lasers. Figure 9 illustrates the frequency range over which each of these devices is useable.

In the earlier valve era it was very difficult to generate signals for radar needs (300 megahertz to 30 gigahertz) due to limitation of electron transit time, but late in the 1940's special self-resonating structures overcame this problem by using fields combined with valve concepts to 'bunch' electrons in a beam — typical such devices are magnetrons and klystrons. Such devices are still the best where high-power is demanded: microwave cooking ovens use magnetrons to generate kilowatt power levels for heating purposes.

The travelling-wave tube is another special electron device capable of UHF and microwave frequency amplification. In this tube an electron beam interacts with an electromagnetic wave travelling along the tube; again the electron bunching effect overcomes the transit time limitation. The design and use of these forms of generator are very specialised. Circuitry at such high frequencies is not accomplished with wires but with waveguides that look more like a piece of precision plumbing than an electronic circuit.

Still higher frequencies can now be generated using various kinds of laser.

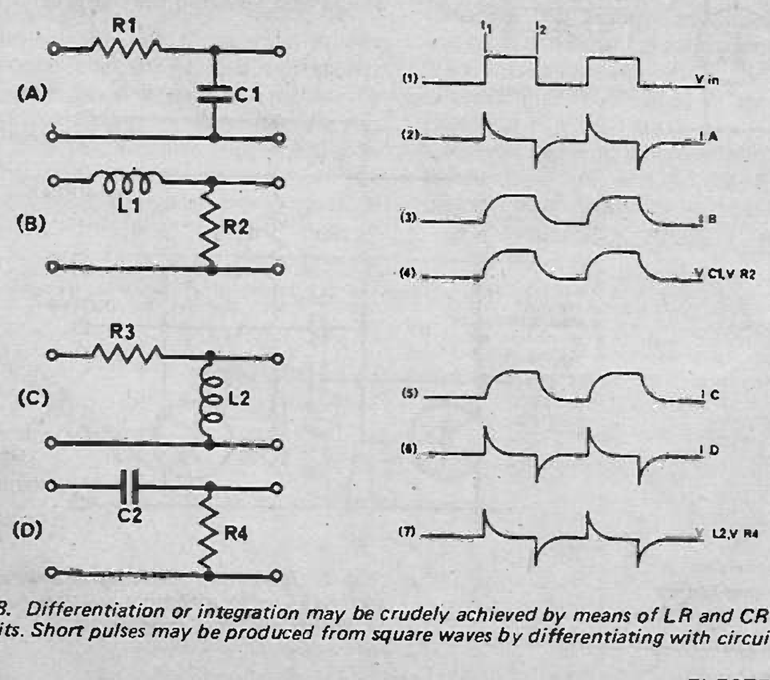


Fig. 8. Differentiation or integration may be crudely achieved by means of LR and CR circuits. Short pulses may be produced from square waves by differentiating with circuit (D).

COHERENT RADIATION

A proper understanding of what is meant by 'coherent radiation' is essential to understanding why devices such as lasers are so important.

There are plenty of devices which produce radiation at super-high frequencies — eg, a hot soldering iron produces infra-red, an x-ray tube produces x-rays and a tungsten filament lamp produces visible light. But none of these sources produce coherent radiation. That is, their output consists of a multitude of separate packets of radiation which, although they may have the same frequency, have randomly different phase. Thus it is only possible to modulate such sources in bulk amplitude. It is not possible to modulate in frequency or phase on a cycle by cycle basis.

Devices such as lasers do produce *coherent* radiation. That is, the radiation is all in step, in terms of phase, and consequently can be modulated on a cycle by cycle basis.

Lasers can provide signal sources ranging from the far infra-red (10^{12}Hz) right through to x-rays (10^{19}Hz). At present no one device can cover this entire range. Some are tunable over a limited part of the spectrum, but most produce a single frequency within this spectrum.

Many laser sources are still in the exotic class and many problems remain to be solved. A major problem still outstanding is detection of such high frequencies. To date the highest frequency detected on a coherent wave by wave basis (that is, not as an incoherent bundle of energy as do most photo detectors) is 88 376 245 000 000 Hz. This is the frequency of the infra-red emission line of the now well developed helium-neon laser. It is just five times lower than visible light. Above that it is still not possible to detect the individual cyclic changes of the coherent sources that now exist.

FURTHER READING

Most books on electronic circuits cover the design of generators. Try "Transistor Manual" — General Electric, 1969.

Application notes for ICs also show how to produce various waveforms.

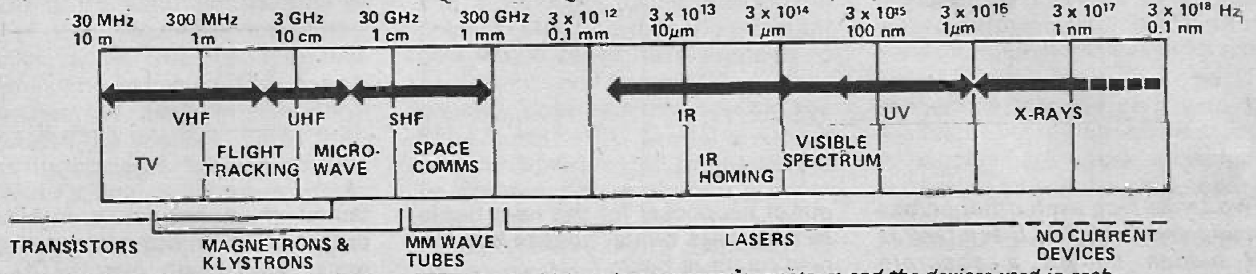


Fig. 9. Chart showing the various regions in the higher electromagnetic spectrum and the devices used in each.

Electronics Tomorrow by John Miller-Kirkpatrick

Two tanks face each other across a small mine field. The Black tank is half hidden behind a concrete bunker whilst its gun follows the meanderings of the White tank crossing the minefield. The driver of the White tank makes a mistake: he is heading towards the other in a straight line. A line which coincides with and ends at the barrel of the Black tank's gun. Black and White fire almost simultaneously and both score direct hits. Each tanks is seriously disabled for a short period. Black now rushes blindly towards White hoping to get a favourable firing position, praying that his own gun will be back in action before White's. White however uses the recovery period to dash for cover behind a bunker wall. He will reappear from behind the bunker and catch Black by surprise. But he misjudges his speed and can't steer clear without clipping the corner of the bunker wall. There is little damage but time is lost in having to manoeuvre out of the damage area. Black has been watching White's mistake and moves in to attack the helpless tank. A wide malicious grin spreads across the driver's face as White desperately tries to turn his gun and fire. "Boom!" from Black's gun. "Splat!" as the shell explodes against the bunker wall. "Boom!". Again from Black tank. Not from his gun this time but from a mine which he has run into. The driver falls to the floor in a hysterical fit of giggles as White takes this opportunity to manoeuvre into position and start wildly firing in the direction of Black's tank. Every shot misses and Black has recovered enough to start his tank spinning on one track with the gun firing continuously. Within a few seconds two shells have hit White. Both drivers are now laughing and crying. Time has run out, Black had won by nine hits to six.

The author, alias Black, digs 10p out of his pocket for the next battle as Pete, alias White, goes to buy the next round of beers

The tank game is one of the latest of the TV games and it is almost funnier to watch then to play (especially after a couple of pints of beer). I found the game in "Tattershall's Tavern" in Knightsbridge Green, London SW1, and I know of one in an amusement arcade near Victoria Station. If you see one stop whatever you are doing and play a battle, I can assure you that you will become addicted very quickly.

The screen is split into three areas. The left and right hand sides look like a maze filled with white odd shaped blocks of "concrete", and the centre contains a minefield with about 30 "mines". Each of two players has one "tank" measuring about ½in. x ½in. but complete with turret, gun, body and two driving tracks. The tank is steered by two levers each controlling the speed of one of the tracks. By pulling evenly on both levers the tank goes straight forward but pulling on one lever only causes the tank to spin around. The gun is fired from a push-button set into the top of one of the two steering levers, firing rate is about one shot per second with a pause after about four shots. Each time your tank is hit by a shell or by a mine it flashes on and off for about five seconds during which time you have no control over the tank or its gun.

The game is even more fascinating if you understand the basic concept and logic of TV games. The amount of logic involved in defining each tank and controlling the turning of the tank is in itself probably more complex than the total logic for a TV tennis game. To define two tanks, bunkers, mines, shells, variable tank speed, firing rate and other goodies that I haven't mentioned must require a mini-computer. With micro-processor systems still costing over £100 this type of game is not yet really an amateur constructional project but many more will be seen in amusement arcades and pubs and eventually as "plug-ons" to consumer TV sets.

An interesting point to mention in passing is that the American amateur constructor is now being offered micro-processor chips and M-P systems in the same way that calculator chips and kits were being offered a couple of years ago. For about $1600 you can buy a complete kit for an "Intelligent Terminal" which you can program in Basic. It will work by itself or it can be connected by phone link to a larger "mainframe" computer system at a bureau.

LOGIC GATE PRICES TUMBLE

About a year ago we compared TTL gates to the new National Semiconductors 74C series of CMOS circuits. The comparison in cost was about 2½:1. In other words a 7400 was about 20p and a 74200 was about 50p. Since then all CMOS prices have dropped considerably and most prices are now only just higher than the equivalent TTL IC. When considering LSI systems the price per gate comes down to ridiculous figures with 3000 gate calculator chips costing about £1.50 or about 20 gates per 1p. This is about one hundredth of the gate cost in TTL SSI and about one twentieth of the cost of complex TTL MSI chips.

Extrapolating from MSI and SSI designed minicomputers, a 16 bit processor (say 10 000 gates) plus a 32K word memory (256 000 gates) could cost about £150. Add on a few ISO controllers and interfaces and you have a complete mini computer for £200. Note the use of the term mini-computer as opposed to micro processor which typically has a lot less RAM storage attached to it. Allow for metal boxes, plugs, profit, labour, etc and you have a complete business machine doing payroll, ledgers, stock, etc for £2000-£3000.

A new technology threatens to reduce this figure even more down to the cost level of the pocket calculator and incidentally reduce the size of the main components to that of the calculator. Integrated Injection Logic (IIL or I^2L) first became known in 1972 when researchers at IBM in Germany formulated the concept. Since then Texas Instruments have produced the world's first IIL microprocessor and Fairchild have produced a 4K RAM using IIL. With Fairchild now moving into the watch and clock chip markets after bailing out CAL-TEX perhaps we can expect to see IIL timing chips in the near future. Texas Instruments might well be intending to use IIL in their TIFAX modules, in the Mark II if not in the Mark I; after all TIFAX is only a type of microprocessor with a 8K bit RAM added to it.

It is difficult to explain how IIL works in a short article; suffice it to say that the average IIL gate has a speed performance equal to TTL, a power performance similar to MOS, about a tenth the chip space of TTL and about a hundredth of the cost of a TTL gate. It may well be 1978 before IIL costs start to become really competitive with PMOS, NMOS or CMOS which are at present about one hundredth of TTL costs at LSI level. The final choice may be on application demand as it was with PMOS. Without the consumer demand for calculator and clock chips using PMOS the price per chip and thus the price per gate would never have dropped to its present level so quickly. A large quantity consumer application has to be found for IIL, to enable further research and quantity production to be initiated. This consumer product may well be in the form of a microprocessor for TV games, TV communication and Teletext applications. By the early 1980s you may well be buying (or renting?) a TV set with colour, stereo, time, Teletext, games and computer terminal ability for about £100 (or whatever £100 is with 5 years inflation added).

Another new technology that we have heard about — GASMOS — is in its very early stages of development. It is claimed to use a fraction of the power of CMOS and have direct interface to seven segment mantle displays. The only gate we have seen so far is the equivalent to a 7402 NOR gate with a very vague data sheet. One of the important application notes warns against testing for logic 'I' with a naked flame. We will keep you in touch with developments in this promising new technology.

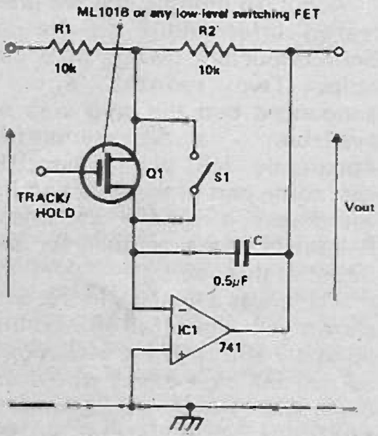
SAGA CONTINUED

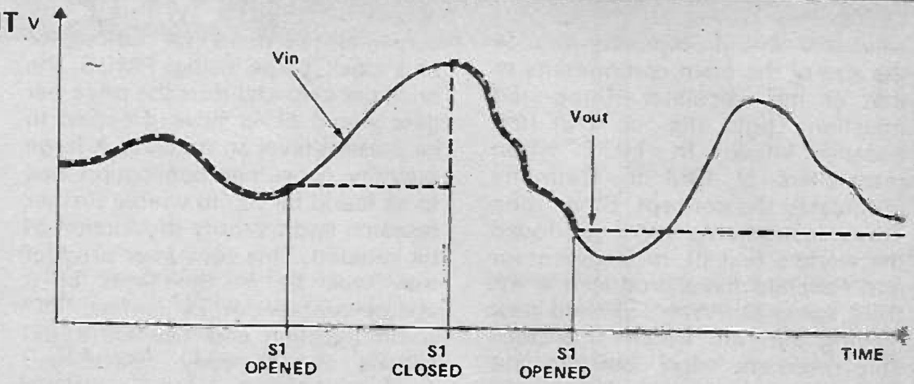
About 18 months ago we pre-released information on National Semiconductors' MM5 309 clock chip. Two months ago we announced that the chip was now available — a bit prematurely. Apparently NS were dissatisfied with some part of the chip and have withdrawn it before its release. Release is now scheduled for about Sept-Oct this year.

There was a mistake in the circuit shown with the MM5309 connected to a 7489 RAM. It was suggested that the digit drives would drive both the 7410 gates and the multiplex transistors without interface, in fact it is best to install a 7407 buffer to interface the digit drives to the 7410 and transistors. Thanks to Mr Shorrock of Morecambe for pointing this out after he tried the same circuit using the compatible MM5311 chip.

tech-tips

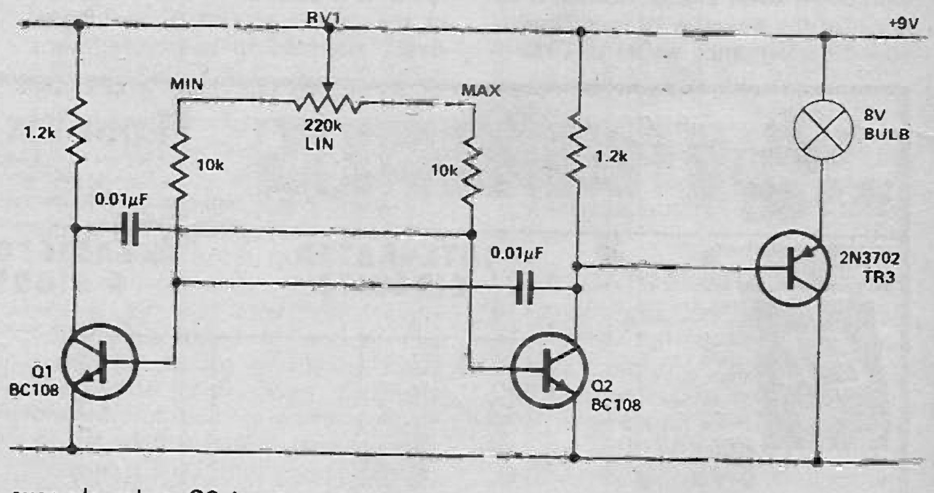
SIGNAL TRACK AND HOLD CIRCUIT





When the switch is closed (or the FET conducting), circuit is behaving as an inverting amplifier with a gain of $\frac{R2}{R1}$. As the inverting terminal of the op amp is a virtual earth, the capacitor is kept charged to the output voltage by the op amp. When the switch is opened (and the FET non-conducting) the voltage at the output is held constant by the capacitor, the current demands of the next stage being met by the op amp. Note that the value of C should be chosen such that its impedance at the operating frequency is large compared to R1 and R2.

VARIABLE BRILLIANCE LAMP FOR D.C. SUPPLIES



A simple and inexpensive unit for reducing the brilliance of a lamp and at the same time reducing the current drain, thus increasing battery life considerably. A power saving does not happen by merely inserting a resistor in series with the bulb, hence the reason for the above circuit.

Q1 and Q2 form an astable multivibrator, the RV1 varying the mark/space ratio. The output from Q2 collector is fed to Q3 base, either satuating Q3 or turning it off. Varying the mark/space of the lamp.

A notable point is that as Q3 is either fully 'on' or '**off**' it need not be a high wattage type. As an example, when Q3 is satuated, Vce = 0.3V approx, and the lamp current is 0.2A the power across Q3 is W = V x 1 = 0.3 x 0.2 = 0.06.

THERMOCOUPLE THERMOMETER

The circuit illustrated was devised to provide a low-cost, sensitive thermometer for measuring temperature differences. The transducer used is a thermocouple consisting of two wires of the same metal, often copper, joined at the two points A and B by a wire of different metal. This thermocouple pair generates a small voltage difference across the points A and B when a temperature difference exists between the junctions a and b. This voltage varies almost linearly with temperature for differences up to about 100°C, although this assumption should not be made in calibrating the thermometer for accurate measurement.

A 741 is used (IC1) for amplifying the small voltage difference between the points a and b enabling a rugged voltmeter to be used to display the temperature difference. The potentiometer is used to set the meter to zero; values of 1kΩ makes setting easy when measuring small temperature differences. However, it may prove necessary to adjust the value of R1 or R2 if zero setting cannot be obtained. If fairly large temperature differences are being measured, VR1 could be increased to 1kΩ.

The sensitivity of the circuit is controlled by the full scale deflection of the voltmeter chosen, on the setting of VR2 (the voltage gain is the ratio VR2/R3), and on the choice of metals in the thermocouple. If the

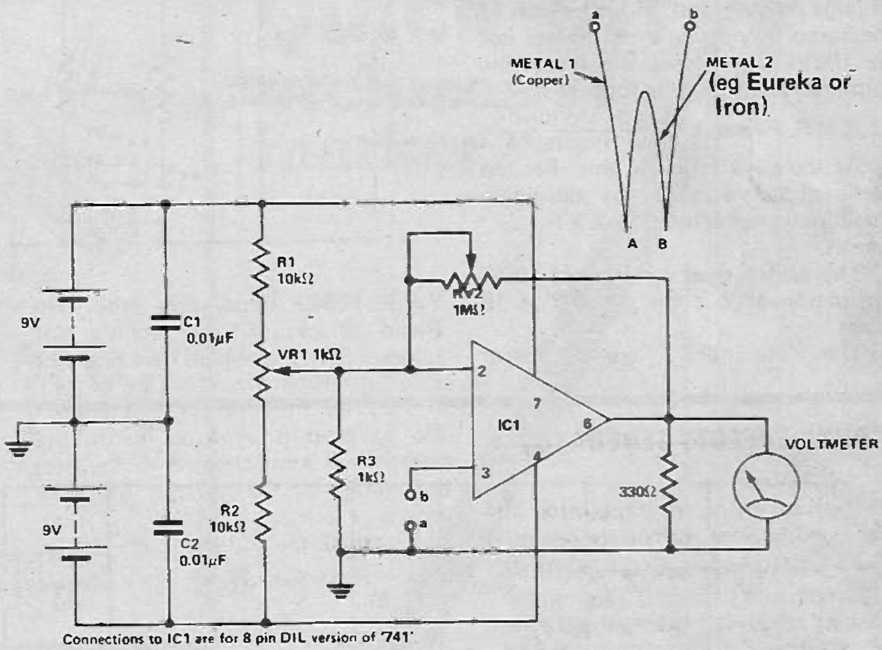
Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to the Editor, Electronics Today International, 36 Ebury Street, London SW1W 0LW.

gain of the circuit is set high (at 1,000), electrical noise pick-up and drift become serious problems and it is advisable to assemble the circuit in a metal, earthed box and to ensure the unit is kept at constant temperature.

For best results, the power supplies should be stabilised and balanced Capacitors C1 and C2 filter out any electrical noise on the power supply leads; if the thermocouple leads are long, a similar value capacitor across a and b should be used for the same reason.

Calibration and use of the thermometer is carried out by immersing one junction in a liquid at a reference temperature, say melting ice, and using the other junction to monitor the changing temperature.



Connections to IC1 are for 8 pin DIL version of '741'

AUDIO AMPLIFIER

In this circuit a 741 is used to drive a complementary output stage from a split supply of 9–0–9V.

The input signal is coupled to the non-inverting input of IC1 via C1.

The amplified output signal from the IC used to drive Q1, which is connected in the emitter follower mode.

Q2, in Q1's emitter circuit, provides sufficient bias for Q3 and Q4 to eliminate crossover distortion and prevents thermal runaway in these transistors.

R4 sets Q1's current at 44mA.

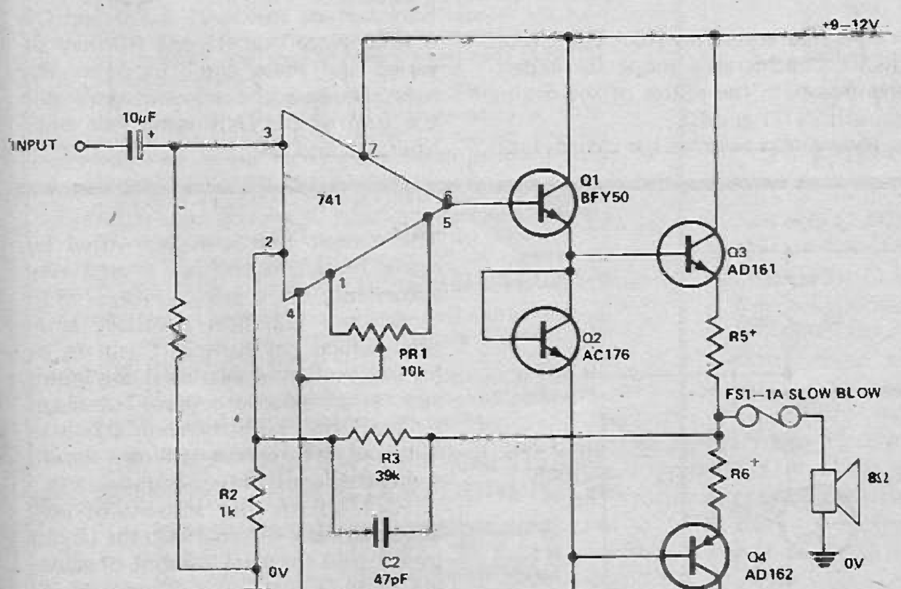
The low value resistors, R5 and R6 in the emitter circuit of Q3 and Q4 should be wire-wound types with a minimum rating of 1W.

Overall feedback is provided by R3 and R2, C2 is incorporated to roll off the response at R.F.

Q3 and Q4 should be a matched pair and require a heatsink of at least 12 sq.in. of 18swg aluminium sheet from which they should be insulated with mica washers and nylon bushes in the usual manner.

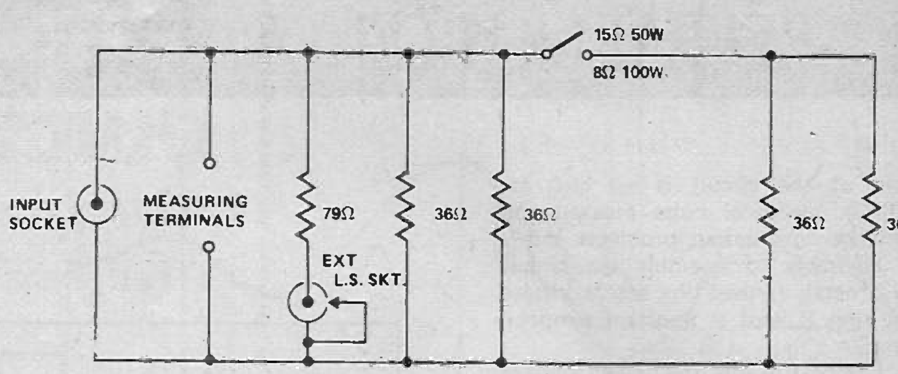
Before use the circuit must be correctly set up. This is accomplished by adjusting PR1 so that the voltage at the junction of R5 and R6 is 0V.

This must be done before connecting the speaker.



tech-tips

A DUMMY LOAO FOR HIGH POWER AMPLIFIERS



This dummy load will replace the normal big loudspeaker system needed when testing amplifiers of up to 100W rating. The power is absorbed as heat in large resistors and this power can be measured by putting a multimeter (set tp 100V a.c.) across the measuring terminals and using the formula

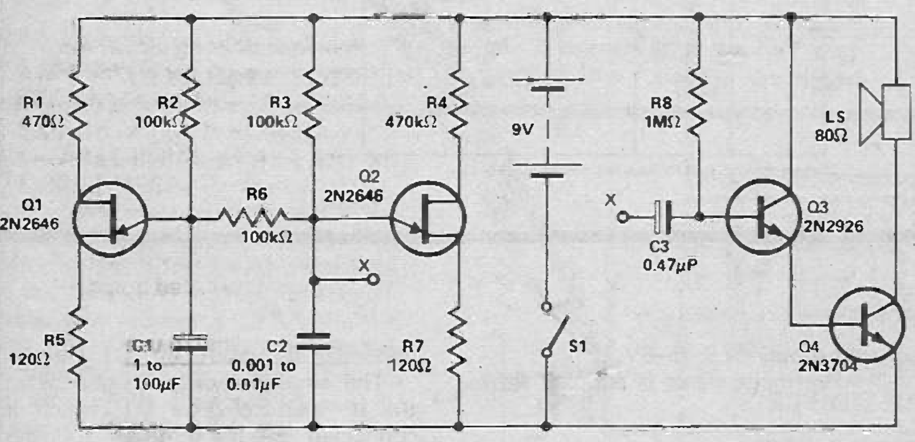
$$\text{R.M.S. Power} = \frac{(\text{R.M.S. Voltage})^2}{\text{Load Resistance}}$$

At the same time the amplifier can be heard at low volume by plugging a small loudspeaker into the 'EXT. L.S.' socket.

The switch gives a choice of 100W dissipation at 8 ohms or 50W at 15 ohms.

The resistors are Labgear YJ PL11040 (obtainable from The Radio Shack, 161 St. John's Hill, London S.W.11.) which have one section of 36 ohms at 25W and one section of 79 ohms at 9W. They should be mounted in a well ventilated box.

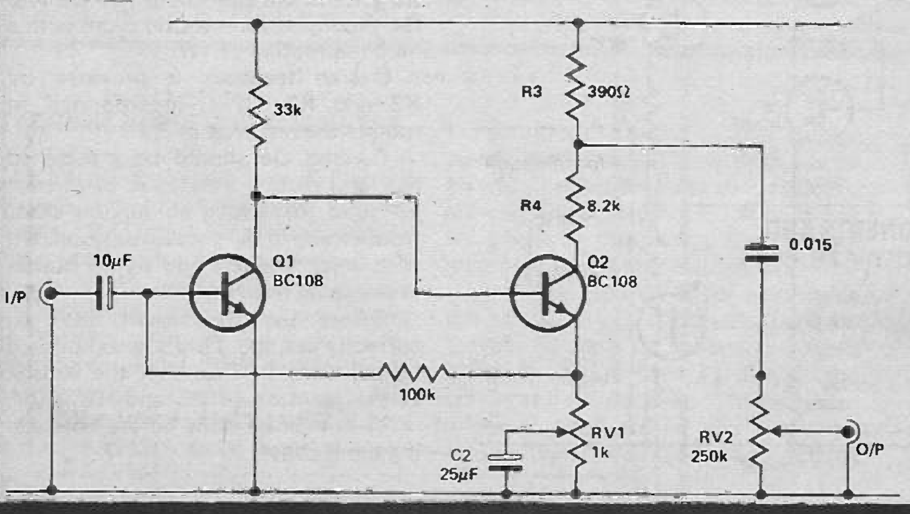
SOUND EFFECTS GENERATOR



Interesting sound effects are produced by the circuit shown in the figure. The sounds generated by the speaker LS arise from the coupling of two unijunction transistor oscillators by means of the resistor R6. The circuit allows considerable scope for experimenting with the values of the timing capacitors C1 and C2.

As soon as switch S1 is closed, both C1 and C2 begin to charge via resistors R2 and R3, respectively. Owing to the smaller time constant of the R3/C2 combination, UJT Q2 discharges before Q1, the pulse being fed to the speaker via C3 and the Darlington-pair amplifier consisting of Q3 and Q4. Meanwhile C1 is much more slowly charging so that the next time that C2 begins to charge there is small voltage already on its upper plate and a shorter time elapses before Q2 fires once again. Thus Q2 fires faster and faster until the voltage on C1 is sufficient to fire Q1. The cycle then repeats. The sound heard consists of a tone of rising pitch which abruptly stops as Q1 fires and then repeats. For starters, make C1 10μF and C2 0.1μF. Note that R2 and R3 may be varied and these could be pots. R8 may require some adjustment to suit the gain of the Darlington Pair amplifier, Q3 and Q4.

FUZZ BOX FOR ELECTRIC GUITARS



This circuit has been well tried by many musicians and has proved very successful.

Q1 and Q2 form a voltage amplifier which has sufficient gain to be 'overdriven' by a relatively low input, such as an electric guitar. The result is that the output from Q2 is a 'Squared-Off' version of the input, giving the required fuzz sound.

RV1 adjusts the amount of negative feedback inserted into the circuit by C2, and thus the amount of squaring of the signal. The purpose of R3 and R4 is to lower the output voltage to a suitable level, which is then adjusted as required with the volume control VR2.

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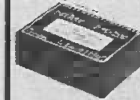

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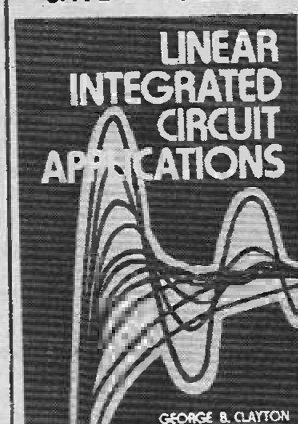

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