ELECTRONICS TODAY

electronics today international

SEPTEMBER 1976

30p

SOUTH AFRICA 60c
CANADA $1

LOW COST VDU

TWO METER POWER AMP
BREAKDOWN BEACON
CMOS TO MAINS
TOSHIBA ST910 REVIEW

NEWS . . . CONSTRUCTION . . . DEVELOPMENTS . . . AUDIO

15—240 Watts!

HY5
Preamplifier

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

FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo

APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address

SPECIFICATIONS:

INPUTS Magnetic Pick-up 3mV Ceramic Pick-up 30mV Tuner 100mV Microphone 10mV Auxiliary 3 100mV, input impedance 47kΩ at 1kHz

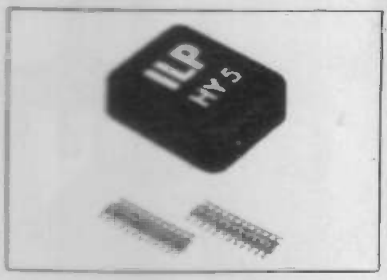
OUTPUTS Tape 100mV, Main output 500mV R.M.S.

ACTIVE TONE CONTROLS Treble ± 12dB at 10kHz Bass ± at 100Hz

DISTORTION 0.1% at 1kHz Signal/Noise Ratio 68dB

OVERLOAD 38dB on Magnetic Pick-up SUPPLY VOLTAGE ± 16-50V

Price £4.75 + 59p VAT P&P free.



HY30
15 Watts into 8Ω

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

FEATURES: Complete Kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build

APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — audio oscillator

SPECIFICATIONS

OUTPUT POWER 15W R.M.S. into 8Ω. DISTORTION 0.1% at 1.5W

INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz —3dB

SUPPLY VOLTAGE ± 18V

Price £4.75 + 59p VAT P&P free.

Available June '76

HY50
25 Watts into 8Ω

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

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components

APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV

OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 25W at 1kHz

SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB

SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm

Price £6.20 + 77p VAT P&P free.

HY120
60 Watts into 8Ω

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

FEATURES: Very low distortion — Integral heatsink — Load line protection — Thermal protection — Five connections — No external components

APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ

SPECIFICATIONS

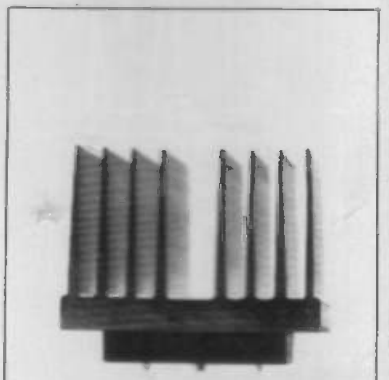
INPUT SENSITIVITY 500mV

OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.04% at 60W at 1kHz

SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz —3dB SUPPLY VOLTAGE ± 35V

SIZE 114 50 85mm

Price £14.40 + £1.16 VAT P&P free.



HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral heatsink — No external components

APPLICATIONS: Hi-Fi — Disco — Monitor — Power slave — Industrial — Public Address

SPECIFICATIONS

INPUT SENSITIVITY 500mV

OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz

SIGNAL/NOISE RATIO 96 dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V

SIZE 114 100 85mm

Price £21.20 + £1.70 VAT P&P free.

HY400
240 Watts into 4Ω

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

FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components

APPLICATIONS: Public address — Disco — Power slave — Industrial

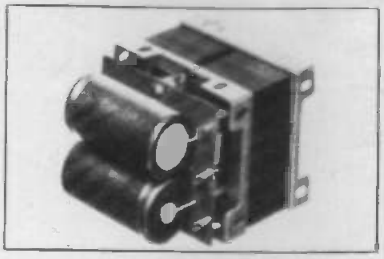
SPECIFICATIONS

OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1kHz

SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE ± 45V

INPUT SENSITIVITY 500mV, SIZE 114x100x85mm

Price £29.25 + £2.34 VAT P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£4.75** plus 59p VAT P/P free

PSU50 suitable for two HY50's **£6.20** plus 77p VAT P/P free

PSU70 suitable for two HY120's **£12.50** plus £1.00 VAT P/P free

PSU90 suitable for one HY200 **£11.50** plus £0.92 VAT P/P free

PSU180 suitable for two HY200's or one HY400 **£21.00** plus £1.68 VAT P/P free

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SEPTEMBER 1976 VOL 5, No. 9

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TRANSISTORS

BRAND NEW, FULLY GUARANTEED

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
AC117K	*0.30	BC170	0.09	BF271	*0.31	2N930	*0.21
AC122	*0.12	BC171	0.09	BF272	*0.81	2N1131	*0.18
AC125	*0.18	BC172	0.09	BF273	0.36	2N1132	*0.18
AC126	*0.14	BC173	0.09	BF274	0.36	2N1302	*0.15
AC127	*0.11	BC174	0.15	BFW19	*0.61	2N1303	*0.15
AC128	*0.11	BC175	*0.22	BFX29	*0.25	2N1304	*0.18
AC132	*0.15	BC177	*0.16	BFX84	*0.19	2N1305	*0.18
AC134	*0.15	BC178	*0.16	BFX85	*0.25	2N1306	*0.21
AC137	*0.15	BC179	*0.16	BFX86	*0.22	2N1307	*0.21
AC141	*0.19	BC180	*0.25	BFX87	*0.22	2N1308	*0.24
AC141K	*0.80	BC181	0.25	BFX88	*0.22	2N1309	*0.21
AC142	*0.19	BC182	0.09	BFY50	*0.13	2N1613	*0.16
AC142K	*0.26	BC182L	0.09	BFY51	*0.13	2N1711	*0.16
AC151	*0.16	BC183	0.09	BFY52	*0.13	2N1889	*0.32
AC153K	*0.34	BC183L	0.09	BFY53	*0.13	2N1890	*0.46
AC154	*0.28	BC184	0.09	BSX19	*0.16	2N1893	*0.36
AC155	*0.28	BC184L	0.09	BSX20	*0.16	2N2147	*0.73
AC156	*0.20	BC186	*0.29	BSY25	*0.10	2N2148	*0.58
AC157	*0.25	BC187	*0.29	BSY26	*0.16	2N2192	*0.36
AC165	*0.20	BC207	0.11	BSY27	*0.16	2N2193	*0.36
AC166	*0.20	BC208	0.11	BSY28	*0.16	2N2194	*0.36
AC167	*0.20	BC209	0.12	BSY29	*0.10	2N2217	*0.22
AC168	*0.25	BC212	0.10	BSY38	*0.19	2N2218	*0.18
AC169	*0.15	BC212L	0.10	BSY39	*0.19	2N2218A	*0.18
AC176	*0.11	BC213	0.10	BSY40	*0.29	2N2219	*0.18
AC176K	*0.26	BC213L	0.10	BSY41	*0.29	2N2220	*0.22
AC177	*0.25	BC214	0.10	BSY95	*0.13	2N2221	*0.18
AC178	*0.29	BC214L	0.10	BSY95A	*0.13	2N2222	*0.18
AC179	*0.29	BC225	0.26	BU105	*1.90	2N2368	*0.18
AC180	*0.20	BC226	0.36	MAT100	*0.19	2N2369	*0.12
AC180K	*0.50	BC251	0.10	MAT101	*0.20	2N2369A	*0.12
AC181	*0.20	BC301	*0.28	MAT120	*0.19	2N2411	*0.25
AC181K	*0.30	BC302	*0.25	MAT121	*0.20	2N2412	*0.25
AC187	*0.22	BC303	*0.31	MJE521	*0.58	2N2646	*0.34
AC187K	*0.23	BC304	*0.37	MJE2955	*0.88	2N2711	*0.21
AC188	*0.19	BC327	0.12	MJE3055	*0.57	2N2712	*0.21
AC188K	*0.23	BC328	0.12	MJE3440	*0.51	2N2714	*0.21
ACY17	*0.28	BC337	0.12	MPF102	*0.28	2N2904	*0.14
ACY18	*0.20	BC338	0.12	MPF104	*0.28	2N2904A	*0.18
ACY19	*0.20	BC440	*0.31	MPF105	*0.28	2N2905	*0.18
ACY20	*0.20	BC460	*0.37	OC19	*0.34	2N2905A	*0.18
ACY21	*0.20	BCY30	*0.25	OC20	*0.80	2N2906	*0.12
ACY22	*0.17	BCY31	*0.27	OC22	*0.47	2N2906A	*0.14
ACY27	*0.19	BCY32	*0.31	OC23	*0.49	2N2907	*0.15
ACY28	*0.19	BCY33	*0.22	OC24	*0.37	2N2907A	*0.16
ACY29	*0.34	BCY34	*0.26	OC25	*0.39	2N2923	0.15
ACY30	*0.29	BCY70	*0.15	OC26	*0.38	2N2924	0.15
ACY31	*0.29	BCY72	*0.20	OC28	*0.60	2N2925	0.15
ACY34	*0.21	BCY72	*0.15	OC29	*0.60	2N2926G	0.09
ACY35	*0.21	BCZ10	*0.20	OC35	*0.45	2N2926Y	0.09
ACY36	*0.29	BCZ11	*0.26	OC36	*0.51	2N2926O	0.08
ACY40	*0.18	BCZ12	*0.26	OC41	*0.20	2N2926R	0.07
ACY41	*0.19	BD115	*0.83	OC42	*0.25	2N2926B	0.07
ACY44	*0.36	BD116	*0.81	OC44	*0.16	2N3010	*0.71
AD130	*0.39	BD121	*0.67	OC45	*0.13	2N3011	*0.15
AD140	*0.49	BD123	*0.67	OC70	*0.10	2N3053	*0.15
AD142	*0.55	BD124	*0.78	OC71	*0.10	2N3054	*0.48
AD143	*0.49	BD131	*0.36	OC72	*0.15	2N3055	*0.40
AD149	*0.45	BD132	*0.40	OC74	*0.15	2N3391	0.15
AD161	*0.36	BD133	*0.67	OC75	*0.16	2N3391A	0.17
AD162	*0.38	BD135	0.41	OC76	*0.16	2N3392	0.15
AD161 & AD162(MP)	*0.69	BD136	0.41	OC77	*0.26	2N3393	0.15
		BD137	0.46	OC81	*0.16	2N3394	0.15
		BD138	0.51	OC81D	*0.16	2N3395	0.18
ADT140	*0.51	BD139	0.56	OC82	*0.16	2N3402	*0.21
AF114	*0.22	BD140	0.61	OC82D	*0.10	2N3403	*0.21
AF115	*0.22	BD155	*0.81	OC83	*0.20	2N3404	*0.29
AF116	*0.22	BD175	*0.61	OC139	*0.20	2N3405	*0.45
AF117	*0.22	BD176	*0.61	OC140	*0.28	2N3414	0.16
AF118	*0.32	BD177	*0.67	OC169	*0.28	2N3415	0.16
AF124	*0.28	BD178	*0.67	OC170	*0.26	2N3416	0.29
AF125	*0.18	BD179	*0.71	OC171	*0.26	2N3417	0.29
AF126	*0.28	BD180	*0.71	OC200	*0.28	2N3525	*0.77
AF127	*0.28	BD185	*0.67	OC201	*0.29	2N3614	*0.69
AF130	*0.31	BD186	*0.67	OC202	*0.29	2N3615	*0.76
AF178	*0.51	BD187	*0.71	OC203	*0.26	2N3616	*0.76
AF179	*0.51	BD188	*0.71	OC204	*0.26	2N3646	*0.89
AF180	*0.51	BD189	*0.77	OC205	*0.38	2N3702	0.09
AF181	*0.51	BD190	*0.77	OC308	*0.41	2N3703	0.09
AF186	*0.51	BD195	*0.87	OCP71	*0.44	2N3704	0.08
AF239	*0.38	BD196	*0.87	ORP12/		2N3705	0.08
AL102	*0.75	BD197	*0.92	NSL4931	0.48	2N3706	0.08
AL103	*0.75	BD198	*0.92	ORP60	0.41	2N3707	0.08
ASY28	*0.36	BD199	*0.98	ORP61	0.41	2N3708	0.08
ASY27	*0.31	BD200	*0.98	P20	*0.51	2N3709	0.08
ASY28	*0.26	BD205	*0.81	P346A	*0.20	2N3710	0.09
ASY29	*0.26	BD206	*0.81	P397	*0.43	2N3711	0.09
ASY50	*0.26	BD207	*0998	ST140	*0.13	2N3819	*0.29
ASY51	*0.26	BD209	*0.58	ST141	*0.18	2N3820	*0.51
ASY52	*0.26	BDY20	*1.02	TIP29	*0.40	2N3821	*0.36
ASY54	*0.26	BF115	*0.15	TIP30	*0.45	2N3823	*0.29
ASY55	*0.28	BF117	*0.46	TIP31A	*0.52	2N3903	0.29
ASY56	*0.26	BF118	*0.71	TIP32A	*0.60	2N3904	0.31
ASY57	*0.26	BF119	*0.71	TIP41A	*0.65	2N3905	0.29
ASY58	*0.26	BF121	0.46	TIP42A	*0.72	2N3906	0.28
ASY73	*0.26	BF123	0.51	TIS43	*0.25	2N4058	0.12
ASZ21	*0.41	BF125	0.46	UT46	*0.20	2N4059	0.10
BC107	*0.08	BF127	0.51	ZTX107	0.07	2N4060	0.12
BC108	*0.08	BF152	0.56	ZTX108	0.07	2N4061	0.12
BC109	*0.08	BF153	0.46	ZTX109	0.07	2N4062	0.12
BC113	0.10	BF154	0.46	ZTX300	0.07	2N4284	0.18
BC114	0.16	BF155	*0.71	ZTX500	0.09	2N4285	0.18
BC115	0.16	BF156	*0.49	ZN414	1.11	2N4286	0.18
BC116	0.16	BF157	*0.56	2G301	*0.19	2N4287	0.18
BC117	0.16	BF158	0.56	2G302	*0.19	2N4288	0.18
BC118	0.09	BF159	0.61	2G303	*0.19	2N4289	0.18
BC119	*0.31	BF160	0.41	2G304	*0.25	2N4290	0.18
BC120	*0.81	BF162	0.41	2G306	*0.41	2N4291	0.18
BC125	0.12	BF163	0.41	2G308	*0.36	2N4292	0.18
BC126	0.19	BF164	0.41	2G309	*0.37	2N4293	0.18
BC132	0.12	BF165	0.41	2G339	*0.20	2N5172	0.12
BC134	0.10	BF167	*0.22	2G339A	*0.17	2N5194	*0.56
BC135	0.12	BF173	*0.15	2G344	*0.19	2N5294	*0.56
BC136	*0.16	BF176	0.36	2N404	*0.20	2N5296	*0.56
BC137	*0.16	BF177	*0.36	2N404A	*0.29	2N5457	*0.32
BC139	*0.41	BF178	*0.31	2N524	*0.13	2N5458	*0.32
BC140	*0.31	BF179	*0.31	2N527	*0.50	2N5459	*0.41
BC141	*0.31	BF180	*0.31	2N598	*0.83	2N6121	*0.69
BC142	*0.31	BF181	*0.31	2N599	*0.46	2S301	*0.51
BC143	*0.31	BF182	*0.41	2N696	*0.10	2S302A	*0.43
BC145	0.46	BF183	*0.41	2N697	*0.11	2S302	*0.43
BC147	0.09	BF184	*0.26	2N698	*0.20	2S303	*0.56
BC148	0.09	BF185	*0.31	2N699	*0.36	2S304	*0.71
BC149	0.09	BF187	*0.28	2N706	*0.08	2S305	*0.80
BC150	0.19	BF188	0.41	2N706A	*0.09	2S306	*0.80
BC151	0.20	BF194	0.10	2N708	*0.11	2S307	*0.80
BC152	0.18	BF195	0.10	2N711	*0.31	2S321	*0.57
BC153	0.29	BF196	0.12	2N717	*0.36	2S322	*0.43
BC154	0.20	BF197	0.12	2N718	*0.23	2S322A	*0.43
BC157	0.11	BF198	0.12	2N718A	*0.31	2S323	*0.57
BC158	0.11	BF199	0.12	2N726	*0.29	2S324	*0.71
BC159	0.11	BF200	*0.46	2N727	*0.29	2S325	*0.71
BC160	*0.46	BF222	*0.46	2N743	*0.20	2S326	*0.71
BC161	*0.51	BF257	*0.28	2N744	*0.20	2S327	*0.71
BC167	0.10	BF258	*0.36	2N914	*0.15	2S701	*0.43
BC168	0.10	BF259	*0.48	2N918	*0.31	40361	*0.41
BC169	0.10	BF270	*0.36	2N929	*0.21	40362	*0.51

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

BI-PAK STILL LOW PRICE, FULL SPECIFICATION GUARANTEED

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
7400	0.09	0.09	0.08	7486	0.32	0.30	0.29
7401	0.10	0.09	0.08	7489	2.90	2.80	2.70
7402	0.11	0.10	0.09	7490	0.37	0.35	0.33
7403	0.11	0.10	0.09	7491	0.60	0.58	0.56
7404	0.13	0.12	0.11	7492	0.43	0.42	0.41
7405	0.13	0.12	0.11	7493	0.43	0.42	0.41
7406	0.25	0.24	0.23	7494	0.43	0.42	0.41
7407	0.25	0.24	0.23	7495	0.70	0.68	0.66
7408	0.15	0.14	0.13	7496	0.68	0.66	0.64
7409	0.15	0.14	0.13	74100	1.00	0.98	0.96
7410	0.09	0.09	0.08	74104	0.40	0.38	0.36
7411	0.23	0.22	0.21	74105	0.40	0.38	0.36
7412	0.26	0.25	0.24	74107	0.36	0.34	0.32
7413	0.26	0.26	0.25	74110	0.56	0.54	0.52
7416	0.28	0.27	0.26	74111	0.83	0.81	0.79
7417	0.28	0.27	0.26	74118	0.90	0.88	0.86
7420	0.12	0.11	0.10	74119	1.25	1.20	1.15
7422	0.28	0.27	0.26	74121	0.26	0.26	0.25
7423	0.30	0.28	0.26	74122	0.50	0.48	0.46
7425	0.30	0.28	0.26	74123	0.58	0.56	0.54
7426	0.30	0.28	0.26	74141	0.60	0.58	0.56
7427	0.30	0.28	0.26	74145	0.96	0.94	0.92
7428	0.42	0.38	0.36	74150	1.30	1.25	1.20
7430	0.12	0.11	0.10	74151	0.76	0.74	0.72
7432	0.30	0.28	0.26	74153	0.95	0.93	0.91
7433	0.39	0.37	0.35	74154	1.50	1.45	1.40
7437	0.30	0.28	0.26	74155	0.80	0.78	0.76
7438	0.30	0.28	0.26	74156	0.80	0.78	0.76
7440	0.12	0.11	0.10	74157	0.95	0.93	0.91
7441	0.64	0.62	0.60	74160	1.00	0.98	0.96
7442	0.65	0.63	0.61	74161	1.00	0.98	0.96
7443	1.10	1.05	1.00	74162	1.00	0.98	0.96
7444	1.10	1.05	1.00	74163	1.00	0.98	0.96
7445	0.95	0.80	0.85	74164	1.25	1.20	1.15
7446	1.10	1.05	1.00	74165	1.25	1.20	1.15
7447	0.67	0.65	0.63	74166	1.48	1.44	1.39
7448	0.80	0.78	0.76	74174	1.00	0.95	0.90
7450	0.12	0.11	0.10	74175	0.95	0.93	0.91
7451	0.12	0.11	0.10	74176	1.16	1.11	1.06
7453	0.12	0.11	0.10	74177	1.16	1.11	1.06
7454	0.12	0.11	0.10	74180	1.16	1.11	1.06
7460	0.12	0.11	0.10	74181	2.00	1.90	1.80
7470	0.25	0.24	0.23	74182	0.90	0.88	0.86
7472	0.22	0.21	0.20	74184	1.67	1.62	1.58
7473	0.26	0.24	0.22	74190	1.50	1.45	1.40
7474	0.27	0.25	0.23	74191	1.50	1.45	1.40
7475	0.48	0.46	0.44	74192	1.25	1.10	1.05
7476	0.25	0.24	0.23	74193	1.15	1.10	1.05
7480	0.50	0.48	0.46	74194	1.15	1.10	1.05
7481	1.02	1.00	0.98	74195	0.80	0.78	0.76
7482	0.83	0.81	0.79	74196	1.00	0.98	0.96
7483	0.98	0.96	0.94	74197	1.00	0.98	0.96
7484	0.90	0.88	0.86	74198	2.10	2.00	1.90
7485	1.25	1.20	1.15	74199	1.95	1.90	1.85

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

SPECIAL POWER OFFER

R.C.A. 2N5295. NPN to 3 PLASTIC POWER

VCE 50V VCB 60v
P 38w Ic 4A

hFE 30-120

ONLY £1.50* for 10

*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	0.26	0.20	0.25	0.36	0.38	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	0.98	—
800	—	—	0.58	0.65	0.81	0.81	0.92	1.22	1.38	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	0.18	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	0.86	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	300mA (DO7)	750mA (SO16)	1A Plastic	1.5A (SO16)	3A (SO10)	10A (SO10)	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	*1.25
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	*1.91
1000	0.13	0.28	IN4007	0.11	0.23	0.44	*0.60	*2.31
1200	—	0.32	IN4007		0.28	0.54	*0.69	*2.88

*TRIACS

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

DIACS

BR100 *0.23
D32 *0.23
(These two diacs are recommended for use with triacs.)

SUPER UNTESTED PAKS

Pak No.	Description	Price
U1	120 Glass Sub-min G.P. Germ. diodes	0.60
U2	50 Mixed Germanium transistors AF/RF	*0.60
U3	75 Germ. gold bonded sub-min like OA47	0.60
U4	30 Germ. transistors like OC81, AC128	*0.60
U5	60 200mA sub-min silicon diodes	0.60
U6	30 Sil. trans. NPN like BSY95A, 2N706	*0.60
U7	16 Sil. rect. 750mA up to 1000	0.60
U8	50 Sil. diodes DO-7 250mA like OA200/202	0.60
U9	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 6Amp sil. rect. BYZ13 up to 800 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 SCRs TO-5 up to 600 PIV	*1.20
U32	25 Zener diodes 400mW DO-7 3-33 volts mixed	0.60
U33	15 Plastic 1 Amp sil. rect. IN4000 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	*0.80
U38	30 Fast switch sil. trans. NPN 400MHz	*0.60
U39	30 RF. Germ. PNP trans. 2N1301/5 TO-5	*0.80
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 80W 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.

★INDICATOR

L.E.D. Displays

DL707 Common anode, 0.3" **85p**

DL747 Jumbo common anode, 0.6" **£1.70**

DL727 Double digit display, common anode, 0.5" **£2.00**

L.E.D.s

Available in 0.125" and 0.2" dia. lenses

Red **10p**. Green **17p**. Yellow **17p**.

Mounting clips 2p each

3015F Minitron 7-segment filament **£1.11**

NIXI TUBE — ITT 587OS

Character height 13.46mm

SPECIAL OFFER 5 for £2.00

V.A.T.

All prices EXCLUDE V.A.T.

Please add 8% to all prices marked ★ Remainder add 12½%

AVDEL BOND

SOLVE THOSE STICKY PROBLEMS!

with

CYANOACRYLATE C2 ADHESIVE

The wonder bond which works in seconds — bonds plastic, rubber, transistors, components permanently, immediately!

OUR PRICE ONLY 70p★

for 2gm phial

VOLTAGE REGULATORS

TO 3 Plastic Encapsulation

uA 7805/L129
5V (equiv. to MVR5V) 1.25

uA 7812/L130
12V (Equiv. to MVR12V) 1.25

uA 7815/L131
15V (Equiv. to MVR15V) 1.25

uA 7818
18V (Equiv. to MVR18V) 1.25

D.I.L. SOCKETS

	1	25	100+
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
BPS24 24-pin type (low cost)	0.35	0.33	0.30

★ DIODES

AA119	0.08	BYZ16	0.41
AA120	0.08	BYZ17	0.36
AA129	0.08	BYZ18	0.38
AAY30	0.09	BYZ19	0.28
AAZ13	0.10	CG62	
BA100	0.10	(OA91 Eq)	0.06
BA116	0.21	CG651	
BA126	0.22	(OA70-OA79)	0.07
BA148	0.15	OA5 Short	
BA154	0.12	Leads	0.21
BA155	0.15	OA10	0.14
BA165	0.14	OA47	0.07
BA173	0.15	OA70	0.07
BB104	0.15	OA79	0.07
BY100	0.16	OA81	0.07
BY101	0.12	OA85	0.09
BY105	0.10	OA90	0.07
BY114	0.12	OA91	0.07
BY124	0.12	OA95	0.07
BY126	0.15	OA200	0.07
BY127	0.16	OA202	0.07
BY128	0.16	SD10	0.06
BY130	0.17	SD19	0.06
BY133	0.21	1N34	0.07
BY164	0.51	1N34A	0.07
BYX38/300	0.43	1N914	0.06
BYZ10	0.36	1N916	0.06
BYZ11	0.31	1N4148	0.06
BYZ12	0.31	ISO21	0.10
BYZ13	0.26	IS961	0.07

UNTESTED AUDIO PACKS

Comprising 5 I.C.s 76003/76023 series

ONLY £1 per PAK
Complete with data

FM STEREO DECODER

Comprising 5 I.C.s like **MC1307** and **SN76110**

ONLY £1.50 per PAK
Complete with data

BRIDGE RECTIFIERS

2A/50vRMS	0.35
2A/100vRMS	0.40
2A/200vRMS	0.45
2A/400vRMS	0.50
2A/1000vRMS	0.60

P&P

Postage and packing add 25p. Overseas add extra for airmail. Minimum order £1

BI-PAK

PO BOX 6, WARE, HERTS

BI-PAK

High quality modules for stereo, mono and other audio equipment.

NEW

PUSH-BUTTON

STEREO FM TUNER

OUR PRICE ONLY

£19.95 Fitted with Phase Lock-loop Decoder

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T538.**
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection.
Full instructions supplied.

£2.65

VAT ADD 12½%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER

PA100

OUR PRICE

£13.50

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27.55.** plus 62p postage.

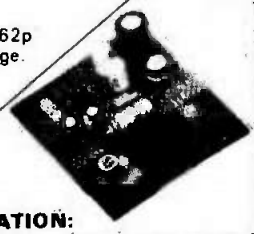
TEAK 60 AUDIO KIT: Comprising: Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £9.20** plus 62p postage.

Frequency Response + 1dB 20Hz - 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to RIAA curve with 1dB from 20Hz to 20KHz.
Supply — 20-35V at 20mA.

Dimensions
299mm x 89mm
35mm

AL-20-30 AUDIO AMPLIFIER MODULES



The 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 5 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 home.

SPECIFICATION:
- **Harmonic Distortion Po=3 watts f=1KHz 02.5%**
- **Load Impedance 8-16ohm**
- **Size: 75mm x 63mm x 25mm**
- **Frequency response ±3dB Po=2 watts 50Hz-25Hz**
- **Sensitivity for Rated O/P — Vs=25v. RL=8ohm f=1KHz 75mV.RMS**

AL20 5w R.M.S. £2.65 AL30 10w R.M.S. £2.95

STEREO 30

COMPLETE AUDIO CHASSIS
7+7 WATTS R.M.S.

P & P 45p

£15.75

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 pick-up, 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, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins)

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £3.65 plus 62p p & p.

AL 60 25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latests solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£3.95

NEW **PA12** NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL 20/30 Amplifier Modules. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V .5mA. Size 152mm x 84mm x 33mm.

£6.50

PS12 Power supply for **AL20/30, PA12, SA450** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C.
Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.20

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.

Transformer BMT80
£2.60 + 62p postage

£3.00

BI-PAK

P.O. BOX 6, WARE, HERTS.

news digest

YOU'RE NEVER ALONE WITH AN MPU

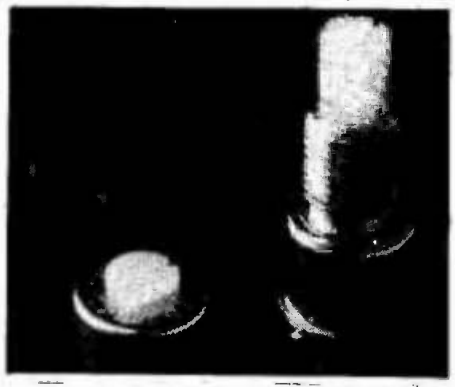
The worlds largest ever ship, the 550,000 ton 'Batillus' is under MPU control! All engine control monitoring and alarm systems are now run from the system shown in the picture. The video monitors are hooked to the MPU 'Alphaprom' units – one per engine – which each have 225 alarm points throughout its system.

The control room has an alpha-numeric printer, which reads out to the operator any deviation in levels considered significant, along with precise time codes. New alarms appear as red type, and faults rectified as black. Naturally a loud acoustic alarm is also provided. After all the controller might be colour-blind!

CSI Bv, P. O. Box 174 Vlaardingen, Holland.

VERY SUBMIN SWITCH

Roxburgh Electronics have a new subminature rotary switch which is sealed in an industry-standard TO-5 can. Designated the Series 30, the switch offers a wide range of configurations, and from 2 to 8 switchpositions.



Nominally rated at 0.5A, 125V AC, the switch contacts are capable of handling up to 3A, and the Series has been designed for direct mounting to PCB's, or for panel-mounting by means of an optional bush.

A thumbwheel switch is also available.

Roxburgh Electronics Limited, 22 Winchelsea Road, Rye, Sussex.

SINGLE-CHIP JFET PREAMPLIFIER

The first monolithic JFET preamplifiers types T100/300 by Siliconix will serve as single-device replacements for the discrete component assemblies generally used to buffer hig-impedance signals from piezo-electric and capacitive microphones/transducers. They operate at low power levels from single DC power supplies of 1.3 to 30V. Applications include hearing aids, microphone preamplifiers and general purpose impedance converters. Two versions have been introduced, both in TO-72 metal can packages.

No external components are required for operation with devices such as ceramic electret-condenser, and air-condenser, microphones, or piezo-electric capacitive transducers.

Each chip contains an N-channel depletion-mode, junction field effect transistor (JFET), with a diffused source resistor and back-to-back Schottky diodes. The diodes from the high-impedance, gate-bias resistance. The circuit is self biasing.

Siliconix Limited, 30A High Street, Thatcham, Newbury, Berks RG13 4JG.

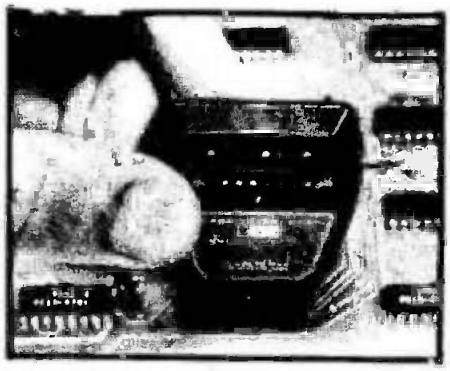
TRUTH TABLE DETECTOR CLIP

The 548A Logic Chip from H.P. is designed to clip on to a 16-pin DIP-pack IC, when its light-emitting diodes show the logic states of each of the IC's pins simultaneously.

It is automatic for all logic families from 4 to 18V DC. Three volt CMOS is tested by connecting a 4.5V supply to an auxiliary power pin.

With internal, self-seeking logic circuitry, the 548A locates the supply and ground pins automatically; it can be placed on the IC 'upside down' or 'rightside up'. Total current drawn by the clip is less than 40mA with 15 LEDs on. Input current is less than 15mA, assuring virtually no circuit loading. Inputs are protected to 30V DC for 1 minute. Price is £77.

Hewlett-Packard Limited, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.



SHARP PRACTICES IN WATCHES?

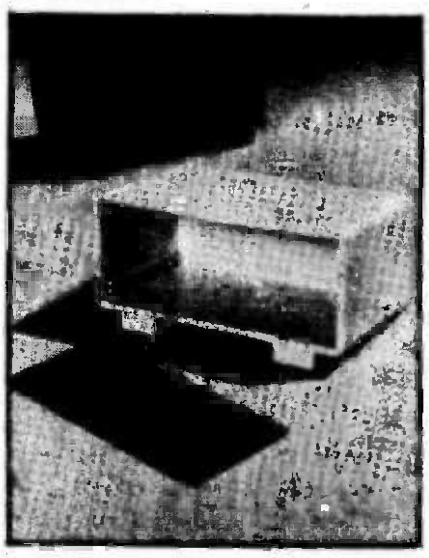
One very interesting little snippet caught our eye last month – Gillette, the well known face scraping company, are adverting in the USA for digital watch engineers. Both LCD and LED men are required, as are I^2L logic designers. With their past history Gillette can't fail to carve themselves a good chunk of the market, (literally!).

GAMES FOR HIRE

Later this year Fairchild Semiconductors who have recently taken a hand in digital watches, will be introducing their long awaited TV games chips into Europe. These are based on the F8 microprocessor, and according to Fairchild, can handle teletext as well. In order to assure themselves of a market, the company plans to do a deal with a TV rental company so that games could be hired with the set. The cost to the user would be about £1 extra on top of a colour rental.

TIME BOX

Not for pursuit of Daleks, but ideal for digital clocks, this new case from West Hyde is moulded in anti-static ABS with 3½mm walls. It has high impact strength, and integral front feet which lift the case to good viewing angle. Two positions for PCB's are provides.



Available in white, red, orange and blue in any quantity, all have 3mm thick red acrylic window panels.

Dimensions: 56mm x 131mm x 71.5mm deep. Prices: 1 off £1.79 – 100 off less 25%.

West Hyde Developments Limited, Ryefield Crescent, Northwood Hills, Middlesex HA6 1NN.

NEW CATALOGUE FROM MARSHALL'S

One of the catalogues which we at ETI refer to most has just been updated: that from Marshall's. The new edition has 160 pages – considerably larger than the previous one. More information of semiconductor lead-outs are included as is a new listing of Japanese equivalents.

For callers the price is 30p but it's also available by post for 40p from A. Marshall, 42 Cricklewood Broadway, London NW2 3ET.

CLOCK MODULE SHRINKS

The interest generated by the MA1001 series of clock module subsystems has encouraged National to introduce a further series, designated MA1002. This new series miniaturises the complete module to a package only 7.5mm x 3.5mm,

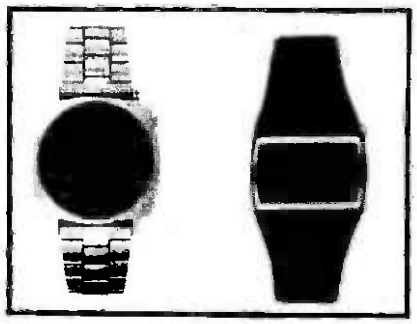
Various versions are available for 12/24 hours formats and input frequencies, and further details are available on request from National Semiconductor, 19 Goldington Road, Bedford, MK40 3LF.

HOME ON THE (TEXAS) RANGE

The consumer electronics fields is about to be asked to hear the weight of yet another giant. Texas Instruments are placing their highly digital boots firmly in the earth of the home market, and expect them to take root there, and grow to 93% of their total business in 1978.

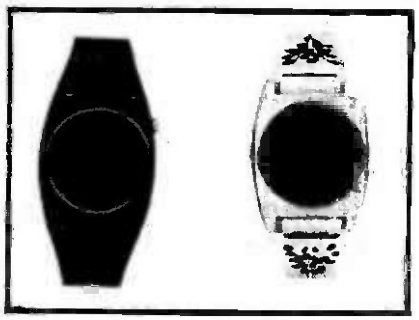
Whether or not they achieve the full bloom of this success depends entirely as to whether you and I take to the gifts the giant comes bearing. It almost gives one a feeling of power does it not?

As a starter T.I. have introduced 16 digital watches, 12 of which are in plastic cases. Technology is I^2L, not



the ubiquitous MOS – a move to newer pastures, broken by Sinclair. The range is priced from £15.95 to around £32. Yer pays yer money and takes yer choice – of case and strap, the modules are the same in all the watches, and give 5 functions as usual. The styling is certainly carefully thought out, and new types will be dropped onto the public as and when T.I. deem it timely to do so.

A calendar feature is incorporated,



preset to 4 years of correct month length. However since the batteries last you at most a year, and date info is lost on switch-off (battery change) so don't get *too* excited with the idea.

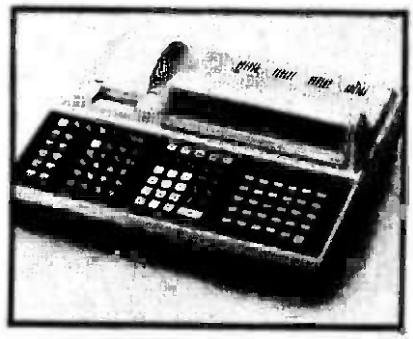
Marketing is to be through anybody and everybody who will sell the watches, so they will be around very quickly. The displays are all LED but Texas are expending many hours of toil in the LCD field, and expect to bring to fruition a watch with this display sometime during 1977.

Calculators are the other channel from which T.I. hopes our money will flow. In order to speed this flood, they have an extensive new range with several very ingenious machines. At the low cost end we have the TI 1600, a slimline rechargable at £17.95. Especially for the student, the TI 30 possess no less than FIFTEEN levels of parenthesis. It also has full scientific facilities, and will turn off the display if you're wasting battery power.

Price £19.95.

The TI 5050 and 5040 are thermal printing machines, the former portable at £99, and the latter desk-bound for £109. Perhaps the most amazing of all is the SR–60. Defined as a calculator only because it requires no peripherals to work, it has a possible 1920 programme steps and 100 memories! The display is alphanumeric, and can interrogate the user if programmed to!

Well, it prompts him anyway, (It is



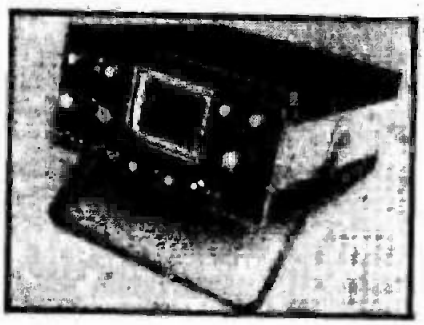
to be hoped we *don't* get an SS machine just yet! Ve hav vays of making you compute and all that). The tings the SR 60 won't do are very few indeed, but for circa £1500 perhaps this is not too surprising. Before we are deafened by crys of 'MPU's rule OK' let us add hastily that this is *not* an MPU machine, but is calculator chip based.

The range all use T.I.'s new (?) Arithmetic Operating Logic, said to be truly arithmetic in operation. In practice it looks like an improvement on ordinary arithmetic logic certainly, and *anything* is an improvement on RPN!

news digest

COLOUR OSCILLOSCOPE

The Scopex 4D25 now includes a special 'Glarecheq' graticule for 'refelection-free' measurement. This does not decrease the brilliance of the trace or increase the spot size but acts to down extraneous reflection.



As a 'reaction against drabness in instrumentation', a pleasant shade of blue has been selected for the front panel, and the controls and bezel have been colour matched.

Technically the 4D25 offers 3% accuracy on both time and voltage measurements, and incorporates a 25MHz bandwidth with Y-amplifier signal delay. Apart from which think how well it will match the wallpaper! Price £245.

Scopex Intruments Limited, Pixmore Industrial Estate, Pixmore Avenue, Letchworth, Herts SG6 1JJ.

IN 3 x 10^6 YEARS TIME, IT WILL BE ONE SECOND SLOW!

RCA are working for the US Navy to determine the feasibility of using hydrogen maser clocks -- precise to one second in three million years -- in Global Positioning Systems (GPS) satellites.

These satellites are part of a tri-service programme under Air Force direction. NTS-1 was launched in July 1974 and tested rubidium clocks. NTS-2 will test cesium clocks; NTS-3 will test hydrogen maser clocks.

A planned constellation of 24 GPS satellites will be continusously transmitting time synchronized signals. A ship, airplane or land craft suitably equipped to receive the signals, will be able to determine its exact position anywhere on the glode.

Hydrogen atoms are employed because of an extremely stable fixed frequency generated under certain controlled conditions. The atoms are produced from hydrogen gas molecules by an electrical discharge and beamed intp a special container in a microwave cavity. The hydrogen atoms undergo an energy state change and emit a frequency that can be used to very accurately control the output frequency.

Can you just see the thing ticking away merrily on your mantelpiece? The BBC would have to phone *you* for a time check -- about 5976 AD!

£37.286 PER DIGIT!

The Data Precision 175 is a full function, 32 range battery and line operated instrument, whose basic sensitivity is 100mV.

With 5 ranges of DC/AC voltage measurement and 100% overrange capability per range, the 175 measures from 100μV to 1000V, protected to ±1000V on any range (including 100mV). Basic instrument accuracy is 0.1%, and this is a 1 year specification over a ±5° temperature range.

Resistance measurements are catered for from 100mΩ to 20MΩ in 6 ranges (basic accuracy of better than 0.1%).

A 'low voltage' mode is provided having the same ranges as the normal resistance measurement, but with only 300mV of open circuit excitation. This enables resistance measurements to be made on circuits while still connected to semiconductor devices.

The £120 the Model 175 costs brings, in addition to the basic instrument, its rechareable battery module, a pair of fuse protected test leads, mains lead with charger, alligator clip adaptors and a complete certificate of traceability.

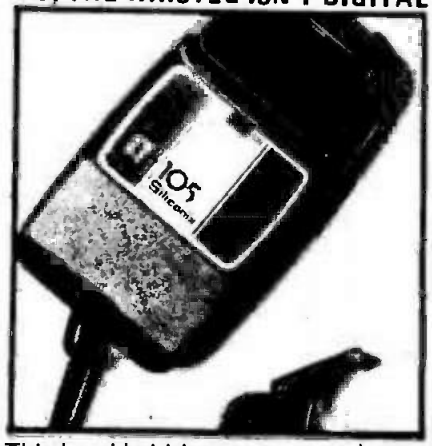
Farnell International Instruments Limited, Sandbeck Way, Wetherby, West Yorkshire LS22 4DH.

FIRST LIVE 4-CHANNEL BROADCAST

Live quadraphonic broadcasting experiments- have been conducted by Radio Clyde (the commercial station servicing the Glasgow area). Four and a half hours of the "Proms 76" concerts, by the Scottish National Orchestra, were broadcast in four-channel mode, direct from Kelvin Hall, Glasgow. on June 26 and July 2, using encoded signals. The encoding system used for this experiment was the Sansui QS Matrix.

The experiment follows one by Piccadilly Radio – in April – where, apart from certain records already encoded, the Staion's output for two days was synthesized via the QS system into 4-channel. The Independent Broadcasting Authority monitored and transmissions. We can only hope for the experiments to spread, with perhaps good ole Auntie taking a hand (or four!).

NO, THE WHISTLE ISN'T DIGITAL



This hand-held battery-powered stopwatch measure time to 50 minutes, 59.9 seconds in one-tenth second intervals. Controls allow simple start/stop, Time IN/Time Out, and include safeguard against accidental reset.

Accuracy is controlled by a quartz crystal, and the display LED. Weighing 6oz., the ET105 is approximately 4½ x 2½ x 1½ ins, and will slip into a jacket pocket.

Price to be announced. Newitt and Company Limited, 81 Goodramgate, York YO1 2LU.

IC IN CAMERA

Contained in a 16 pin DIP the ZNA134 is a complete system, requiring only a single 5V supply. An on-chip oscillator (which can be over-driven) externally permits multiple SPG unit usage.

The ZNA134 incorporates such features as synchronising between units, direct reset to horizontal and vertical counters, facailities for adding and subtracting lines, automatic interlacing and a field reference output. Perhaps its most novel feature is its abaility to provide both CCIR and EIA equalisation by changing the voltage on a single pin.

The ZNA134 generates all the horizontal, vertical, mixed blanking and synchronising pulses necessary for raster generation in 625 or 525 line commercial, industrial or military TV systems. It can be supplied to operate over the military temperature ranges.

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2N492	5.75	2N3394	0.15	2N5459	0.29	AF280	0.85	BC301	0.45	BF200	0.29	MC1303	1.47	TAA300	2.67
2N493	5.98	2N3402	0.30	2N5492	0.42	AL102	1.50	BC303	0.60	BF225J	0.25	MC1310	1.96	TAA263	1.25
2N696	0.25	2N3414	0.15	2N5494	0.45	AL103	1.50	BC307	0.20	BF244	0.35	MC1330P	0.75	TAA350	2.48
2N697	0.16	2N3415	0.17	2N5496	0.50	BC107	0.14	BC308A	0.18	BF245	0.34	MC1351P	0.87	TAA550	0.60
2N698	0.82	2N3416	0.23	2N5777	0.45	BC108	0.12	BC309C	0.25	BF246	0.75	MC1352P	0.87	TAA611C	2.25
2N699	0.55	2N3417	0.27	2N6027	0.45	BC109	0.15	BC317	0.14	BF254	0.20	MC1466L	3.95	TAA621	2.15
2N706	0.12	2N3440	0.57	3N128	0.50	BC113	0.17	BC318	0.13	BF255	0.20	MC1469R	2.80	TAA661B	1.32
2N706AN	0.12	2N3441	0.78	3N139	1.45	BC115	0.19	BC337	0.19	BF257	0.37	ME0402	0.20	TBA641B	2.50
2N708	0.21	2N3442	1.20	3N140	0.85	BC116	0.19	BC338	0.21	BF258	0.49	ME0404	0.15	TBA651	1.69
2N709	0.50	2N3638	0.16	3N141	0.85	BC116A	0.20	BC547	0.12	BF259	0.49	ME0412	0.20	TBA810	0.98
2N711	0.55	2N3638A	0.18	3N200	2.60	BC117	0.22	BC548	0.10	BF459	0.39	ME4102	0.10	TBA820	0.85
2N718	0.22	2N3639	0.30	40361	0.45	BC118	0.16	BC549	0.13	BFR79	0.24	ME4104	0.10	TBA920	2.90
2N718A	0.40	2N3641	0.20	40362	0.48	BC119	0.30	BCY30	1.03	BFS21A	2.60	MJ480	1.65	TIL209	0.30
2N720	0.69	2N3702	0.17	40363	1.00	BC121	0.45	BCY31	1.06	BFS28	1.04	MJ481	1.30	TIP29A	0.50
2N914	0.22	2N3703	0.15	40389	0.50	BC125	0.18	BCY32	1.18	BFS61	0.30	MJ490	1.05	TIP30A	0.60
2N916	0.43	2N3704	0.15	40394	1.20	BC126	0.25	BCY33	0.90	BFS98	0.27	MJ491	1.55	TIP31A	0.62
2N918	0.34	2N3705	0.15	40395	1.20	BC132	0.30	BCY34	0.98	BFX29	0.36	MJ2955	1.00	TIP32A	0.75
2N929	0.25	2N3706	0.14	40406	0.45	BC134	0.15	BCY38	2.00	BFX30	0.38	MJE340	0.58	TIP33A	1.00
2N930	0.26	2N3707	0.18	40407	0.38	BC135	0.15	BCY42	0.60	BFX84	0.38	MJE370	0.68	TIP34A	1.50
2N1302	0.37	2N3708	0.14	40408	0.60	BC136	0.19	BCY58	0.55	BFX85	0.41	MJE371	0.87	TIP35A	1.70
2N1303	0.45	2N3709	0.15	40409	0.55	BC137	0.14	BCY59	0.32	BFX87	0.35	MJE520	0.65	TIP36A	8.35
2N1304	0.40	2N3710	0.14	40410	0.55	BC140	0.60	BCY70	0.25	BFX88	0.32	MJE521	0.75	TIP41A	0.70
2N1305	0.40	2N3711	0.15	40411	2.30	BC141	0.65	BCY71	0.26	BFX89	0.75	MJE2955	1.25	TIP42A	0.90
2N1306	0.31	2N3712	1.20	40594	0.75	BC142	0.30	BCY72	0.24	BFY50	0.30	MJE3055	0.75	TIP29c	0.80
2N1307	0.30	2N3713	2.30	40595	0.85	BC143	0.30	BD115	1.20	BFY51	0.38	MP8111	0.35	TIP30c	0.85
2N1308	0.60	2N3714	2.45	40601	0.70	BC147	0.10	BD116	1.20	BFY52	0.36	MP8112	0.40	TIP31c	0.85
2N1309	0.60	2N3715	2.45	40602	0.50	BC148	0.10	BD121	2.00	BFY53	0.34	MP8113	0.45	TIP32c	1.25
2N1671	1.80	2N3716	2.60	40603	0.60	BC149	0.13	BD123	2.00	BFY90	1.27	MPF102	0.30	TIP33c	1.45
2N1671A	1.92	2N3771	1.60	40604	0.60	BC153	0.27	BD124	2.00	BRY39	0.50	MPSA05	0.20	TIP34c	1.70
2N1671B	2.12	2N3772	1.70	40636	1.15	BC154	0.27	BD131	0.51	BSX20	0.31	MPSA06	0.20	TIP41c	1.00
2N1711	0.27	2N3773	2.65	40673	0.73	BC157	0.12	BD132	0.54	BSX21	0.32	MPSA12	0.35	TIP42c	1.20
2N1907	5.50	2N3779	3.15	AC126	0.37	BC158	0.11	BD135	0.34	BU105	3.05	MPSA55	0.20	TIP2955	1.00
2N2102	0.60	2N3790	2.75	AC127	0.44	BC160	0.78	BD136	0.36	BU205	2.40	MPSA56	0.20	TIP3055	0.50
2N2147	1.40	2N3791	2.75	AC128	0.57	BC167B	0.12	BD137	0.36	CA3080A	1.10	MPSU05	0.40	TIS43	0.30
2N2148	1.65	2N3792	2.90	AC151V	0.35	BC168B	0.12	BD138	0.39	CA3030A	1.80	MPSU06	0.40	ZTX300	0.15
2N2160	1.10	2N3794	0.26	AC152V	0.50	BC168C	0.12	BD139	0.42	CA3028A	0.85	MPSU55	0.45	ZTX301	0.15
2N2218A	0.47	2N3810	0.26	AC153	0.40	BC169B	0.12	BD140	0.46	CA3035	0.80	MPSU56	0.45	ZTX302	0.20
2N2219	0.42	2N3820	0.29	AC153K	0.42	BC169C	0.12	BD529	0.35	CA3057	1.62	NE555V	0.48	ZTX500	0.15
2N2219A	0.52	2N3823	0.61	AC154	0.45	BC170A	0.16	BD530	0.38	CA3046	0.73	NE556	1.30	ZTX501	0.15
2N2220	0.35	2N3904	0.21	AC176	0.40	BC171	0.14	BDY20	1.13	CA3018	2.15	NE560D	4.48	ZTX502	0.18
2N2221	0.22	2N3906	0.22	AC176K	0.45	BC172	0.12	BF115	0.36	CA3089E	2.00	NE561	4.48	ZTX530	0.23
2N2221A	0.25	2N4036	0.67	AC187K	0.40	BC177	0.19	BF117	0.70	CA3090Q	4.25	NE565	1.30	ZTX531	0.22
2N2222	0.25	2N4037	0.55	AC188K	0.45	BC178	0.18	BF121	0.55	LM301A	0.47	OC28	2.00		
2N2222A	0.25	2N4058	0.20	AD142	0.65	BC179	0.21	BF123	0.55	LM308N	1.32	OC35	1.50		
2N2368	0.17	2N4059	0.15	AD143	0.75	BC182	0.11	BF152	0.25	LM309K	1.80	OC42	0.50		
2N2369A	0.21	2N4060	0.20	AD149	0.74	BC182LBC	0.14	BF153	0.25	LM380	0.98	OC45	0.75		
2N2369	0.25	2N4061	0.17	AD150	1.20	BC183	0.11	BF154	0.25	LM381AN	2.07	OC71	0.45		
2N2646	0.55	2N4062	0.18	AD161	1.23	BC183L	0.14	BF159	0.35	LM702C	0.75	OC72	0.45		
2N2647	1.10	2N4126	0.17	AD162	1.23	BC184	0.12	BF160	0.30	LM709T05	0.98	OC81	0.75		
2N2904	0.36	2N4289	0.30	AF106	0.45	BC184L	0.14	BF161	0.60	LM711CAN	0.38	OC83	0.50		
2N2904A	0.37	2N4918	0.85	AF114	0.65	BC207	0.11	BF166	0.40	8DIL	0.35	ORP12	0.60		
2N2905	0.37	2N4920	0.90	AF115	0.65	BC208	0.10	BF167	0.33	14DIL	0.40	R53	1.80		
2N2905A	0.35	2N4921	0.60	AF116	0.65	BC212	0.14	BF173	0.33	LM710	0.45	SL414A	2.35		
2N2906	0.28	2N4922	0.65	AF117	0.65	BC212L	0.14	BF177	0.38	LM3900N	0.55	SL610C	2.35		
2N2906A	0.25	2N4923	0.70	AF118	0.65	BC214L	0.17	BF178	0.45	LM723C	0.60	SL611C	2.35		
2N2907	0.21	2N5190	0.70	AF124	0.65	BC237	0.14	BF179	0.48	LM741T099	0.40	SL612C	2.35		
2N2907A	0.22	2N5191	1.30	AF125	0.65	BC238	0.12	BF180	0.36	LM709CAN	0.48	SL620C	3.50		
2N2924	0.15	2N5192	1.00	AF126	0.65	BC239	0.15	BF181	0.36	8DIL	0.40	SL621C	3.50		
2N2926	0.13	2N5195	1.10	AF127	0.65	BC251	0.15	BF182	0.35	14DIL	0.38	SL623	5.75		
2N3053	0.25	2N5245	0.35	AF139	0.69	BC253	0.22	BF183	0.35	LM747EN	0.78	SL640C	4.00		
2N3054	0.50	2N5294	0.40			BC257A	0.17	BF184	0.35	LM748	0.78	SL641C	4.00		
2N3055	0.65					BC258A	0.17	BF185	0.35	8DIL	0.44				

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SN7408	0.18	SN7430	0.16	SN7448	0.85	SN7476	0.36	SN7493	0.43	SN74141	0.72	SN74163	1.20	SN74193	1.13
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														SN74199	2.04

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CD4006	1.16	CD4021	1.01	CD4045	1.30
CD4007	0.20	CD4022	0.97	CD4046	1.20
CD4008	0.97	CD4023	0.20	CD4047	0.95
CD4009	0.57	CD4024	0.79	CD4049	0.56
CD4010	0.57	CD4025	0.20	CD4050	0.56
CD4011	0.20	CD4027	0.56	CD4510	1.54
CD4012	0.20	CD4028	0.91	CD4511	1.70
CD4013	0.59	CD4029	1.17	CD4516	1.54
CD4014	1.01	CD4030	0.57	CD4518	1.38
CD4015	1.01	CD4031	2.26	CD4520	1.38
CD4016	0.56	CD4037	0.97	CD4553	4.07
CD4017	1.01	CD4041	0.83		

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2 5x3¾in	36	29	22	17
2 5x5in	44	40	—	19
3¾x3¾in	44	40	—	—
3¾x5in	49	54	32	32
3¾ x 17in	1.73	1.44	1.00	1.92
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x200	1.16	1.16		

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Low Cost VDU

560

Part 1: Construction

Components for this project are available from Watford Electronics (who supply the metal case, type WE1), Technomatic, Bywood or Catronics.

LAST MONTH WE DESCRIBED the design requirements and system description of a simple VDU; this month we will cover most aspects of construction with modifications and applications next month. The project has been designed with PCBs in order to simplify construction; there is no reason why the circuit should not be built on Veroboard as was the first prototype of the 560 VDU.

INTERFACE TO TV

The TV set used in the prototype is a Heathkit GR-9900 set built from a kit. If you decide to use this kit set which is one of the most attractive portable sets that I have seen then it will be necessary to break the circuit in the set by removing the positive end of C18 from the PCB. On the prototype two video sockets were added at the rear of the set, one connected to the point where C18 was on the PCB (TV video out), and the other connected to the now floating end of C18 (Video in), both sockets using chassis ground. A short link of coax with a plug at each end will connect the two sockets for normal TV programs or the output from the 560 VDU can be connected to the Video in socket.

It may be possible to modify any other portable set in a similar manner but check that there is a transformer in the mains input circuit. Domestic TV sets may be modified to accept a video signal but check with manufacturer first. The alternative is to use a UHF modulator as supplied by Crofton Electronics but this must be correctly set up or else all of the verticals in each character will have a stepped or wobbly look. If a modulator is used then the 560 VDU can be used with any TV set, colour or B/W. NB: These modulators can transmit back down an aerial line even if the normal aerial line is disconnected and if the modulator output line is too near the aerial line then any other set connected to that aerial may also pick up this signal. This is more likely to happen in flats, etc, where a common TV aerial is very often built-in.

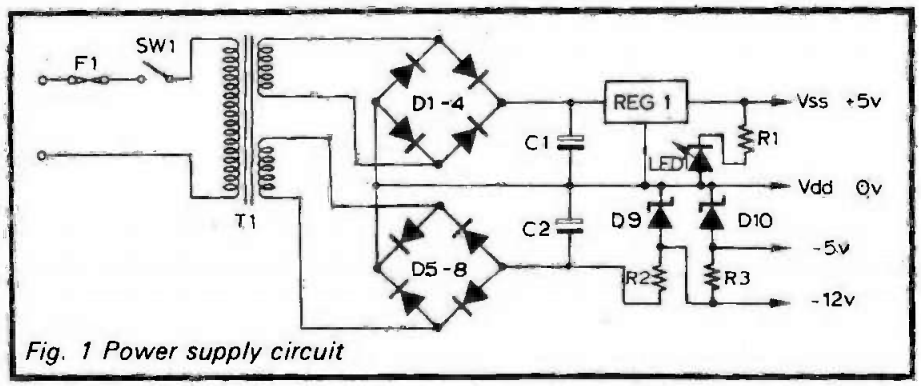


Fig. 1 Power supply circuit

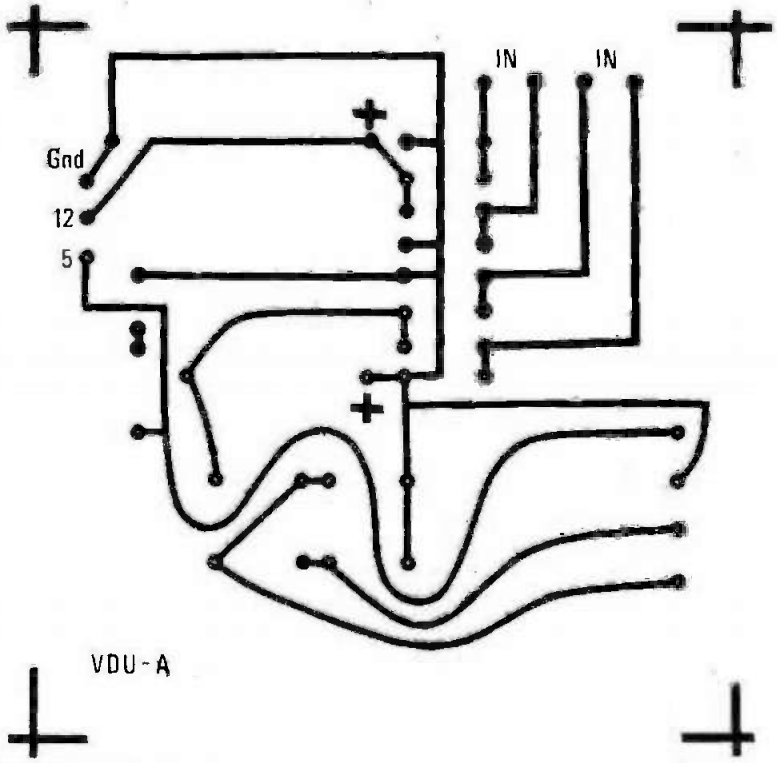


Fig. 2(a) Board A PCB

POWER SUPPLY

The TTL and MOS RAM require a stabilised 5v supply at about 1A current; this is most conveniently supplied by the well-known LM309 voltage regulator which uses the metal case as a heatsink and a groundplane. The MOS ROM (2513 character generator) requires supplies of 5v, GND, −5v and −12v, all at very low current levels; the −5 and −12v supplies are derived from a second winding on the transformer with Vdd as a common ground. The circuit diagram of the power supply shows the

two transformer windings rectified by D1-4 and D5-8 and smoothed by C1 and C2. The output from C1 is used to feed the voltage regulator REG1 which outputs a regulated 5v at up to 1Amp, LED1 and R1 are used as a panel lamp to indicate "Power On". The output from C2 will be in the area of —15v; this is limited by zener D9 to —12v and in turn this —12v is limited to —5v by zener D10. No indicators were used here but an LED could be connected across C2 (with suitable limiting resistor) to give a panel indication that both positive and negative supplies were on.

Note that the transformer must have two separate windings (12-0, 12-0); a 12-0-12 centre-tapped type will not do.

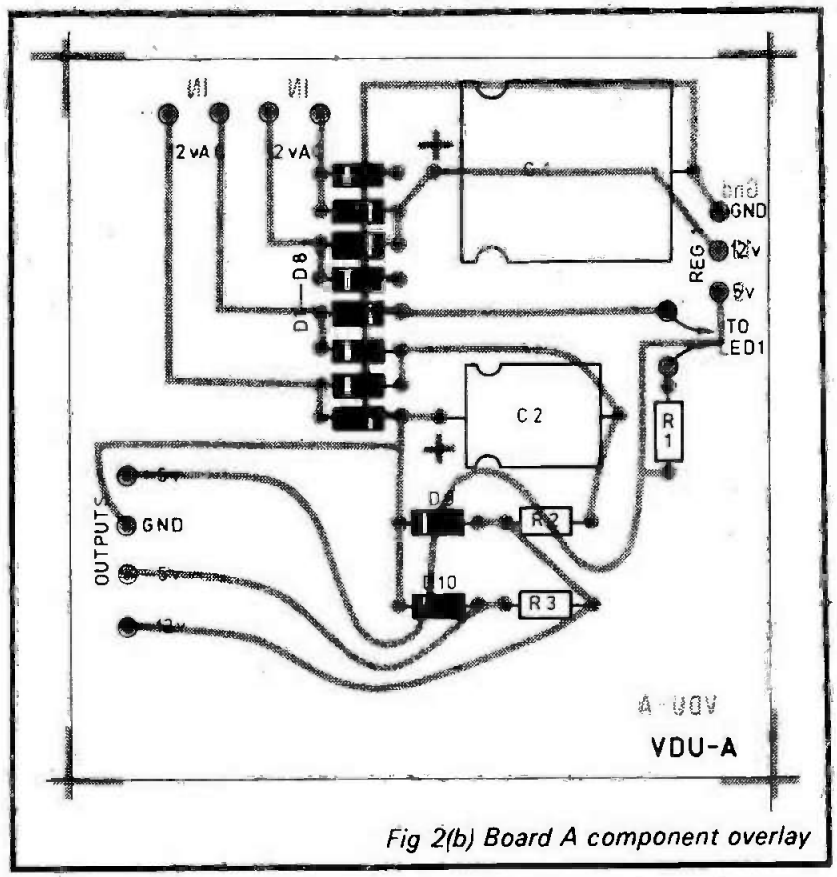


Fig 2(b) Board A component overlay

BOARD 'B'

The block diagram of board 'B' is shown in Fig 3. Its function is to generate TV sync signals and character video information and then to mix these two signals with a blanking signal to produce a standard video signal for input to a modified TV set.

The sync generator is formed by two 555 timers in a stable mode both with a mark/space ratio of about 10:1. IC1 runs at 50Hz and IC2 at 15KHz. The outputs from these ICs consist of a short negative pulse from each which are mixed in IC5 to give a mixed sync signal. We will refer to these signals as FS (Frame Sync), LS (Line Sync) and MSYN. IC3 and IC4 are 555 timers in the monostable mode. IC3 uses FS as a trigger input and produces an output called FSD (Frame Sync Delay) which is basically FS inverted but with the length of the short pulse adjustable by VR3. The width of this pulse is used to define the distance from the top of the screen at which the output will start and the signal is used to blank the video and to reset line and row counters. IC4 produces a similar signal (LSD) which defines the distance from the left-hand side of the screen and is used to blank the video and also resets the Master Clock (MCLK) and character counters.

The Master Clock (MCLK) is generated using two gates of IC5 which will oscillate at about 6MHz whenever LSD is low. As LSD always goes low at the same "time" on each TV line MCLK always starts at the same position on each TV line; this is very important to avoid ragged edges or verticals on the characters.

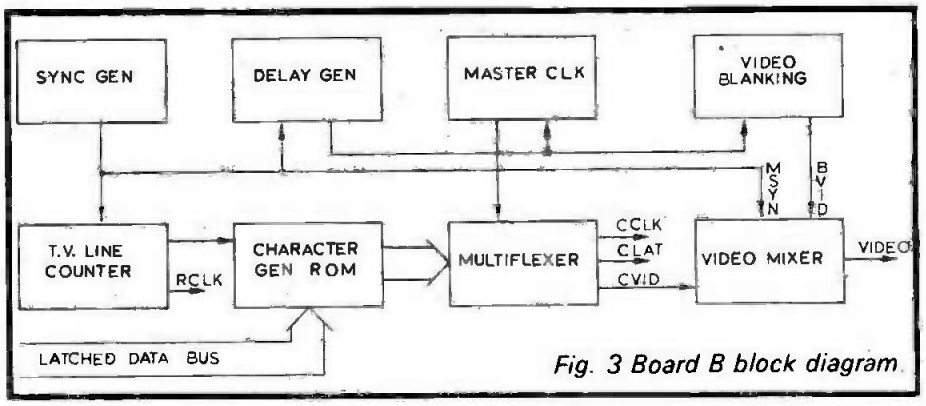


Fig. 3 Board B block diagram

VIDEO GENERATOR

IC15 is a 7421 4-input AND gate (note not a 7420 NAND) which mixes the blanking signals RCLK, FBLK, LBLKI, and BLNK. RCLK occurs on the last two of every ten TV lines after FSD, this thus blanks at the bottom of each character row. FBLK and LBLKI are from the flip-flops IC13-14, the FBLK signal is set by FSD and reset by EOF which is generated when the text row counter exceeds the number of rows (8 at present). LBLKI is formed in a similar manner. To test board "B" connect a temporary link from LBLKO to LBLKI. BLNK signal is generated to "flash" the output character, it can be left unconnected at present. IC15 output (BVID) is mixed with the character video (CVID) from the character generator and multiplexer and then mixed with MSYN to emerge from IC16 as something close to a standard video signal. If we mix this signal reduced by about 50% with the full scale MSYN .we have a standard video signal with the large negative troughs from MSYN very apparent if seen on a scope.

If you build up board "B" with ICs 1-6 and 13-16 and associated components you should now be able to produce a video picture on the set. Set all presets to midway and turn on, adjust VR1 until picture stops "rolling" and then adjust VR2 until picture stabilises horizontally. It was found that FS and LS sometimes drifted off after warming up and thus VR1 and VR2 may need adjusting during use. You may prefer to use panel-mounted potentiometers in place of or in addition to the board-mounted presets.

Having stabilised the picture you should see a set of horizontal lines produced by RCLK, these should be thick white lines with thin spaces between; each white line will

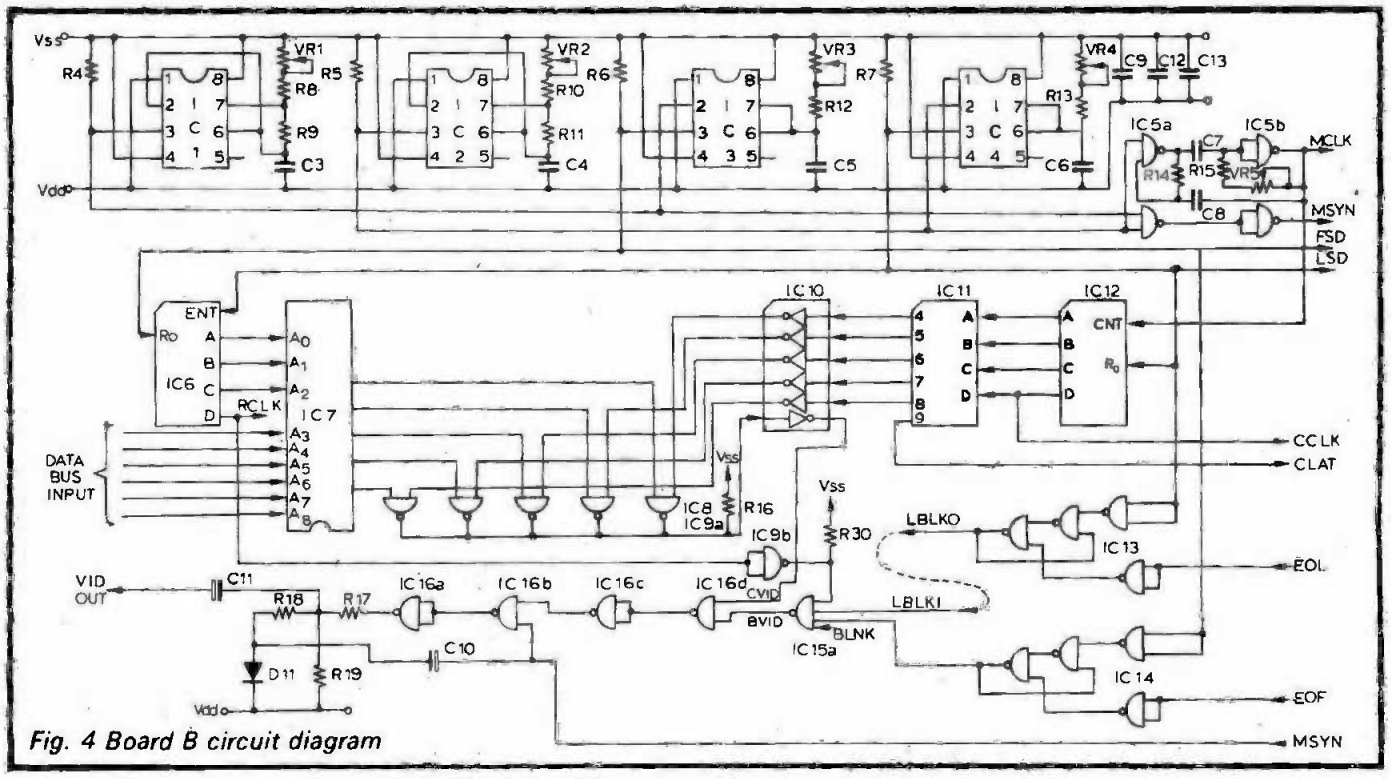


Fig. 4 Board B circuit diagram

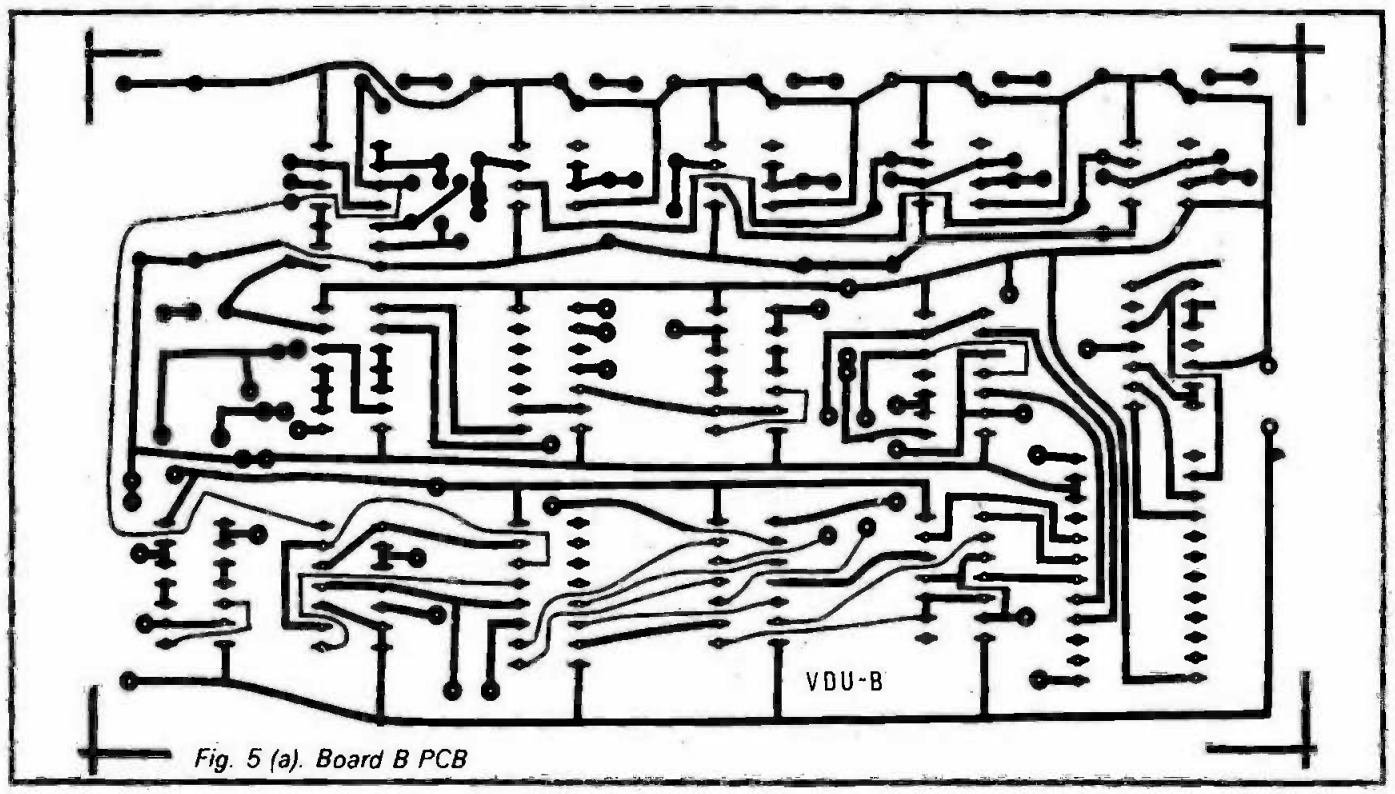


Fig. 5 (a). Board B PCB

become a character row. Adjust VR3 until the first of these rows is about two inches from the top of the screen and then adjust VR4 until the lines start about one inch from the lefthand side of the screen. If you do not have access to an oscilloscope then the TV screen can now be used to test out each part of construction. DISCONNECT POWER SUPPLY AND CONNECTION TO TV BEFORE SOLDERING EACH TIME.

ICS 8-12 can now be mounted and the supply and TV reconnected. This should now show each white row now split up into white boxes. You may also have white vertical lines the same width as the boxes above the FSD line; do not worry about this at this stage. Count the boxes from the left and adjust VR5 until you have about 34-35 boxes across each row. When the EOF and EOL signals are connected from board "C" the boxes will be blanked after number 32 and the rows will be blanked after number 8, thus giving our display "box".

Disconnect, install IC7 with its power supplies (note MOS handling precautions) and reconnect supply and TV. Assuming that all of the 6 data input lines to IC7 are open circuit each character box will show either an "at" sign "@" or a question mark "?" or a mix of both. The inputs may pick up stray 50Hz radiation and swap between all high ("?") and all low ("@"). When you have become bored with watching it you can celebrate being about half-way to completion.

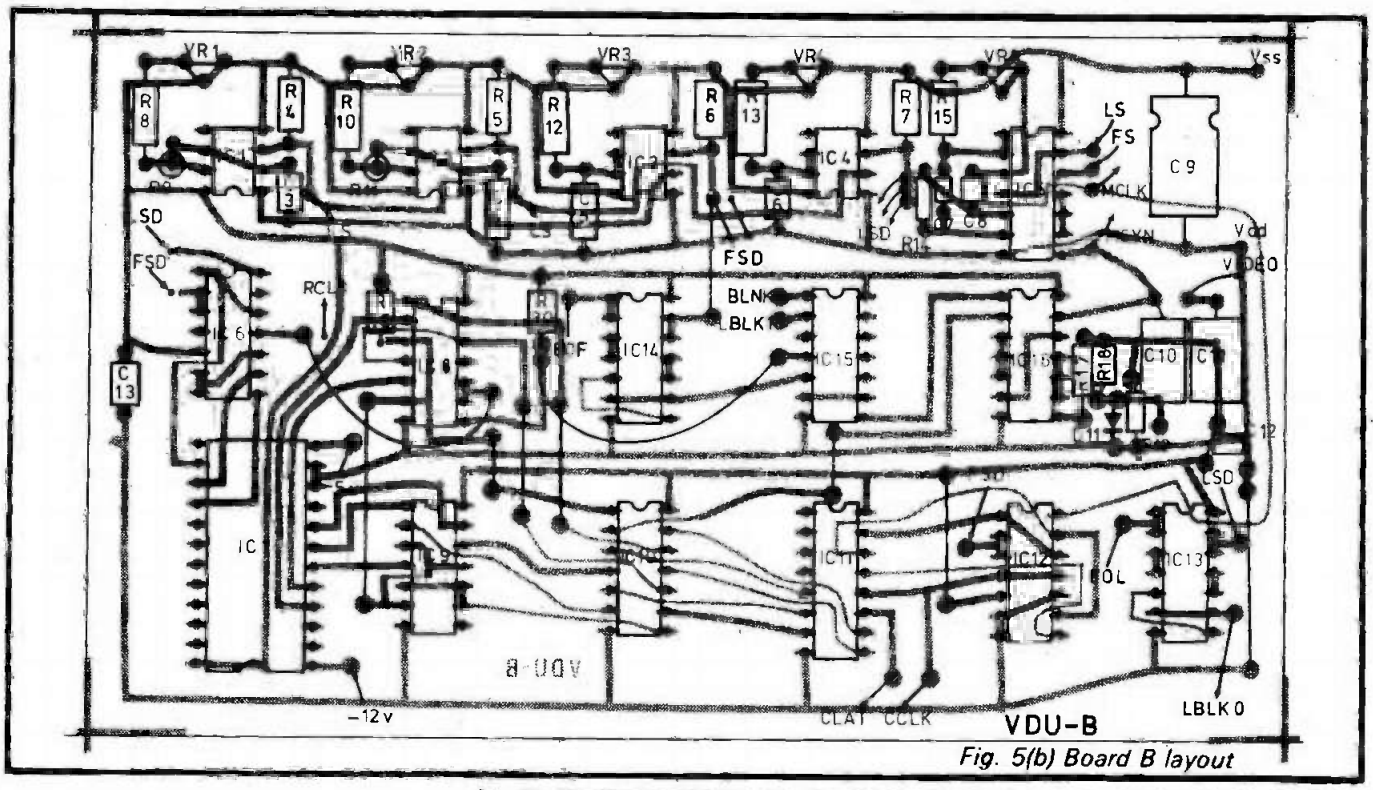


Fig. 5(b) Board B layout

BOARD 'C'

A block diagram of board "C" is shown as Fig 6; assembly is almost as simple as it looks.

Start by inserting ICs 17-19 and connecting CCLK, RCLK, FSD and LSD from board "B" and EOF and EOL back to board "B". The results on the screen should now be that we have finished defining our display box of 32 characters wide by 8 rows high with flip-flops IC13-14 now working correctly by blanking any video generated outside our box.

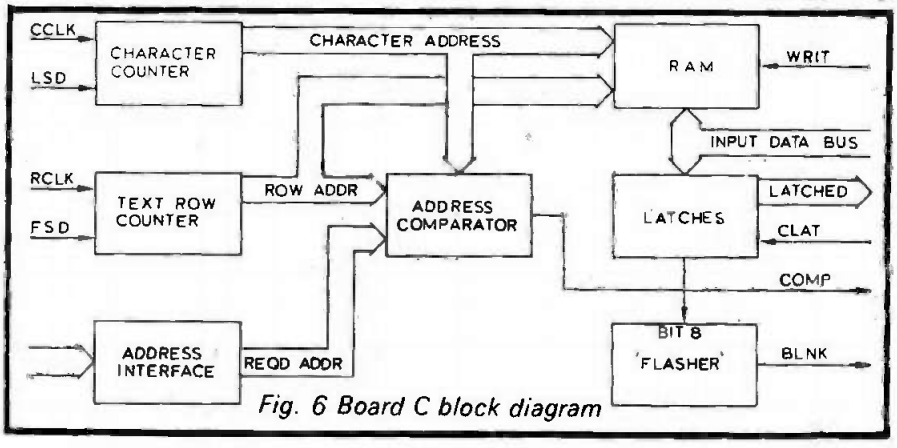


Fig. 6 Board C block diagram

ADDRESS COMPARATOR

Any positive true logic address input from switches or other logic input to IC20-21 will be inverted by these ICs if ENABLE is connected to logic "1"; if ENABLE is at logic "0" then this will cause all 8 outputs to go high thus almost effectively disabling the address inputs. The Enable signal is not used in the basic unit and should be connected to a permanent logic "1" or via a 1K resistor to Vss. If we consider output "C" from IC19 and the inverted H input address line we can look at the expected output from the 7486 to which they are connected. A 7486 is an EXCLUSIVE NOR gate and the logic of EX-OR is a logic "1" if either *but not both* inputs are at logic "1", the output "1" is inverted to logic "0" because this is an EX-NOR gate not EX-OR. Thus we will get a logic "1" whenever either 19C is low and H is high (H low) or if 19C is high and H is low (H high), or in plain language we get a logic "1" if 19C is the same logic level as input H and a "0" if they are different. Each 7486 output can be checked by leaving A-H inputs high and linking each 7486 output in turn to BLNK input to IC15. The results should be as follows: 19C-H output should be high during text rows 5-8 and low during 1-4. As a low input to BLNK will turn off the display we would expect text rows 1-4 to be turned off, 19C will be the inverse of this and thus the 19C input to the 7486 connected to BLNK will turn off rows 5-8 and the 7486 output will turn off rows 1-4. Similarly, counter output 19B will extinguish rows 3, 4, 7, 8, and 19A will turn off rows 2, 4, 6, 8. The outputs from counters 17-18 will blank columns rather than rows with 18A blanking columns 17-32, 17D blanking 9-16 and 25-32, 17C blanking groups of 4, 17B blanking groups of 2 and 17A blanking every alternate column. The outputs from the 7486s are the inverse of the above signals and would thus cause the opposite effects.

The output from IC30 will only go low when all inputs are high and this condition only occurs when the counter outputs have the same value as the A-H address inputs, i.e. when both are addressing the same box on the screen. If the output from IC30 is temporarily connected to BLNK then only one box will be blanked off, if the address inputs are still all high then this will be the box in the bottom right corner. Check other settings of A-H input switches to ensure that the box which you think you should be addressing is the one which is then blanked.

ADDING THE RAM

THE MM2112 is a MOS RAM containing 1024 (called 1K) bits. Each bit can be a '1' or a '0' and on turn-on will be mixed randomly; a bit can set to the desired value by

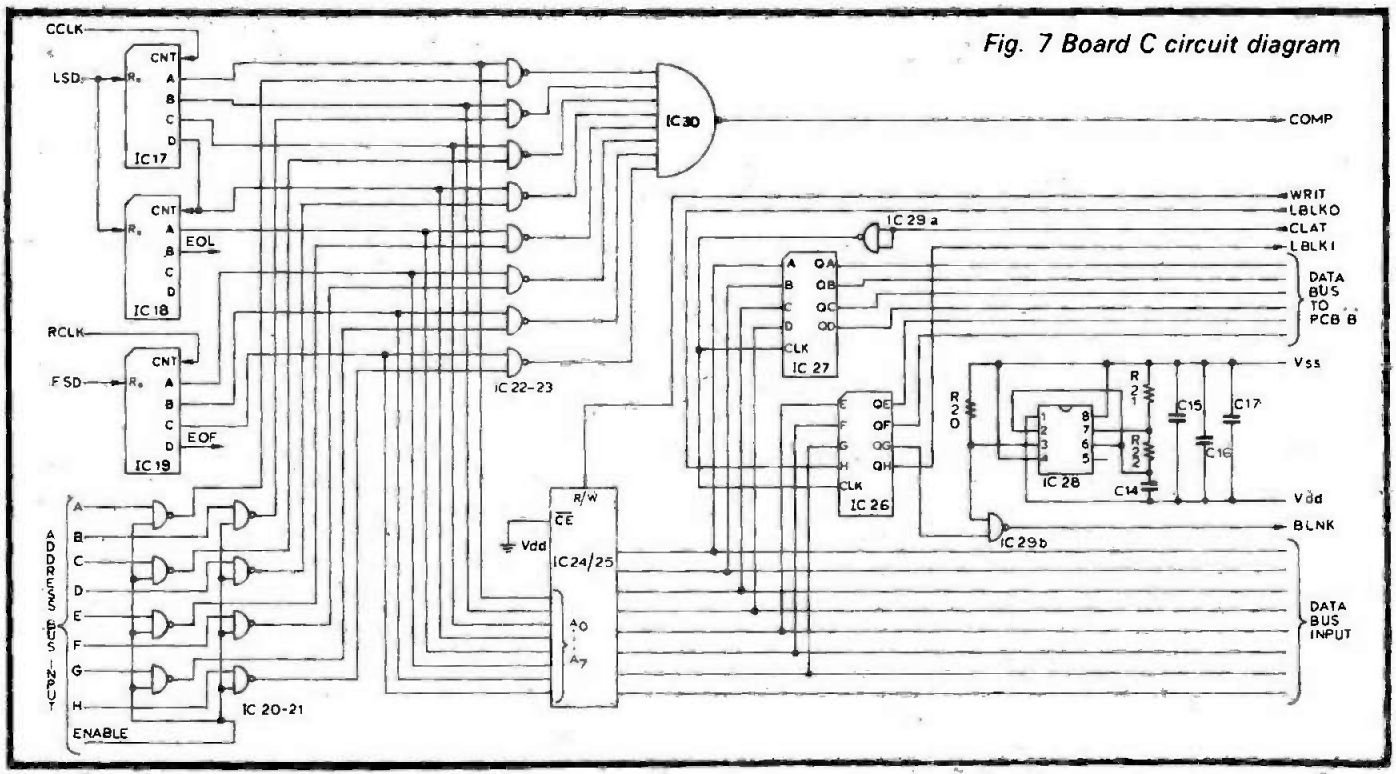


Fig. 7 Board C circuit diagram

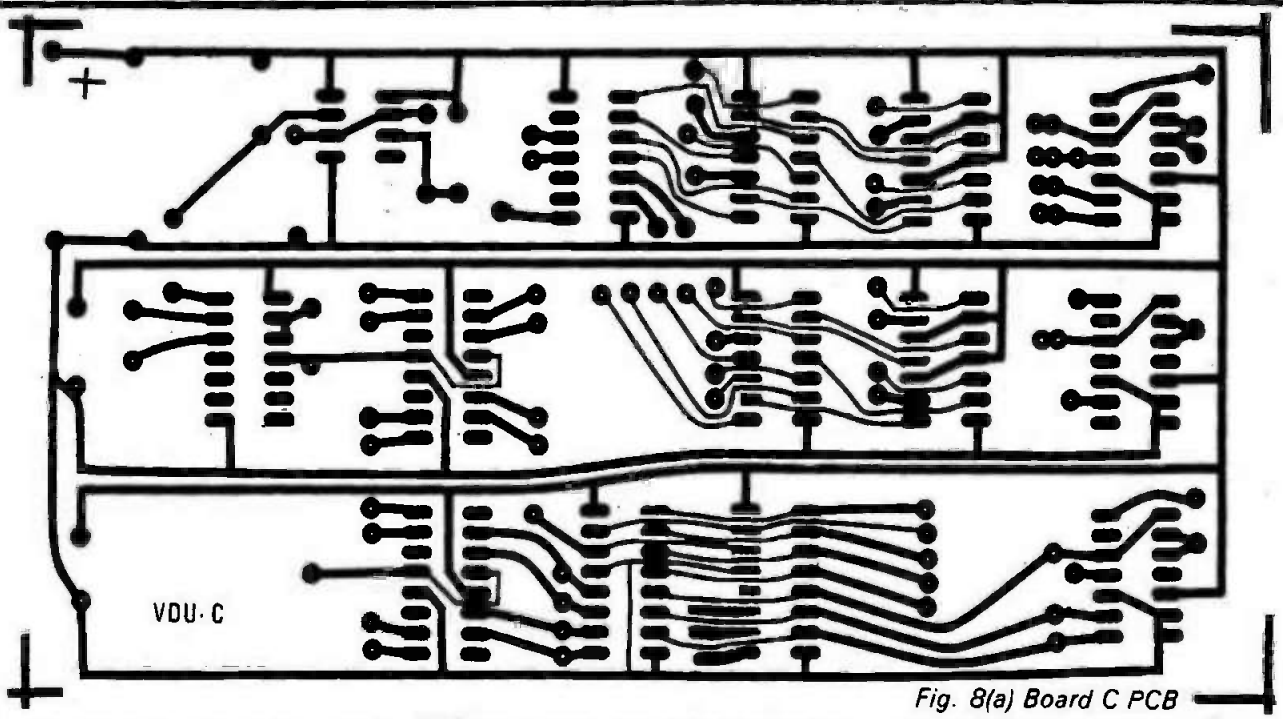


Fig. 8(a) Board C PCB

uniquely addressing that bit, setting up the required data (1 or 0) at the data I/O pin and putting a low onto the R/W pin, preferably in that sequence. Although our RAM contains 1024 bits they are organised internally as 256 words each of 4 bits in each RAM, we have two RAM chips and thus we have a choice of 512 x 4 or 256 x 8 organisation depending on a serial or parallel connection, we need words with at least 6 bits for ASC11 and thus we have chosen the 256 words of 8 bits organisation.

Ignore the concept of writing to the RAM at present and assume that the random pattern inside the RAM at switch-on is the required display output. As each display box is addressed by ICs 17-19 so the word is also selected in the RAM and the appropriate data produced at the RAM I/O pins, six bits of this RAM word are the ASC11 code to be passed to the 2513 ROM. Now we come up against one of the problems of working with MOS devices — speed. The RAM takes at least 650nS to find the required word and present it at the I/O pins but in the meantime the data from the previously addressed word is still at the I/O pins. If we consider the reaction time of the TTL counters to be about 50nS before the data is available for that box. If we displayed the data straight from the RAM then the character would appear to change halfway through each box. First of all we tried to fool the system by starting to display the data during the latter half of each box plus space time by using the upper 5 outputs of the 7442 rather than the lower 5. This would have given us a space 5 units wide and then a character 5 units wide. Unfortunately the RAM data appeared to change at about the 6th or 7th unit and so the first one or two units of our character box were always wrong.

If we latch the RAM outputs at a time when we know that they have settled to their new values then we can use the latched data to pass to

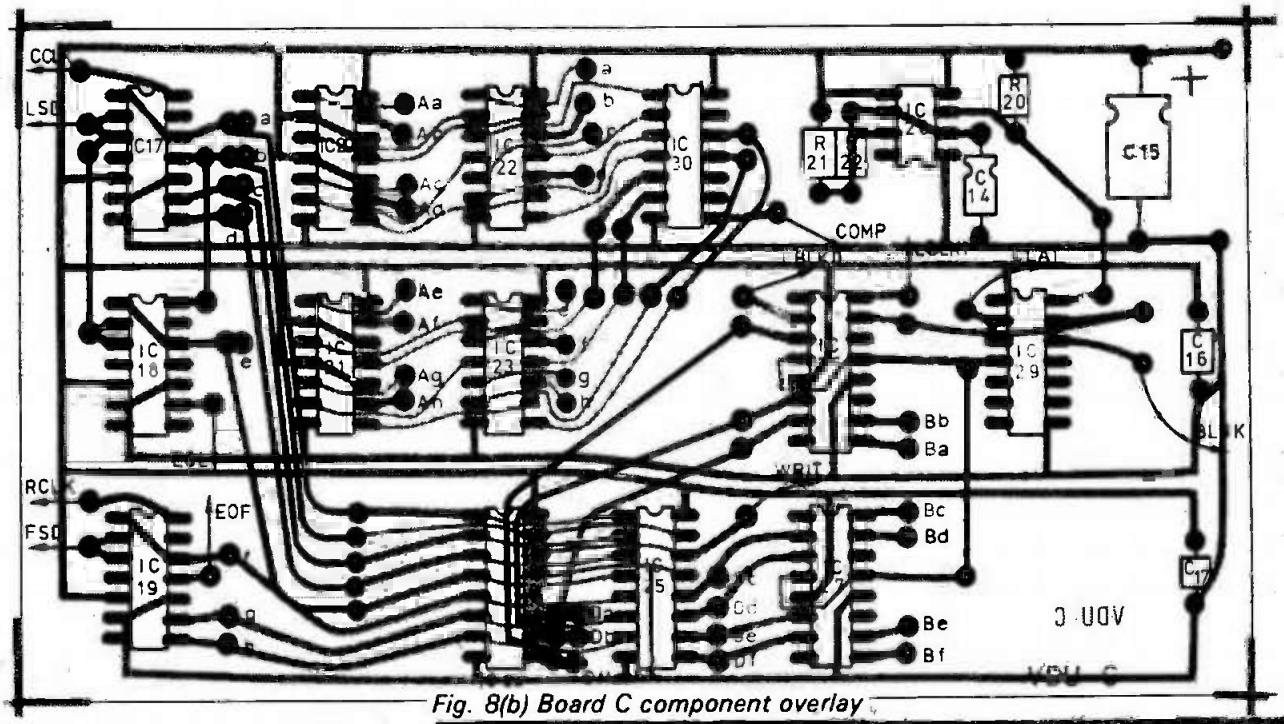
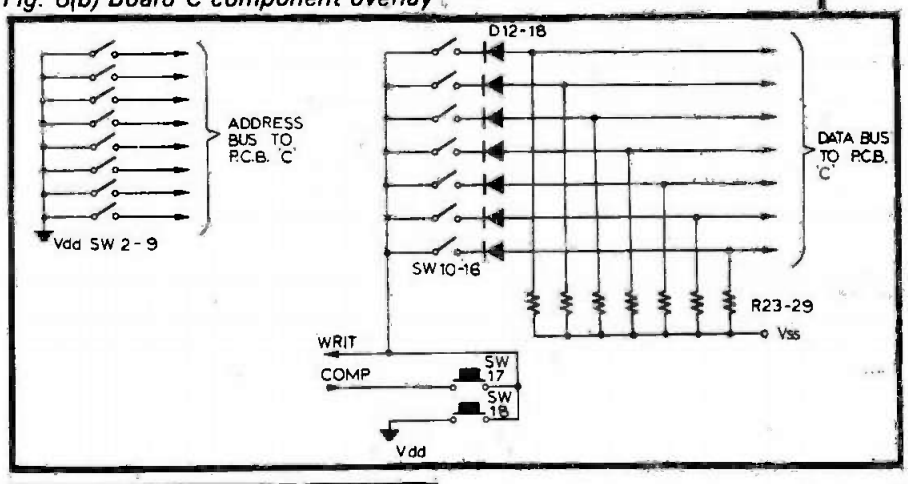
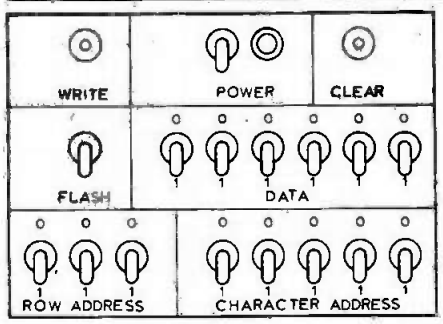


Fig. 8(b) Board C component overlay





the ROM. In our system we have decided to latch with 7442 output 9 and use 4-8 (or any other group of 5) outputs to generate our character. If we consider the first characters in each text row we can expect that box 1 will start with rubbish and then change to the desired character halfway through. At the end of box 1 the data for the first character will be latched to the ROM and thus box 2 will show the first character correctly, char 2 will be latched at the end of box 2 and displayed in box 3, etc. This means that we will have a rubbish box at the start of each row and that char 32 will be blanked because it is in box 33 and box 33 is blanked by the LSD/EOL flip-flop. If we delay the action of this flip-flop until the end of box 1 and the end of box 33 then box 1 will be enabled. We can use the same latch pulse (7442 output 9) to do this causing 9/10ths of box 1 to be blanked by LSD and the last 1/10th of box 33 to be blanked by EOL; as the last 1/10th of every box is always blank anyway (only 4-8 are used) this will have the effect of moving our complete display area about ¼ inch to the right. As we are only using 6 or 7 of the bits we thus have a spare latch in one of the 7475's which we can use to latch the flip-flop. Disconnect the temporary link on board 'B' between LBLKO and LBLKI and connect these points to the spare input and output of IC26. We are only using 6 RAM bits and 7 latch bits at present and thus we have at least one spare. It was decided to use this bit to define that the displayed data should flash on and off to thus bring attention to any important parts of the message. A 555 timer — IC28 — is set up to oscillate at about 1Hz, the output from this is enabled by latched bit 7 and the resulting signal passed to BLNK. If bit 7 is a logical '1' then the appropriate character will be blanked whenever the 555 output is high which is for about half a second every second; if bit 7 is low then the BLNK signal will always be high and thus the character will not flash.

WRITING TO THE VDU

We now have a system which will display any of 128 different characters (64 steady and 64 flashing) in any of 256 possible boxes on our screen. What we need to know is how to write data into the RAM in order to get it displayed on the screen. As we mentioned earlier a low at the R/W input of the RAMs will cause the data at the I/O pins to be placed in the memory location addressed at the same time. Thus if we set up a data word on the input data bus we can write that data into every position of the RAM by holding R/W low for a time in excess of the complete address cycle time, as a complete cycle takes less than 1/50th second we can connect a push-on release-off switch between R/W and Vdd. If the data set up is ASC11 '100000' our switch will load ASC11 spaces into all positions of the RAM and thus the screen will be cleared of all other characters except spaces, for this reason this switch is called 'CLEAR.' Note that CLEAR will load all positions with the data set up. This data will usually be ASCII space but could be any other (all '*' looks very pretty).

Referring to Fig 9 the CLEAR switch can be seen as SW18 connecting writ (which goes to R/W) to Vdd. This switch also connects a low from Vdd to the common of the data switches (and

INTEGRATED CIRCUITS

IC1-4	555	IC16	7400
IC5	7400	IC17-19	7493
IC6	7490	IC20-21	7400
IC7	2513	IC22-23	7486
IC8-9	7403	IC24-25	2112-2
IC10	7404	IC26-27	7475
IC11	7442	IC28	555
IC12	7490	IC29	7400
IC13-14	7400	IC30	7430
IC15	7421	REG1	LM309

DIODES

LED1 TIL209 or similar
D1-8 1N4001 or similar
D9 12V Zener, 400mW
D10 5V Zener, 400mW
D11-18 1N914 or similar.

RESISTORS

VR1 100k vertical preset
VR2 22' vertical preset
VR3 22kvertical preset
VR4 10kvertical preset
VRF 1kΩ vertical preset

R1-3	1k	R15	490R
R4-7	4k7	R16	1k
R8	220k	R17	390R
R9	22k	R18	470R
R10	15k	R19	390R
R11	2k	R20	4
R12	33k	R21	22k
R13	3k3	R22	33k
R14	470R	R23-30	1k

CAPACITORS

C1 2000µF 25V electrolytic	C7-8 150F
C2 470µF 25V electrolytic	C9-11 100f 16V electrolytic
C3 0.1 uF	C12-13 0.47µF ceramic
C4 2200F	C14 4.7µF 16V electrolytic
C5 0.1µF	C15 100µF 16V electrolytic
C6 2200F	C16-17 0.47µF ceramic.

MISCELLANY

PCBs ETI 560A, 560B, 560C
CASE Type WE1 (Watford Electronics)
Transformer T1 0-12v, 0-12V, 1A
FUSE F1 250mA (+holder)
SW1 Mains toggle switch SW12 Miniature toggle switch
SW17 Miniature push-to-make

the flash switch if connected). Each switch is diode blocked from its neighbours and held high by a resistor if not connected to the common Vdd by the switch being closed, thus the data bus (6 or 7 lines) will reflect the open or closed position of the switches if the common line is low. If the common line is open circuit then each bit in the data bus will be held high by its resistor but can be pulled low against this resistor if the RAM output for that bit is low, thus the data bus from the switches is effectively Wire-Or'd to the RAM I/O pins.

If we wish to write to a particular RAM location then we have to set up that location on our address switches and the required data on our data switches. This will have the effect of causing IC30 output (COMP) to go low whenever the comparison between the scanned address and required address shows that the scan has reached the required box. If COMP is now connected to the data switch common then this will go low causing the switch data bus to output lows wherever a switch is closed during the time that comp is low. Similarly, if COMP is connected to WRIT then the RAM will store the data bus whenever COMP is low. Thus whenever SW17 is closed COMP will cause the active data bus to be read into the RAM whenever COMP is low, as this only happens when the required box is scanned then the data for that particular box only is changed. SW17 (WRITE) must be held closed for a minimum of 1/50th second, if it is opened during the time that comp is low then rubbish could be written into the RAM, but as this does not happen very often and it can be corrected by pressing WRITE again we have not guarded against this occurrence.

MODIFICATIONS

FLASH. Bits 7 and 8 can be used for other purposes than flash, eg colour generation if the TV has video inputs for RGB. Remember that bit 8 will need to be latched as is bit 7.
SYNC. External sync may be used if it is split into FS and LS. A switch could be installed to give internal or external sync options. MPUs. If you wish to use the 560 VDU with a microprocessor you will need a socket to connect 8 bit address, 6-8 bit data, COMP and WRIT plus a ground (Vdd) connection. Further details next month.

TAKE AN S-DeC

No15 Electronic Coin Tosser

David Gibson

This device generates a random sequence of binary digits. It has the advantage over tossing a coin in that there is no possibility of cheating.

When the battery is connected the lamp will glow at half its full brightness. To electronically "toss" a coin, connect a lead between sockets 19 and 51 on your S-DeC when the state of the lamp, ON or OFF, will represent a HEAD or a TAIL.

The n-p-n/p-n-p pair (the two transistors on the right) is connected as a Unijunction transistor which oscillates at a frequency determined by the 1μF capacitor and the resistor between sockets 48 and 53 on the S-DeC.

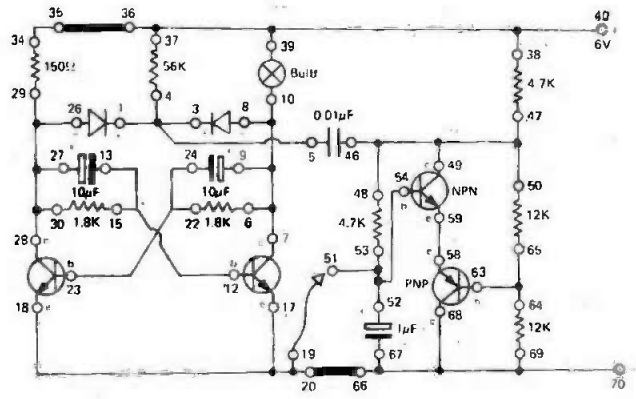


Fig. 1 Circuit diagram of Electronic Coin Tosser showing relevant hole numbers of S-DeC.

The output signal from the oscillator is made to switch a binary multivibrator, the two-transistor circuit on the left, and this in turn switches the bulb on and off. When S-DeC sockets 51 and 19 are connected, the oscillator stops and the binary freezes in the state it had immediately before stopping the oscillation.

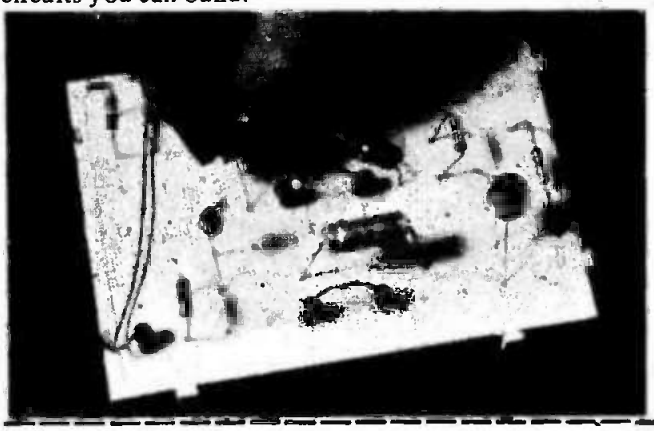
Building circuits like this is simple if you use an S-DeC (see photograph). Component leads are plugged into the relevant numbered holes (see circuit diagram) and are automatically connected into circuit.

Beneath the holes are special sockets connected together in a pattern which is shown on the upper surface of the S-DeC. When you have finished building the Electronic Coin Tosser, simply unplug your components and use them again.

If you want to keep a circuit permanently wired, then for only a few pence you can buy a Super Solder Board. These printed circuit boards have holes and copper tracks which exactly match those on the S-DeC. To preserve your circuit, simply transfer the components from the S-DeC to exactly the same matching holes on the Super Solder Board and solder a permanent circuit. Holes on both S-DeC and Super Solder Board have the same letter/number marking. Making mistakes is almost impossible.

When you have built your Electronic Coin Tosser you can build other exciting projects on your S-DeC. Many of the circuits featured in the popular electronics construction journals can be built on your S-DeC. In addition, P.B. Electronics has written a special projects handbook for the S-DeC experimenter. The book contains 48 different projects to build. These include record player amplifiers, emotion meter, radio jammer, electronic tug-of-war, strength meter, radio microphone and dozens of others – and you can build every one on your S-DeC.

The S-DeC costs only £1.98 plus 37p post, packing and VAT. It also includes a booklet giving 9 S-DeC circuits you can build.



2m POWER AMP

Most mobile two metre transceivers are limited to about ten watts output. This RF power amplifier boosts output to 45 watts

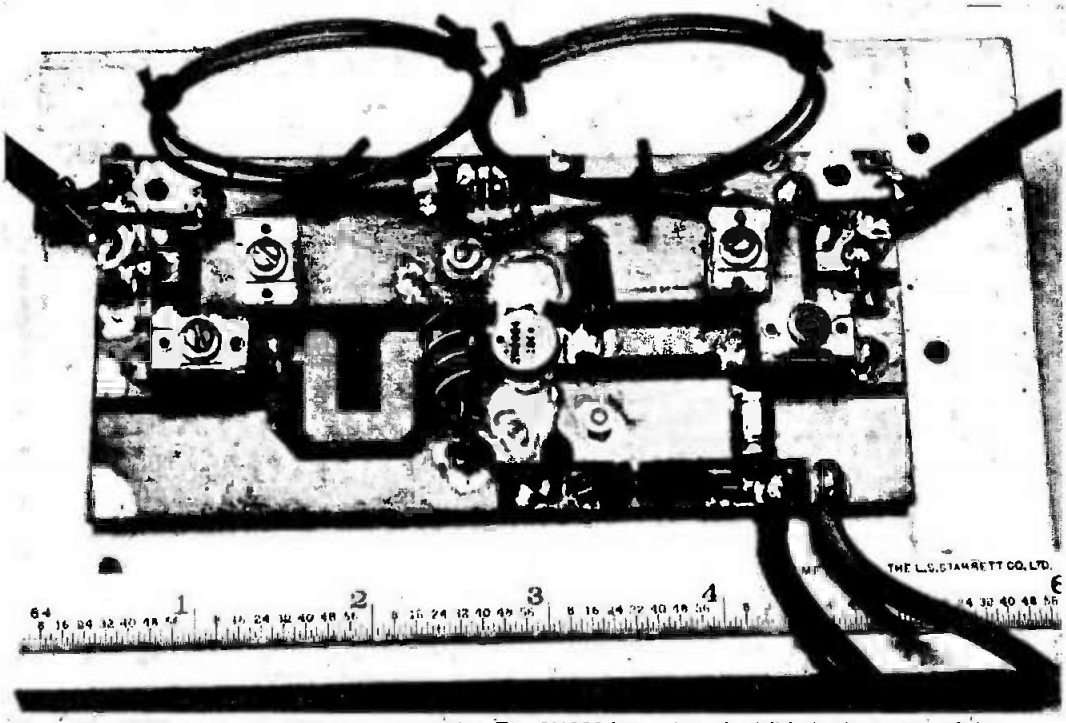


Fig. 1. The 45W, two metre RF power amplifier. The 2N6084 transistor is visible in the centre of the p.c. board. The mica compression trimmers located on the right hand side are for tuning the input, those on the left for tuning the output. The printed inductances are readily visible. The two quarter wave coax lines are visible at the top. They may be coiled up as shown or conveniently arranged in some other way. Note that the components are soldered on the copper side of the printed circuit board.

ONE OF THE MOST POPULAR amateur radio activities these days is FM mobile operation on the two-metre band. The use of FM, particularly mobile, has a number of advantages. It reduces the effects of impulse noise interference, mostly generated by car ignition systems and provides clear, largely noise-free communications. But mobile operation has its problems such as flutter caused by surrounding buildings and terrain, and the relatively low gain of mobile antenna systems.

The majority of mobile transceivers, such as those made by Icom, Yaesu, Trio etc, produce about 10W output power. They also have pretty 'hot' receivers, which means that output power and receiver sensitivity are not 'matched' and you can hear higher power stations or repeaters over much greater distances than they can copy you. Simple solution: an RF power amplifier to boost your output power.

When considering the pocket, or how much a suitable power amplifier would cost, a good rule of thumb is 'less than 70p per watt'. Thus, one needs to consider a single transistor. This must have adequate gain and be able to accept an input power in the range of 8 to 12 watts. There are a number of suitable transistors that commence at this level and will produce output powers in the range of 25 to 50 watts or more from a power supply rail of 12V. Those transistors producing output powers over 50 watts from the 10 to 12 watt price level become more expensive on a per-watt basis than those transistors producing output powers below 50 watts. The higher power transistors require a substantially larger heatsink also — increasing size and cost considerations. As most of the popularly used commercial transceivers — and many homebrew ones, are quite small physically, the size of the power amplifier is also a consideration.

Apart from cost, *availability* of suitable transistors and other components is a necessary consideration. The 2N6084 transistor fits all our requirements very well. The data sheet on this transistor indicates a power input of between 8 watts and 12 watts at a supply voltage of 12.6 volts. The manufacturers claim that the transistor will withstand severe mismatch under operating conditions. A graph of power output versus power input (i.e.: drive power) is given in Fig 2 along with a table of typical performance and base input — collector output impedances.

Having chosen the device, an appropriate circuit, suitable for a kit or simple home construction was necessary. The current ARRL VHF Handbook describes a circuit that works very well, but has a number of drawbacks, local availability of some of the components in particular. It was also felt that the design could be simplified with a consequent reduction in components and

2m POWER AMP

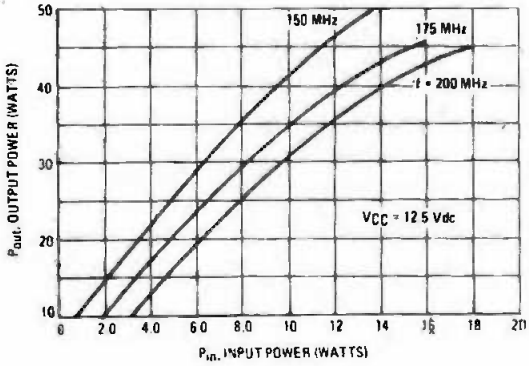
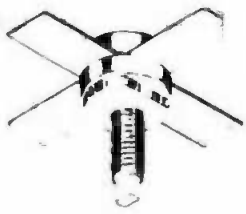


Fig. 2. Power output Vs power input for 2N6084.



Physical construction of 2N6084

fo = 175 MHz, Vcc = 12.5 VOLTS			
PIN WATTS	POUT WATTS	INPUT OHMS	OUTPUT OHMS
4	21.7	0.8 – j 1.1	2.2 – j 0.3
8	37.1	0.8 – j 1.3	1.7 – j 0.5
10	40	0.8 – j 1.45	1.65 – j 0.4
12	46.5	0.8 – j 1.6	1.6 – j 0.3

Fig. 2(b). Input and output impedances vs power for 2N6084.

cost. Another drawback was the problem of an antenna changeover relay. To cope with this level of power and have adequate isolation between the transmitter output and receiver input contacts a coaxial changeover relay is necessary. These items are not on everybody's shelf and generally cost in excess of £10 over the counter. Very off-putting.

DIODE AND COAXIAL LINE SWITCHING

Quarter wave coaxial lines and diodes are now being successfully used for this purpose however — and several articles describing the technique have recently been published in amateur radio publications. The method is simple, cheap and very effective. The circuit is shown in Fig 4 and works as follows:

During the receive condition, all the diodes are non-conducting and thus present a high resistance to the signal coming from the antenna. Thus, no signal is dissipated in the amplifier input or output circuits. The two diodes from the centre point present a high impedance across the coax line and thus have no effect on incoming signals from the antenna. Thus the signals travel through the two quarter-wave coax lines to the antenna input of the receiver without loss. When the transmitter is operated, all diodes conduct. The diodes at the centre point of the two quarter-wave lines will conduct and since a quarter-wave line shorted at one end presents an open circuit at the other end, each quarter wave line will present a high impedance at the input and output terminals respectively. The diodes between the input terminal and the power amplifier stage input will conduct and pass the driving power. The diodes between the power amplifier and the output terminal will likewise conduct, passing the output of the amplifier to the output terminal. The output power cannot return to the input as the two diodes from the centre point of the coax lines will conduct, shorting the quarter-wave line and presenting a high impedance at the output terminal. Happily, the impedance of the quarter-wave coax lines is immaterial and anything suitable may be used. However, their lengths must be an accurate quarter wavelength electrically taking into account the velocity factor of the cable. In developing this project, some trouble was experienced in this respect — so make sure you have the right length. It appears that the velocity factor of ordinary, run-of-the-mill, garden variety RG58/U coax, obtainable from most suppliers varies considerably in its velocity factor, even over relatively short lengths. You can use this type of coax but a lot of pruning and turning will be required. If a cable manufactured to tighter tolerances in velocity factor is used, this problem disappears. It is suggested that cables such as RG59B/U (or C/U) or RG223/U, which are nominally 5 mm diameter be used. Alternatively, a 2.5 mm diameter cable such as RG174/U may be used. All these cables have a velocity factor of 0.665 and have been found to be consistent in practice. They must, however, be accurately cut to the lengths specified, as detailed later.

Some trouble was also experienced with a commonly available 2.5mm diameter cable of unknown type number, so be wary.

THE POWER AMPLIFIER CIRCUIT

The circuit is illustrated in Fig 4. Inductances L1 and L2 are actually rectangular, 5.5 mm wide strips, on the printed circuit board. They are not microstripline sections which would require a double-sided printed circuit board so single-sided p.c. board is used in this project.

Turning capacitors, C4, C5, C6, C7 are all mica compression trim-

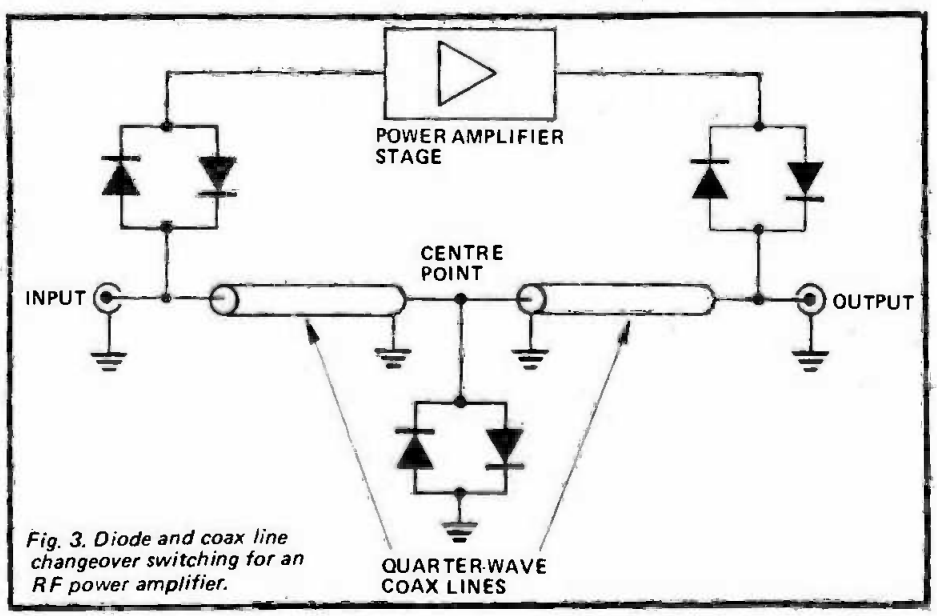


Fig. 3. Diode and coax line changeover switching for an RF power amplifier.

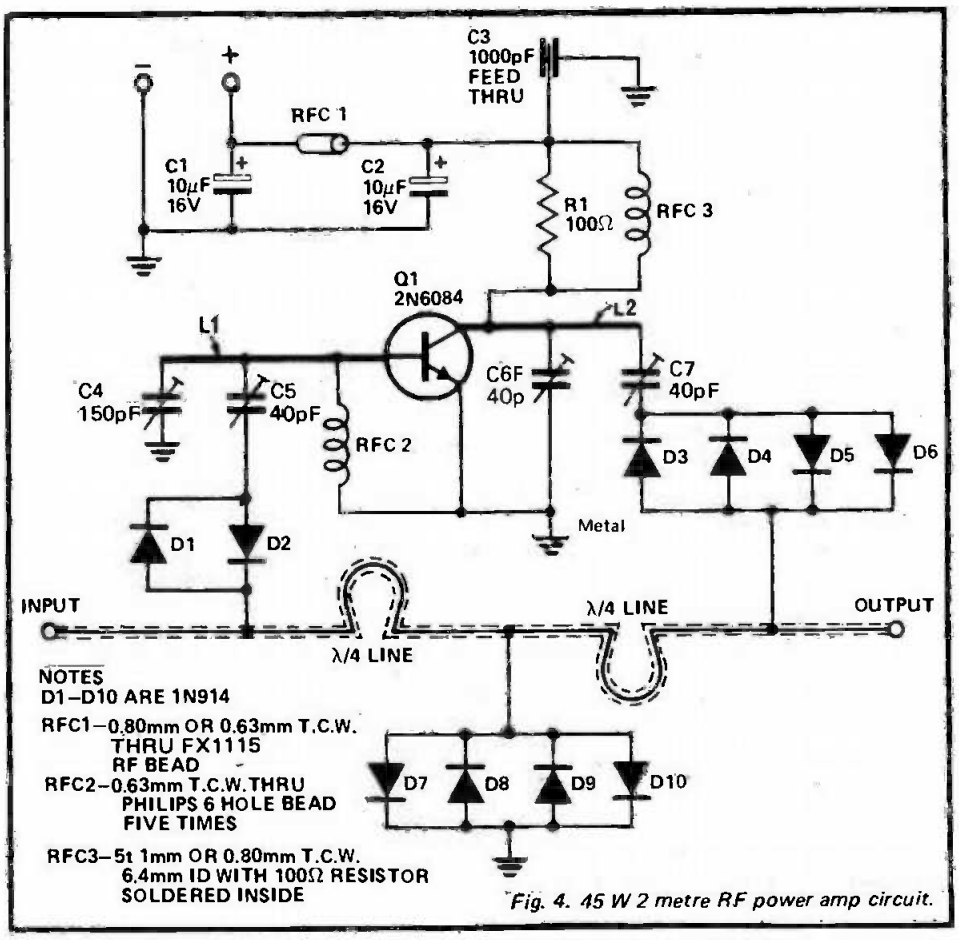


Fig. 4. 45 W 2 metre RF power amp circuit.

mers mounted on a ceramic base and are readily seen in Fig 1.

The dc return for the transistor base circuit is via an RF choke, RFC2, visible just to the right of the transistor in Fig 1. This consists of a number of turns of tinned or enamelled copper wire passed through the holes of a six-hole ferrite bead. This makes a low resistance, high inductance RF choke. Some published circuits specify the use of a low value resistor, or two resistors in parallel, in place of an RF choke in this part of the circuit. However, this is not recommended as the available power output is considerably reduced.

The transistor collector is shunt fed from the supply via RFC3. This is simply five turns of tinned or enamelled copper wire of a suitable heavy gauge, anything between 20SWG and 26SWG is adequate, with a low value resistor mounted inside to dampen it and lower the Q. A resistor value between 47 ohms and 180 ohms is quite satisfactory. The supply end of RFC3 is decoupled for RF by a 1000 pF feedthrough capacitor used as a standoff and tie point.

As the low frequency gain of the 2N6084 is quite high, the supply is also decoupled by several large value electrolytic capacitors, C1 and C2. The latter is a 10uF/35 V tantalum. The supply input is decoupled by C1 and RFC1. C1 is a 10uF electrolytic. RFC1 is an FX1115 ferrite bead, slipped over a 22 mm length of tinned copper wire. The gauge of wire is largely immaterial. Anything between 22SWG and 26SWG is quite satisfactory.

The diode switching requires a total of ten diodes. These may be 1N914 (1N418) or 1N916 types, although these were found to be only barely adequate for the job. They do get quite hot to the touch after only a few minutes operation. More suitable types would be the Philips type BAX13, or even better still — BAV10. These latter ones are recommended. Despite the heating problem, no failures have been experienced with 1N914 diodes. However, if you have a predeliction for holding long 'overs', then use the recommended types for added safety. Absolute minimum lead length possible must be used when soldering them into position.

The input and output tuned circuits, consisting of L1-C4-C5 and L2-C6-C7 respectively, are designed to match the transistor base input and collector output impedances, at the required input and output power levels, to about 50 ohms. C5-C4 and C7-C6 foform capacitive dividers. From the table included with Fig 1, it is obvious that the transistor impedances vary with power level. Thus the amplifier shoule be tuned up at the power level at which it is intended to be used. There is sufficient range in the tuning capacitors to accommodate a range of input power levels.

The 2N6084 is encased in the MT-72 stripline package, having two emitter leads. The collector lead has one corner removed — see the illustration of the package in Fig 2. The collector lead is also marked by a dot on the header as can be seen in Fig 1 & 6. The threaded stud is electrically isolated from the transistor Leads. This sort of package construction reduces lead inductance and allows the stud to be bolted directly in contact with a heatsink for maximum heat transfer. The 2N6084 is manufactured by both Motorola and Solid State Scientific (SSS).

HEATSINK REQUIREMENTS

A heatsink is required to dissipate at least 45 watts of heat with a low temperature rise. As operation is of an intermittent nature, with relatively long intervals between on periods, heatsinks requirements can be relaxed somewhat. A 150 mm length of 100 mm wide heatsink having fins on one side only (fins about 25 mm deep) as can be seen in Fig 1, was found to be quite adequate. A diecast box having dimensions somewhat larger than the pc board could be used but its heatsinking properties would be barely adequate and amplifier on times would have to be kept short. A proper heatsink is recommended. The heatsink illustrated was obtained un-anodised. A black anodised heatsink would certainly do a better job. However, it is good practice to sand off the anodising in the immediate vicinity of the transistor stud, where it contacts the heatsinks.

CONSTRUCTION

The amplifier is constructed on a single-sided printed circuit board, 120 mm long by 58 mm wide, the board layout being given in Fig. 5. The component layout is illustrated in Fig. 6, and one can get a good idea of the component layout also from Fig. 4. Note that all the components are mounted on the *copper side* of the board, contrary to common practice adopted with most other circuits constructed on pc board.

If you have facilities for making your own pc board, construction

2m POWER AMP

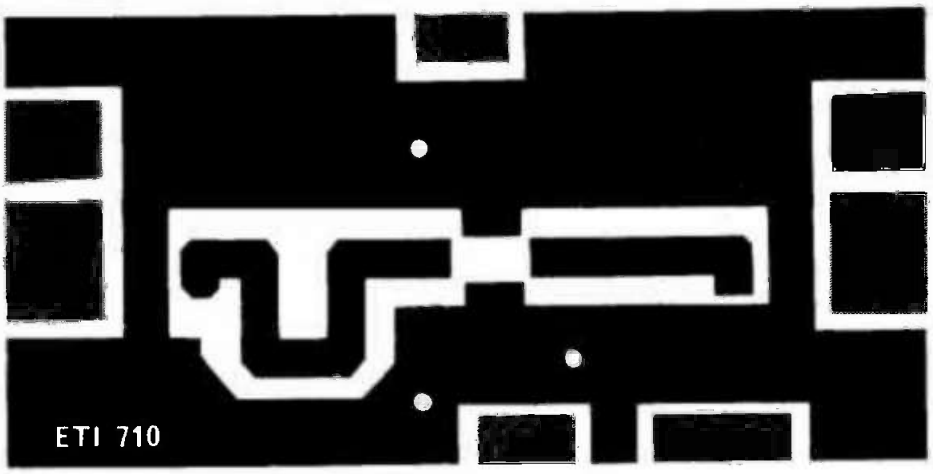


Fig. 5. Printed circuit board layout, copper side.

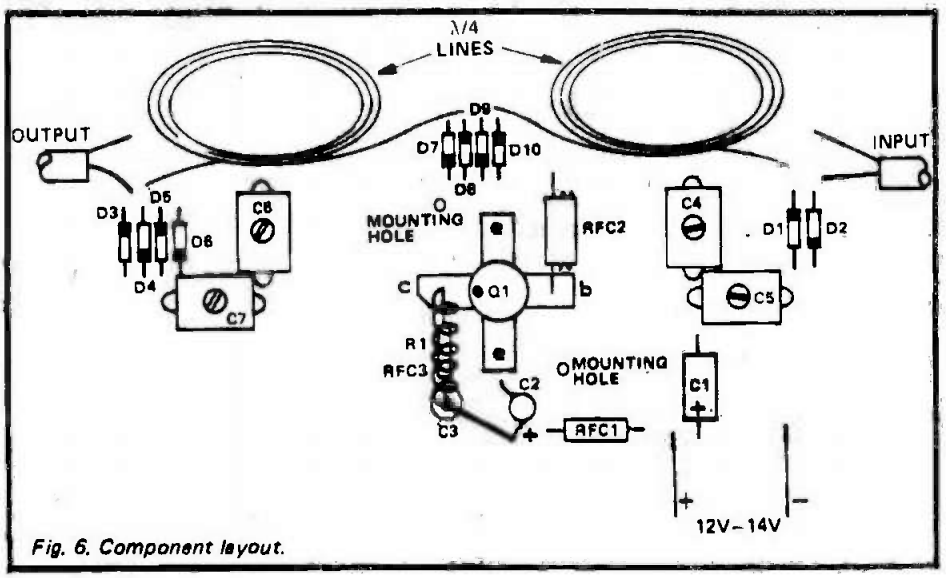


Fig. 6. Component layout.

should commence by first making the board. Although the board is of very simple design, it should preferably be made by one of the etching processes. Do not attempt to make the pc board by cutting away the unrequired copper. This usually results in: (a) a board that looks grotty and (b) a project that either does not work at all or does not work satisfactorily.

Commence by drilling the transistor mounting hole in the pc board using a 9.5 mm (⅜in) drill. File it out slightly with a small round file so that the transistor header is a loose fit through the board. Next drill the two mounting holes, which are positioned diagonally opposite each other either side of the transistor, and the 100pF feedthrough capacitor mounting hole. Use a 3.2 mm (⅛in) diameter drill. A clearance hole of about 4.5 mm to 5 mm diameter (3/16in) will need to be drilled in the heatsink beneath the position of this capacitor.

Now place the pc board centrally over the heatsink to be used and mark the positions of the transistor mounting hole, the feedthrough capacitor clearance hole, nd the two mounting holes. Drill the heatsink using a 4.5 mm drill (3/16in) as this is a good clearance size for the American 4-40 threaded stud on the 2N6084. Then drill clearance holes in the heatsink for the mounting bolts and the feedthrough capacitor.

Once the pc board and heatsink have been drilled and the hole positions checked to see that everything fits correctly without strain, the pc board may be wired.

Commence by mounting the mica compression trimmers, C4, C5, C6, C7. Refer to the layout in Fig. 6. The trimmer capacitors are constructed with large lugs, formed of the capacitor plates, that project more or less straight down from the ceramic body of the component. Carefully bend the end of each lug out at right angles before soldering the capacitor in place. Use a hot soldering iron with a large tip and solder rapidly, making sure that the solder is adequately melted to ensure proper wetting of the joint. It is advantageous to lightly tin the lugs before soldering. A temperature-controlled iron, such as the Weller, with an appropriate tip, is recommended.

Next slip a 22 mm or 25 mm length of 24 or 26SWG tinned copper wire through the Neosid type 159 x 059 x 375/F8 RF bead, making RFC1, and solder it into place as shown in Fig. 6. Now mount C1, C2 and C3. Cut the lead of the feedthrough capacitor (C3) flush with the body of the component on the back (heatsink) side of the board, as shown in Fig. 7.

When mounting C1 and C2 ensure that the proper polarity is observed. If C2 is connected to reverse it goes up in flames when the power is applied. It may damage C1 as well.

Mount all the switching diodes using an absolute minimum of lead length. Check that they are correctly oriented.

Before mounting the 2N6084, cut the base and collector leads to about 6 mm (¼") length. This should be done with care so as not to damage the rather soft leads. A

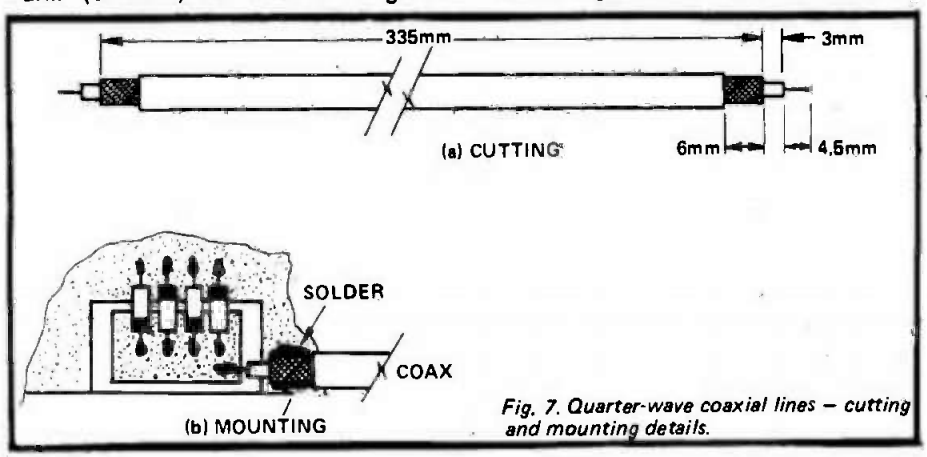


Fig. 7. Quarter-wave coaxial lines – cutting and mounting details.

Fig. 8a. Mounting feedback capacitor C3.

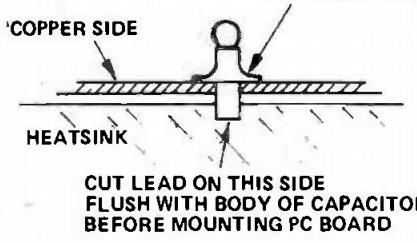
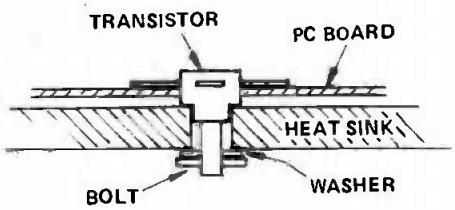


Fig. 8b. How the 2N6084 is mounted.



pair of sharp, ordinary household scissors is a good tool for the job. On the premises that what people don't know won't hurt them, turn your back when you do this little job or else do it at some suitable hour in the dead of night so that the prime user/owner of the scissors doesn't see what you are doing. It avoids complications such as black eyes and minor stab wounds. Reasoned arguments such as the softness of the metal tend to go unheeded.

Straighten the leads carefully if necessary, so that they run straight out from the transistor header without any kinks. Place the transistor on the board and see that the leads sit flush on the board right up to the transistor header. Orient the transistor as shown in Fig 6. Carefully solder it into position, flowing the solder near to the 2N6084 case. Use a hot iron and ensure that proper wetting of the joints occurs.

Next wind RFC2 and RFC3. RFC2 requires a length of 26 SWG tinned copper wire about 100 mm long. Thread it through the six-hole Philips ferrite head five times. Solder it into position from the base of the transistor to the ground plane as shown in Fig 6. Keep the leads short. RFC3 requires a 100 mm length of 18 or 20 gauge B & S tinned copper (enamelled copper wire is also suitable). Wind five turns around the shank of a 6 mm (¼") diameter drill or other suitable former and then slip it off. Cut the leads to a suitable length, 5 mm to 7 mm is adequate, and then stretch the coil to a length of about 12 mm. Solder one end to the collector of the 2N6084 and the other end to the top terminal of the feedthrough capacitor, C3. Solder a short link of hookup wire from this terminal to the rectangular pad nearest C3, see Fig 8.

The pc board may now be mounted into position on the heatsink. Apply a little silicone grease or heatconducting compound to the transistor stud where it contacts the heatsink. Bolt the transistor down first. Carefully orient the mounting holes beforehand. Now slip a suitable-sized nut or fibre washer under the pc board mounting holes. Either should be a close fit between the pc board and the heatsink so that no upward or downward strain is placed on the transistor leads. Any upward strain may cause the cap to pop off — an inconvenience rather than a disaster, as it can be glued back on with a quick-setting glue without any apparent ill effect. Extreme care must be exercised in doing this though. Not a recommended procedure, but possible. Any downward strain can cause the transistor leads to 'tear' at the header. This sort of damage is very difficult to repair.

The quarter-wave coax lines may now be installed. Cut two lenghts to the dimensions shown in Fig 7. Solder the lines into position as illustrated, being careful not to damage the centre conductor or insulation. Use a hot iron and solder quickly. The braid at each end is best tinned beforehand. Alternatively, wrap it with a length of light gauge (say 265 WG) tinned copper wire and tin the lot before attaching the line to the pc board.

The coax lines may be coiled and tied up as shown in Fig 1 or they may be wrapped conveniently in any position around the inside of any cabinet or case the amplifier may be mounted inside.

Finally, the input and output connections can be made via short lengths of coax to convenient coax sockets. As individual constructors will have different requirements in this regard, it is best left as an individual decision. Sockets that are compatible with the existing installation are best used.

The power supply leads will need to be rated to carry currents up to six amps. Any connectors will need to be adequately rated to carry these currents. As the amplifier is completely stable with no drive, and does not draw any current, it is not necessary to switch the 12 volt supply rail, except perhaps as a precaution, and this may be routed via a complete installation supply switch.

A COMPLETE KIT OF COMPONENTS for the 2m power amp is available from **Catronics Ltd, Communications House, 20 Wallington Square, Wallington, Surrey,** for £23.10 inc VAT and 20p p&p. They are also able to supply individual components e.g. 2N6084 at £19.40, special coax at 25p/metre, BAV10 diodes at 11p each and the PCB at £1.23, all including VAT and with a standard postage and packing charge of 20p.

TUNE UP

Tune up is quite simple. You will need a dummy load of adequate rating and either an in-line power meter of reasonable accuracy or some power output indicating device. A power supply that can deliver up to six amps at 14 volts (maximum) is necessary. An ammeter that can read up to at least six amps would be handy also.

After carefully checking the construction, apply a supply voltage of between 12 and 14 volts. Check that no current is drawn by the amplifier.

With the dummy load connected and the driving transciever or transmitter, apply a drive of between 5 W and 12 W, preferably the lower power. Tune the input trimmers for a peak in the output power indication. Do not hold the drive on too long with the amplifier in this condition. Next, apply drive again and tune the two output trimmers for a maximum in output indication.

Now, with the maximum drive power to be used, touch up all the trimmers for maximum power output.

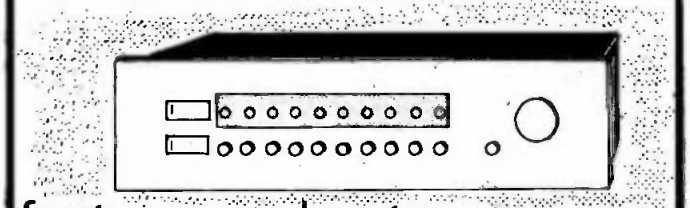
Maximum collector dissipation should be kept under 80 watts. Also see that the maximum continuous collector current of six amps is not exceeded.

PERFORMANCE

At a supply voltage of close to 13 volts and a drive level of between 7 to 8 watts, a power output of 42 watts was obtained from the prototype. This is a gain of around 7 dB. The manufacturers of the 2N6084 specify a minimum gain of 4.5 dB at 175MHz. However, one could expect a somewhat higher minimum gain at 146 MHz. An efficiency in excess of 55% is readily obtainable.

ambit international

WIRELESS SPECIALISTS



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MC1310	2.20	NE561	2.50	ZTX551/451pn	0.18
SN76660	0.75	NE562	2.50	BF256	0.34
TBA120AS	1.00	NE565	2.50	40673/MEM616	0.50
TBA651	1.81	NE566	2.55*	40822/MEM615	0.38
uA720	1.40	7805UC	1.55*	BD535n(60v - 50w)	0.52
LM380	1.00	TDA1412	0.95*	BD536p(60v - 50w)	0.53
LM381	1.81	78M20UC	1.20*	BD609n(80v - 90w)	0.70
TBA810	1.09	uA723	0.80*	BD610p(80v - 90w)	1.20
TCA940	1.80	NE550	0.80*	n = NPN type	
TDA2020	2.99	NE567	2.50*	p = PN P type	

VARACTORS		FOIL TRIMMERS		POTS	
MVAM2	1.05	3–12pF	0.18	100k+100k LIN	0.60
MV104/88104	0.45	4–30pF	0.23	100k+100k with.... 50% tap	0.65
BA102	0.30	6–45pF	0.26	20 turn 100k..... diode law	0.35
BA121	0.30	(7.5 diameter types).			

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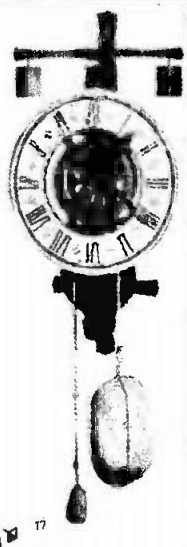

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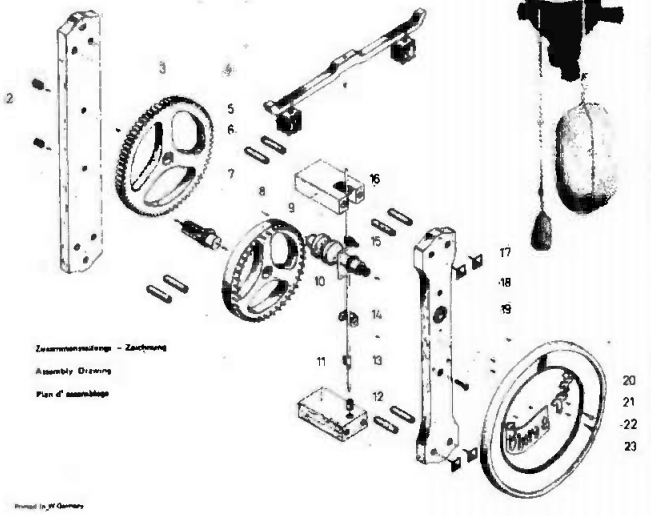

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Opto-Electronics

With the advent of precision-moulded optical systems the way to practical opto-electronic devices has really opened up.

FOR SOME time now there has been an increasing trend towards integration between optics and electronics. For this there are two main reasons: visible light may well become the carrier medium for the next generation of communications systems, and the greater need for accurate information in all fields has led to a great expansion in the demand for visual displays.

Before visible light can be employed for data transmission, a whole range of components will have to be developed as the optical equivalents of electrical plugs and sockets, jacks, switches and relays, amplifiers, attenuators, filters, tuners and similar units.

Miniaturisation resulting from solid-state technology has drastically reduced the size of electronic equipment. Meters, indicators and display screens, however, cannot be similarly reduced in size, because no one could read them. An important sector of opto-electronics therefore concerns itself with providing legible data from systems of the smallest possible size. The most common example is probably the light-emitting diode (LED) display.

The layout and arrangement of printed circuit boards and the interchangeable plug-in modules (which presuppose the absence of permanent wiring to the outer case), often create problems of conveying indication from the point most convenient to the circuit designer to the point most convenient to the user. Again, optical components in the form of mirrors, prisms, light guides and lenses (or any combination of them) can solve such problems.

ADVANTAGES OF PLASTICS LENSES

Several clear polymers, such as acrylics, polystyrene, polycarbonate, ABS, cellulose, vinyl, polyester and others, can be used instead of glass to make optical components. The most important technical advantages of plastics optics are freedom of design, greatly reduced assembly costs, greatly reduced weight, and elimination of shattering.

On average, optical plastics are about 55-65% lighter than glass. In practical terms the weight saving is usually much greater because most of the metal mounting and retaining parts essential for glass lenses can be dispensed with, since plastics lenses can be moulded with integral spacers and retaining lugs.

The most interesting aspect of plastics lenses is the freedom of optical form conferred by the nature of the material. With moulded plastics optics, human skill is concentrated on the manufacture of the moulds, from which any required number of lenses of uniform quality can be produced, aspheric (non-spherical) lenses can readily be made.

Aspheric lenses are important because they permit aberrational correction of a system without affecting its focal length and magnification. Certain shortcomings of spheric lenses can therefore be eliminated or minimised by 'aspherising' one or several lens surfaces in an optical system. A given amount of correction can be achieved by fewer components if one or more of them are made aspheric. In both cases significant savings result.

The advantage of aspherics is well

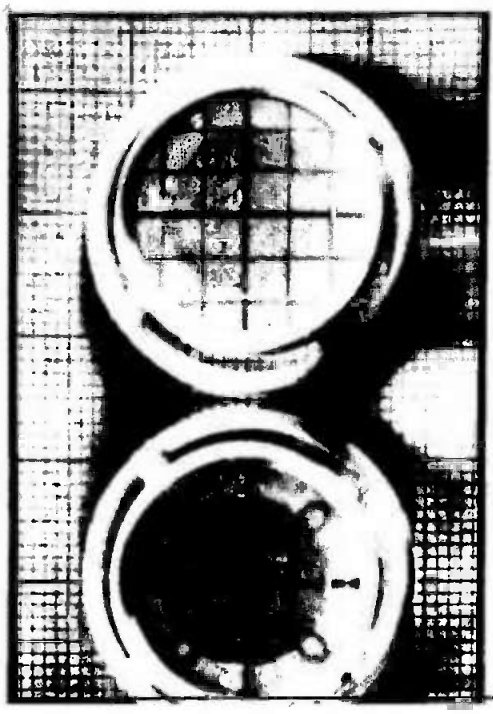


Fig.1. The aspheric lens (top) gives an undistorted view of at least 20 squares, while the spherical glass lens (below), of the same diameter and power, only shows four reasonably undistorted squares.

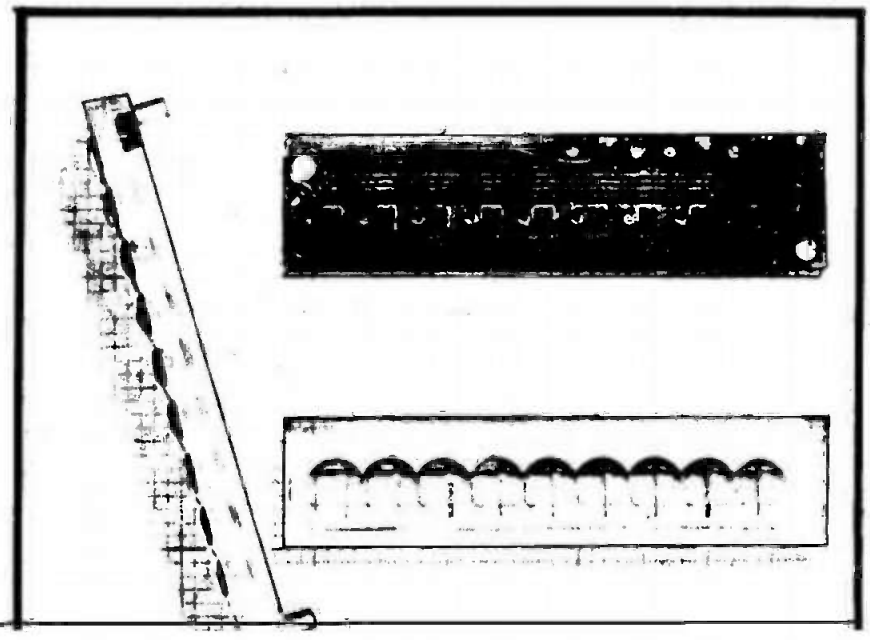


Fig.2. Integral array of nine miniature aspheric lenses with a magnification of 3x for an electronic pocket calculator.

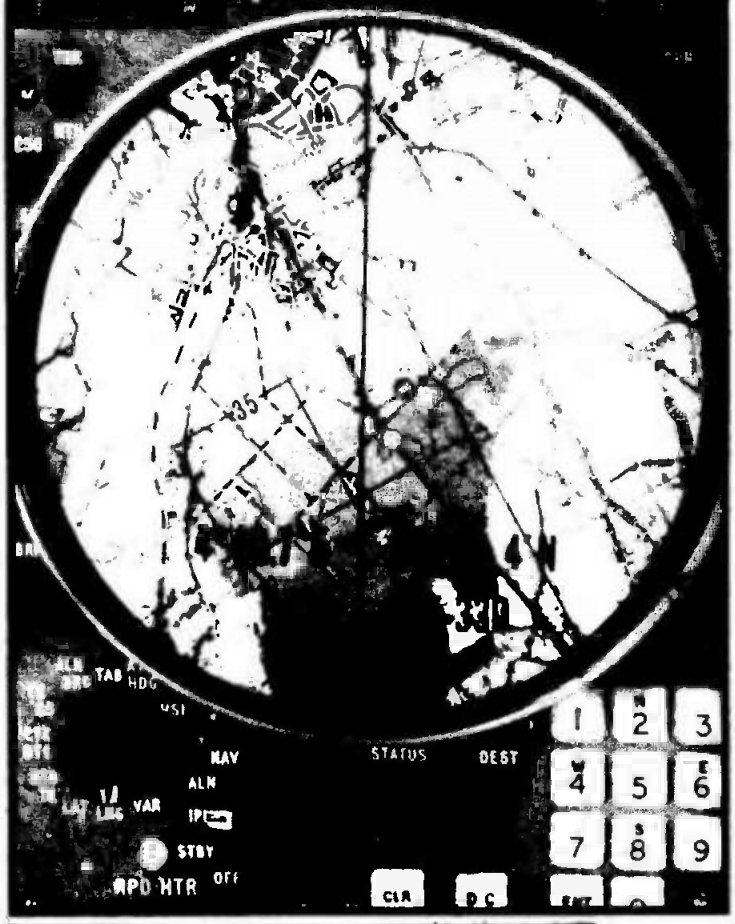


Fig. 3. This combined mini-computer, moving map and electronic display unit (Comed) for aircraft navigation uses a moulded plastics lens of complex aspheric design to give an undistorted, brilliant image of the map.

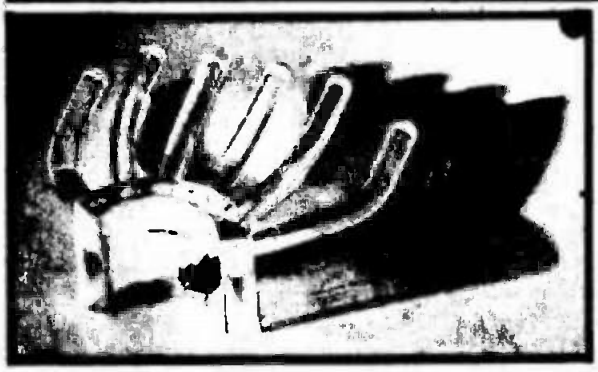


Fig. 4. This one-piece light guide splits the light from a single bulb into six beams to scan six rows of holes in a punched card for an automatic telephone dialling unit.

shown in Fig.1. Both magnifiers have the same size and magnification, but while the aspheric moulded plastics lens in the top unit has a distortion-free field of view of 20 squares, the spherical glass lens of the lower unit has an effective field of view of only four squares. Yet the glass lens is heavier and more expensive.

Aspherics can be also produced at apertures greater than f/1. They are already widely used in portable devices involving high magnification, such as reading aids for sub-normal vision. Aspheric lenses from 3 mm to 180 mm diameter are readily available, while lenses up to 630 mm diameter have been made. In opthalmics, magnifications of 8x are frequently used.

INTEGRAL PLASTICS OPTICS

The freedom of shape conferred by moulding frees designers from the limitations imposed by glass – he can create systems which are functionally superior. Plastics lenses can be moulded with integral lugs, bosses, rims, pivots and similar mounting, swivelling, adjusting and actuating members, in a wide range of shapes, sizes or configurations, as shown for instance in Fig.4. This means that in a well-designed product, the optical system parts snap or slide into the housing without any further assembly operations and, with precision-moulded housings, no subsequent setting or adjustment should be necessary.

TYPICAL APPLICATIONS

A multiple aspheric lens array moulded integrally with its mounting plate is shown in Fig. 2, with the associated nine-digit seven-bar circuit board for pocket calculators. The moulding has two pins on the underside which locate through the two holes in the board in two further holes in the calculator casing. Two ledges on the underside of the moulding ensure that it is held at the correct focal distance above the board. Assembly is therefore very simple and the need for any adjustment is eliminated. The lenses have a magnification of 3x and provide a distortion-free image.

A much larger moulded lens is used on the Ferranti Comed (combined map and electronic display) for aircraft, shown in Fig.3. In addition to alpha-numeric readouts of latitude, longitude, range, bearing and other navigational data, the unit has a screen on to which a moving map or radar picture can be projected from the rear. The lens is a bivex type, the flatter surface having a special form known as a Schmidt corrector plate. This complex aspheric surface is essential to ensure an undistorted image from any position, despite movements of the pilot's head, and a brilliant image even in strong daylight.

Light guides can be of many different basic types, depending on the function they are required to perform. A good example is the Card Callmaker, a compact unit which can automatically dial a telephone number with up to 16 digits when the appropriate punched card is inserted into it. The light guide (see Fig.4), which is moulded accurate to ± 0.012 mm in all dimensions, has six 'fingers', which split the light from a single lamp into six beams. Each finger incorporates a lens at its tip, which focuses the light on to a photocell. The inserted card blocks the light, except where holes are punched in any of the six rows available. This automatic dialling unit could, of course, also work with six lamps and conventional glass lenses, but then failure of any one lamp out of six would result in a wrong number. If the single lamp in the Card Callmaker fails, the unit will simply not operate. This moulded unit is much cheaper than a light guide made up from bundles of glass fibres.

In addition to lenses, prisms, light guides and similar components, mirrors and reflecting surfaces of almost any shape can also be produced. Aluminium, gold and thorium are most commonly used for coating the reflective surface, which may be the front or rear surface of the component.

Integrally moulded optics will undoubtedly play an increasing part in opto-electronics, including such equipment as self-scanning arrays, low light level vision aids (both active and passive), cathode-ray tubes (for combined optical digitisers), rear-ported cathode-ray tubes (for combined optical and electronic projection), photometers and densitometers, video recording systems, optical character readers, holographic and thermal imaging equipment, laser equipment of all kinds and many others. ●

FIXED CAPACITORS

PART 2

This section in our electronic component series is a definitive guide to the many various systems commonly in use.

THE CHARACTERISTICS AND value of a capacitor may be indicated on the body of the component in one of three ways:—

(a) The value, tolerance, working voltage and any other characteristic may be stamped or printed on the body of the component. This is usually used on physically large components such as paper capacitors, electrolytics etc. However, it is being increasingly used on smaller capacitors, particularly plastic film types. Figure 1 shows representative markings.

(b) A sequence of coloured bands or dots is painted on the component body. This is deciphered according to the standard colour code table for the value and tolerance. Additional bands may indicate other characteristics according to a specified table.

(c) The value and other characteristics may be indicated by a 'typographic' code; a sequence of numbers and letters stamped or printed on the component body. There is a variety of these codes. These will be elaborated upon shortly.

The particular marking code used depends largely on the style and type of capacitor, i.e: paper, mica, button mica, plastic film, ceramic, etc, and the code preferred by the manufacturer.

The temperature coefficient of a capacitor may be expressed directly in parts per million per centigrade degree (ppm/°C) or simply the significant figures preceeded by the letter N for a negative coefficient or P for a positive coefficient. Examples are given below:—

P100	=	+100 ppm/°C
P30 or P030	=	+30 ppm/°C
NP0	=	0 ppm/°C (negative/positive zero)
N30 or N030	=	−30 ppm/°C
N033	=	−30 ppm/°C
N075 or N080	=	−75 ppm/°C
N470	=	−470 ppm/°C
N2200	=	−2200 ppm/°C

Wound foil and metallized capacitors may have a black line marking one end of the component body, as illustrated in Figure 2. This indicates that the *outermost* foil is connected to the lead at that end of the body. This is useful in bypassing applications or where the 'hot' terminal may be sensitive to the surrounding environment. This lead is connected to the circuit common, or the 'low' portion of the circuit and shields the 'hot' electrode of the capacitor, reducing stray coupling to or from the external circuit.

Remember that the capacitors are non-polar so that the black line does not indicate polarity or the negative terminal.

Mica Capacitors: The most common method of marking moulded mica capacitors is by an arrangement of coloured dots. The widely used British and American systems are illustrated in Figs 3 and 4. The value and tolerance may be found by referring to Table I. The other characteristics may be obtained from Table 2.

Three, four, five and alternative six-dot codes have been employed from time to time. These are illustrated in Fig 5. The capacitor's value and other characteristics can be obtained from Table I. The alternative six-dot code is for high-tolerance, high stability capacitors.

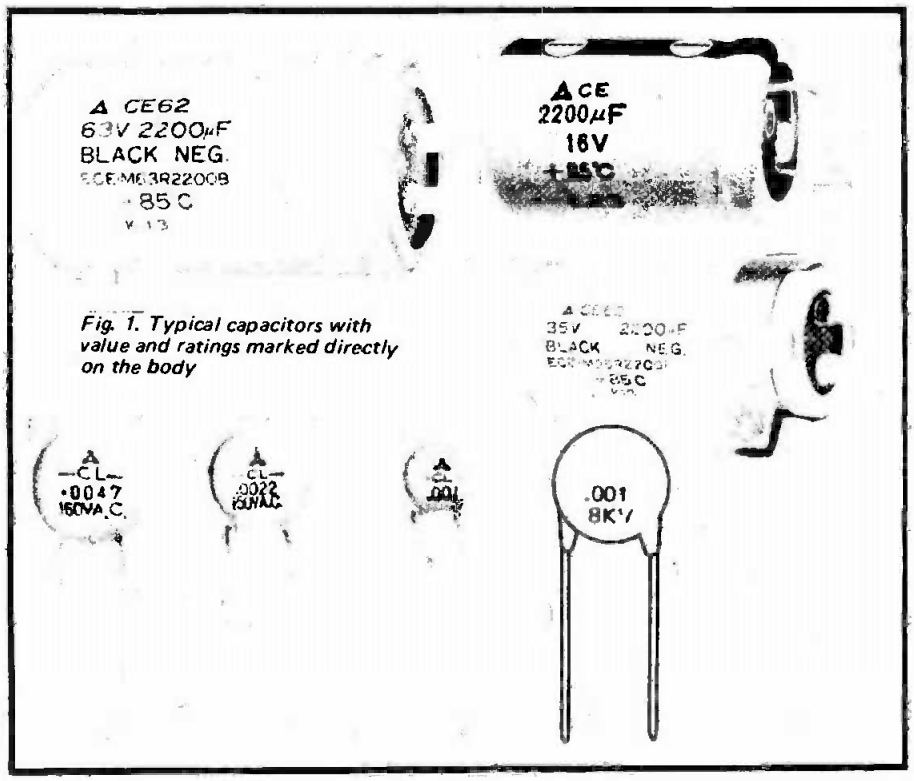


Fig. 1. Typical capacitors with value and ratings marked directly on the body

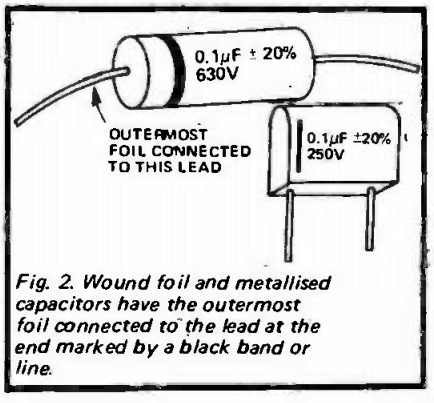


Fig. 2. Wound foil and metallised capacitors have the outermost foil connected to the lead at the end marked by a black band or line.

TABLE I
MICA CAPACITOR COLOUR CODE

Colour	1st & 2nd Digits	Multiplier	Tolerance	Voltage Rating	Characteristic	
					Temp. Coeff. (ppm/°C	Capacitance Drift
Black	0	1	±20%**		± 1000	±5% + 1 pF
Brown	1	10	± 1%		± 500	±3% + 1 pF
Red	2	10^2	± 2%	350	± 200	±0.5%
Orange	3	10^3			± 100	±0.3%
Yellow	4	10^4		750	– 20 to + 100	±0.1% + 0.1 pF
Green	5	–	± 5%		0 to + 70	±0.05% + 0.1 pF
Blue	6	–				
Violet	7	–				
Grey	8	–		2000	–50 to + 150	±0.3% + 0.2 pF
White	9	–	±10%		–50 to + 100	±0.2% + 0.2 pF
Gold	–	0.1				
Silver	–	0.01				

Note: Value indicated in pF. ** no-colour also used in lieu of black.

TABLE 2

Colour	Voltage Rating	Operating Temp. Range
Black		–55 to +70°C
Brown	100	
Red		–55 to +85°C
Orange	300	
Yellow		–55 to 125°C
Green	500	
Blue		–55 to +150°C
Violet		
Grey		
White		
Gold	1000	
Silver		

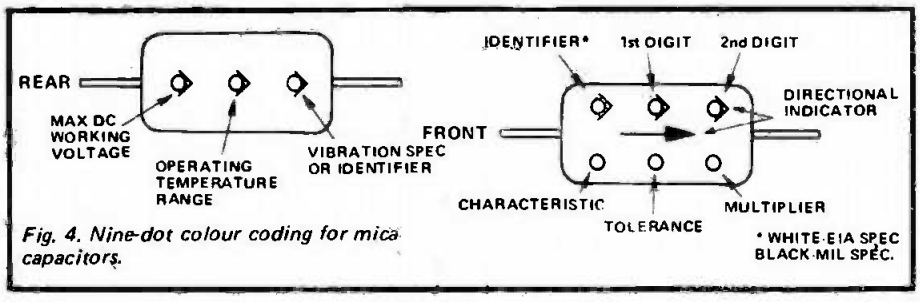


Fig. 4. Nine-dot colour coding for mica capacitors.

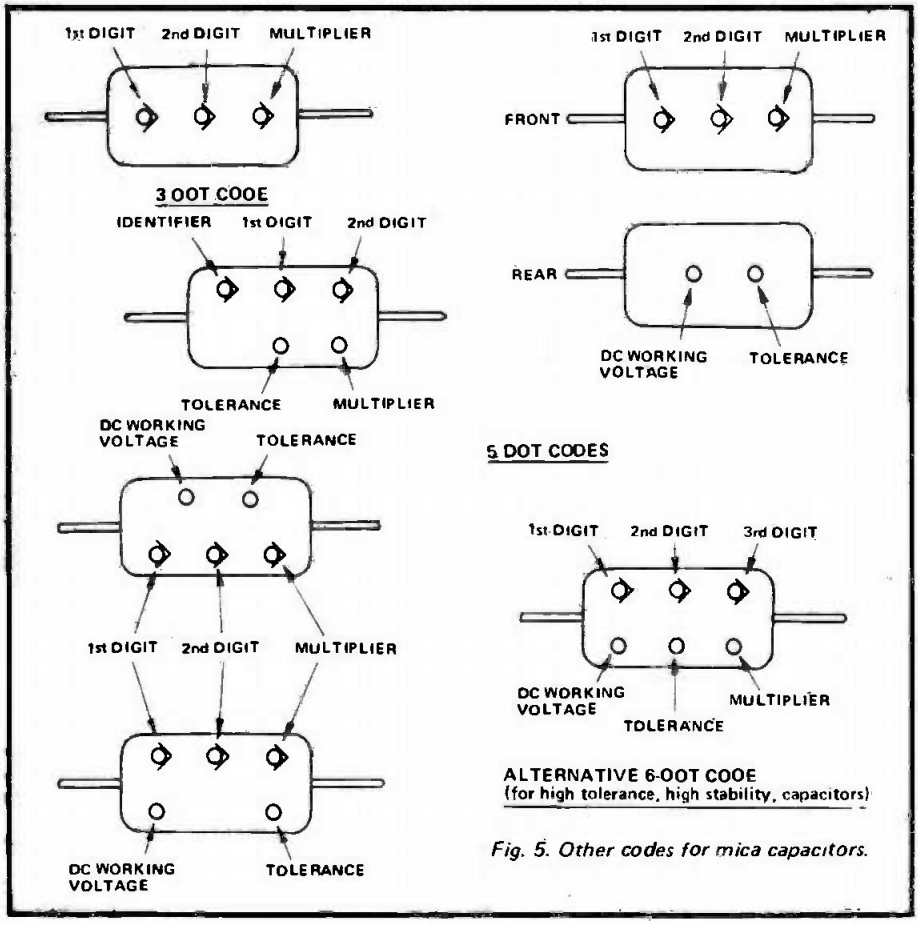


Fig. 5. Other codes for mica capacitors.

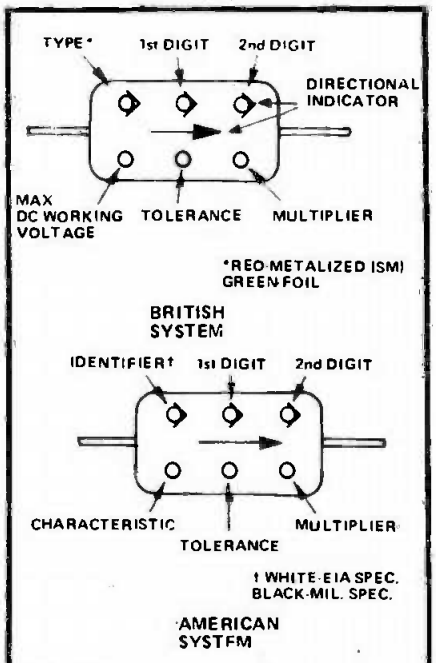


Fig. 3. Six-dot colour coding for mica capacitors.

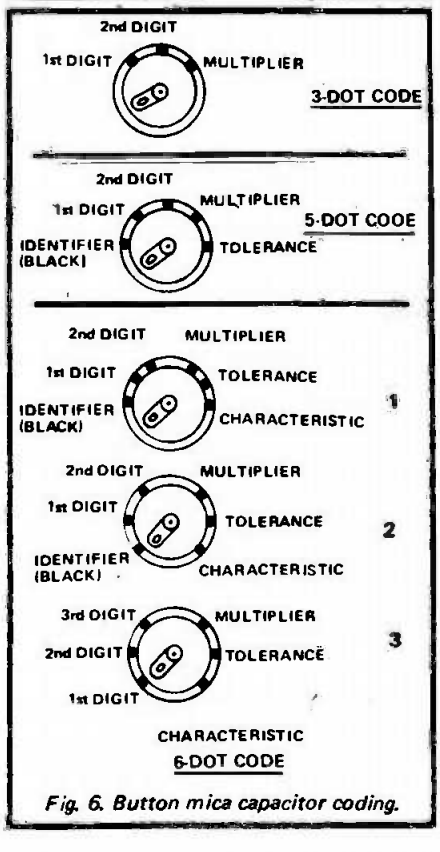


Fig. 6. Button mica capacitor coding.

Button Mica Capacitors: The characteristics of button mica capacitors are indicated by a system of three, five or six dots on the rim of the component. These are illustrated in Fig 6. The value and characteristics are obtained from Table I.

Note that there are three six-dot codes. Numbers 1 and 2 are for standard tolerance capacitors but number 3 in Fig 6 is for close tolerance, high stability types where the capacitance is specified to three significant figures.

Ceramic Capacitors: A variety of

FIXED CAPACITORS

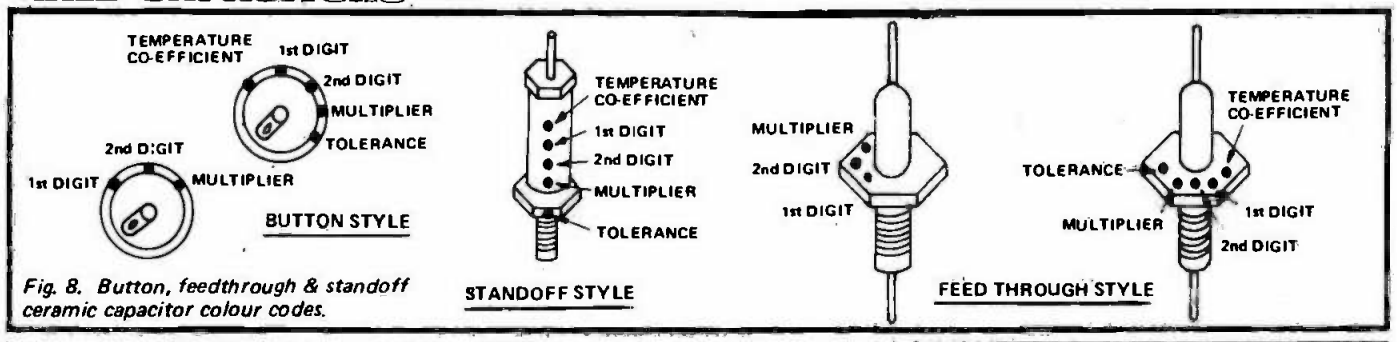
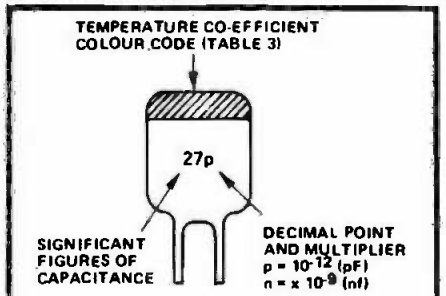
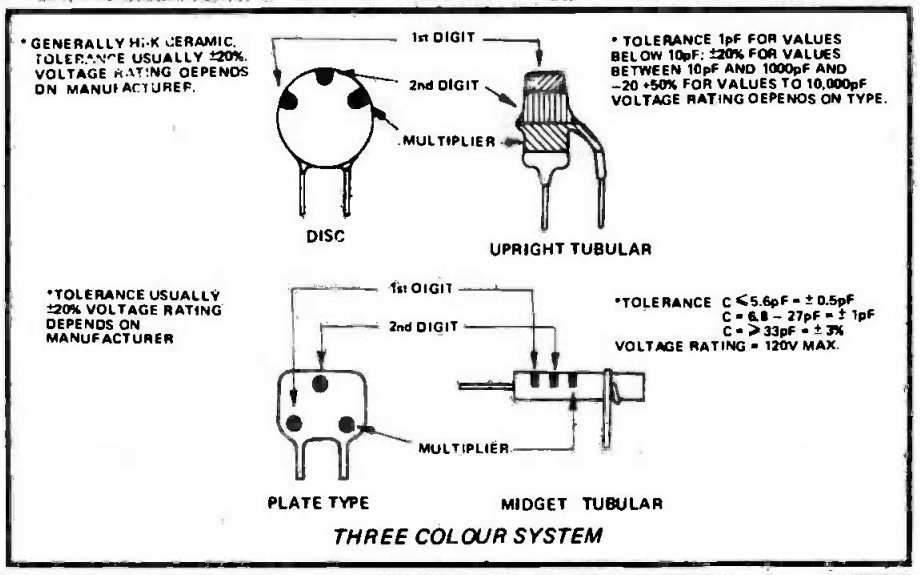


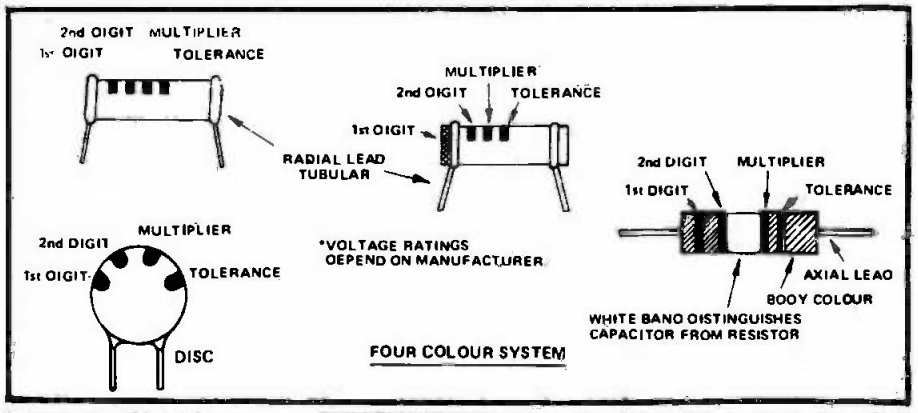
Fig. 8. Button, feedthrough & standoff ceramic capacitor colour codes.

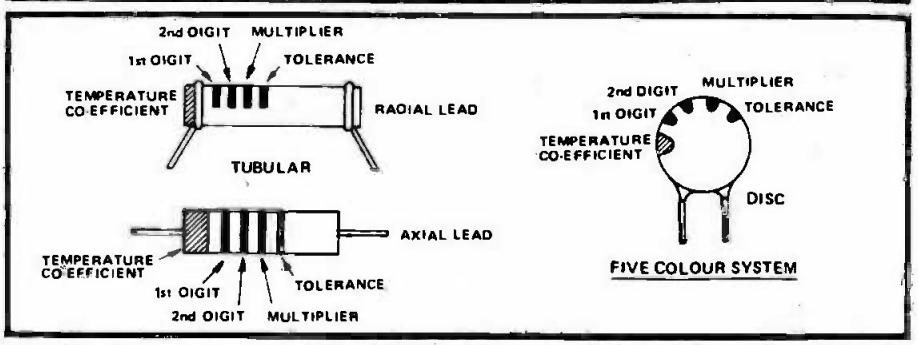


(pF)	marking	(pF)	marking
0.68	p68	15	15p
0.82	p82	18	18p
1.0	1p0	22	22p
1.2	1p2	27	27p
1.5	1p5	33	33p
1.8	1p8	39	33p
2.2	2p2	47	47p
2.7	2p7	56	56p
3.3	303	68	68p
3.9	3p9	82	82p
4.7	4p7	100	n10
5.6	5p6	120	n10
6.8	6p8	150	n15
8.2	8p2	180	n18
10	10p	220	n22
12	12p	270	n27

Fig. 9. Typographic code used on miniature plate ceramic capacitors.







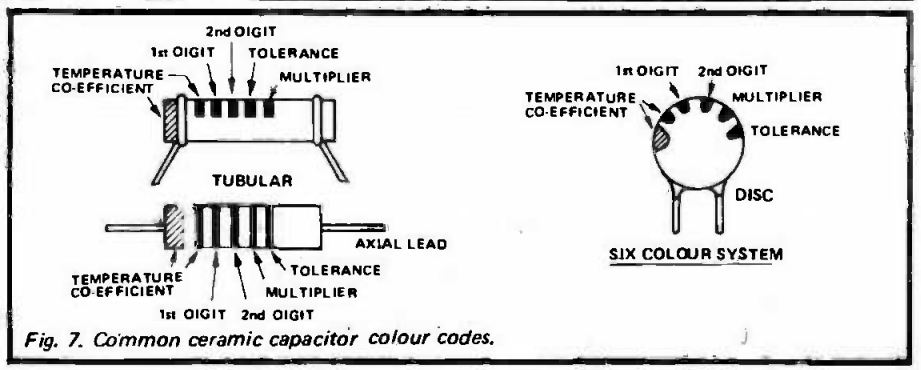


Fig. 7. Common ceramic capacitor colour codes.

typographic and colour codes is used for ceramic capacitors, largely depending on style of construction and the preference of the manufacturer. The codes used for various construction styles are illustrated and explained.

Colour code systems for the common styles of ceramic capacitor are illustrated in Fig 7. Note that in the five and six colour systems, the first band or dot is always larger than the others. For the axial lead style, this distinguishes them from resistors. In the six-colour system, the first two bands indicate the temperature coefficient. The value and other characteristics of these capacitors may be obtained from Table 3. Figure 8 illustrates colour codes for button, feedthrough and standoff style capacitors.

The typographic codes used on ceramic capacitors are illustrated in Figs 9, 10 and 11.

The code used on miniature plate ceramic capacitors, typical of the type manufactured by Philips, is illustrated in Fig 9. The value is indicated in *farads*, the letters p and n being used as a multiplier and to indicate the decimal point. If the multiplier is omitted, the value is indicated directly in pF. The temperature coefficient is indicated by a

TABLE 3

CERAMIC CAPACITOR COLOUR CODE

COLOUR	1st & 2nd digits	Multiplier	Tolerance C≤10pF (pF)	C≥10pF (%)	Temperature Coefficient	6-COLOUR SYSTEM TEMPERATURE COEFFICIENT Integrer	Multiplier
Black	0	1	±2pF	±20	NPO	±0	1
Brown	1	10	±0.1	±1	N030/N033	−3	10
Red	2	10^2	±0.25	±2	N075/N080	−8	10^2
Orange	3	10^3	±0.25	±2.5 (or 3)	N 150	−1.5	10^3
Yellow	4	10^4			N 220	−2.2	10^4
Green	5		±0.5	±5	N 330	−3.3	–
Blue	6				N 470	−4.7	–
Violet	7				N 750	−7.5	–
Grey	8	10^{-2} (0.01)	±0.25			+3	–
White	9	10^{-1} (0.1)	±1.0	±10	P 100	+1	–
Red and Violet	–	–	–	–	P 100	–	–

NOTE: Value indicated in pF

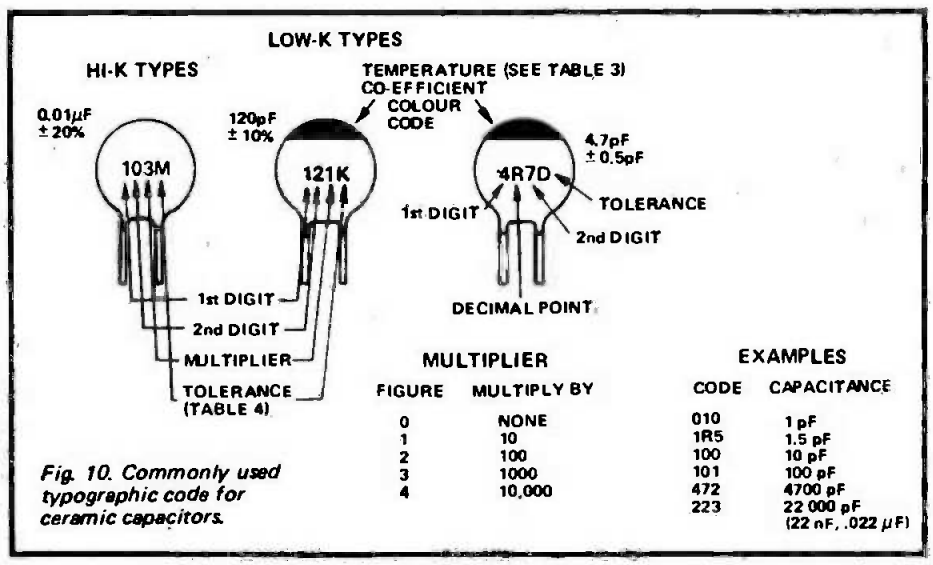


Fig. 10. Commonly used typographic code for ceramic capacitors.

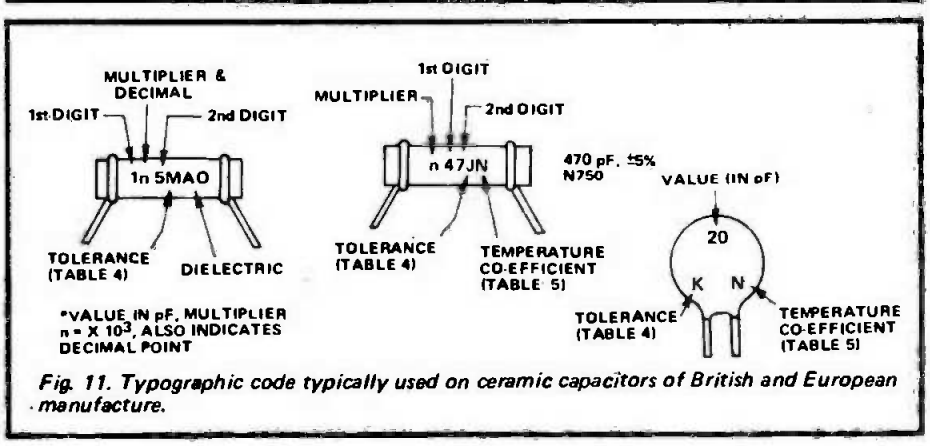


Fig. 11. Typographic code typically used on ceramic capacitors of British and European manufacture.

TABLE 4

Typographic Tolerance Code

Letter	Tolerance ≤10 pF	Tolerance ≥10 pF
B	±0.1 pF	
C	±0.25 pF	
D	±0.5 pF	
E	–	±25%
F	±1 pF	±1%
G	–	±2%
H	–	±2.5%
J	–	±5%
K	–	±10%
M	–	±20%
P	–	−0 + 100%
S	–	−20 + 50%
W	–	−0 + 200%
X	–	−20 + 40%
Z	–	−20 + 80%

TABLE 5

Typographic T.C. code

Letter	Temp. Coeff.
A	P100
C	NPO
D	N033/N030
E	N047/N050
F	N075/N080
G	N150
H	N220
J	N330
K	N470
N	N750
P	N1500
R	N2200
S	N3300
T	N4200
U	N4700
V	N5600

coloured band on top of the capacitor, the characteristic can be obtained from Table 3. Values below 100 pF (In) are generally Low-K, temperature compensating (TC) types. Hi-K types will not have the coloured band. Typical markings and corresponding values for low value capacitors are shown in the table on the right of Fig 9.

Another widely used code is illustrated in Fig 10. Generally, this involves a group of three numbers with a following letter. The first two numbers are the significant figures of capacitance, the third digit denoting the number of following zeros. The value is indicated in pF. For values below 10 pF which require a decimal point, the letter R is interposed between the two significant figures of capacitance. The value is followed by a single letter indicating the tolerance. The tolerance can be obtained from Table 4. If the tolerance code is not included, assume a tolerance of ±20%. Low-K types will have a colour-coded band on top similar to the miniature plate ceramics, and Table 3 will indicate the value.

A typographic system used commonly on capacitors of British and European manufacture, particular tubular, radial-lead types, is illustrated in Fig 11. Values below 100 pF are indicated directly in pF. Values between 100 pF and 1000 pF are indicated in pF using the multiplier n (= x10³). The position of the multiplier may indicate the decimal point. For example, a 470 pF capacitor will be marked n47 for the value, whereas a 1500 pF capacitor will be marked In5. Values above 10000 pF are generally marked in uF.

A system of two or three letters following the value are used to indicate the tolerance and temperature coefficient or dielectric characteristics of the capacitor in this system. The first letter indicates tolerance, the value

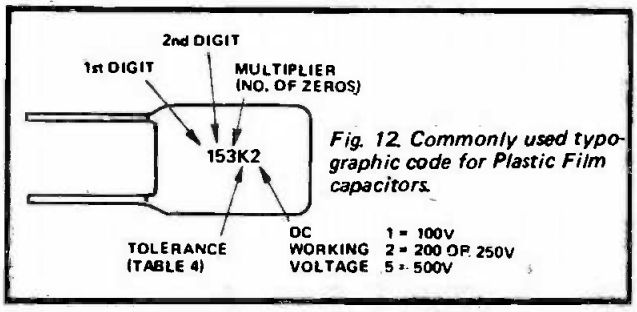


Fig. 12. Commonly used typographic code for Plastic Film capacitors.

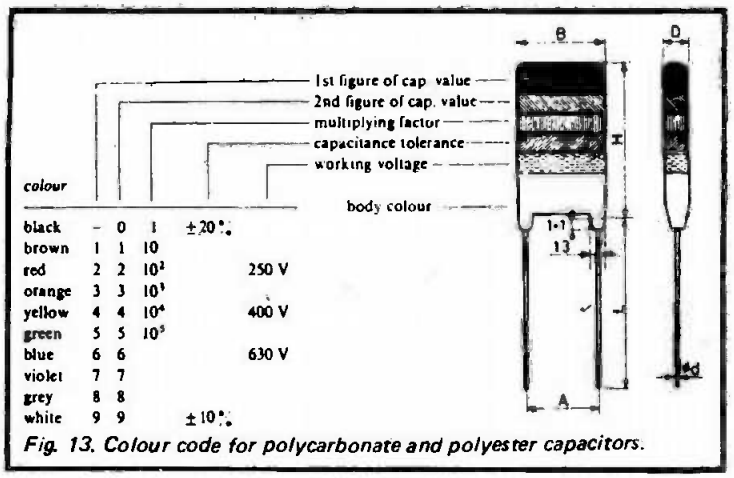


Fig. 13. Colour code for polycarbonate and polyester capacitors.

being obtainable from Table 4. A single letter following the tolerance code indicates that the capacitor is a Low-K TC type, the value of the temperature coefficient can be found from Table 5. If the tolerance code is followed by two letters, this indicates an H-K type and the manufacturer's data should be consulted if the dielectric characteristics are needed.

Some ceramic capacitors of Japanese manufacture may have a voltage rating code, consisting of a number and a letter, or two letters, also stamped on the component. It may precede the value and tolerance code or be placed separately. This code is given in Table 6.

A range of Hi-K disc ceramic capacitors are manufactured that have the value printed on the body and a red band painted at the end opposite the leads. They are commonly known as 'redcaps', the red band indicating a Hi-K capacitor with a 25 Vdc working rating. They should not be confused with a range of epoxy-encapsulated ceramic capacitors manufactured by Erie, which have a red coating all over and are also known as redcaps.

Plastic Film Capacitors: By and large, plastic film capacitors have their value, tolerance and voltage rating marked on them directly. Small, low-value polystyrene capacitors are marked thus:– 47/100. The first figure is the value in pF, the latter figure the dc working voltage. Thus, a capacitor marked that way would be 47 pF, 100 Vdc working. Polystyrene capacitors have the lead connected to the outer foil marked by a black band at the end of the body as illustrated in Fig 2.

Often, the tolerance rating is not marked on plastic film capacitors. Except for polystyrene and mylar capacitors, a tolerance of ±20% can be assumed.

Typographic codes used on plastic film capacitors are very similar to that used on Hi-K disc ceramics as illustrated in Fig 10. For example, a capacitor may be marked 102K, which indicates a 1000 pF, ±10% capacitor. In addition, a single digit following the tolerance code may be added. This indicates the voltage rating and represents volts x 100. For example, a capacitor marked 272K1 is a 2700 pF, ±10% 100 V capacitor.

The common typographic code used on plastic film capacitors is shown in Fig 12.

Polycarbonate and polyester capacitors are marked with coloured bands around their body indicating their value and characteristics – illustrated in Fig 13. The table gives the values of the bands. The capacitance is indicated in pF. The body colour is usually a light tan.

Paper Capacitors: Paper capacitors are large enough to have the value, tolerance and rating printed directly on them. The flat moulded style, largely superceded, now uses a code of four coloured dots, similar to that used on flat moulded mica capacitors. Figure 14(A) illustrates the code for flat moulded paper capacitors. Note that the body will be dark brown or black in contrast to the light tan bodies used on flat moulded mica capacitors. The capacitance and voltage rating may be obtained from Table 1.

Moulded tubular paper capacitors are sometimes marked with a colour code as illustrated in Fig 14(B). The capacitance and tolerance may be obtained from Table 1. The voltage rating is indicated by one or two coloured bands at the end opposite the value. Add two zeros to the significant figures. A single band indicates a rating under 1000 volts. A gold band indicates a rating of 1000 volts. The value is indicated in pF. Example:–

	1st band = brown	
	2nd band = red	
Value	3rd band = yellow	120000 pF
	4th band = black	±20%
	1st band = brown	
Voltage	2nd band = green	1500 volts

Electrolytic Capacitors: Most wet electrolytic capacitors have the capacitance, voltage rating and tolerance rating marked on them. Miniature, low voltage types use a kind of shorthand as follows:– 25/25 means 25 uF, 25 V working. The tolerance is not usually marked on them but it may be assumed to be at least –20%, +80%. The positive terminal will be marked with a + symbol or perhaps a red end cap or red dot. The negative terminal may be marked with a – symbol or a black stripe. One terminal may not be marked. In this case it is usually the negative terminal that is not marked. Most electrolytics have the can connected to the negative terminal. Some high voltage electrolytics have the can insulated and the electrodes brought out to separate terminals.

Tantalum Capacitors: These may have the value marked on them or the value

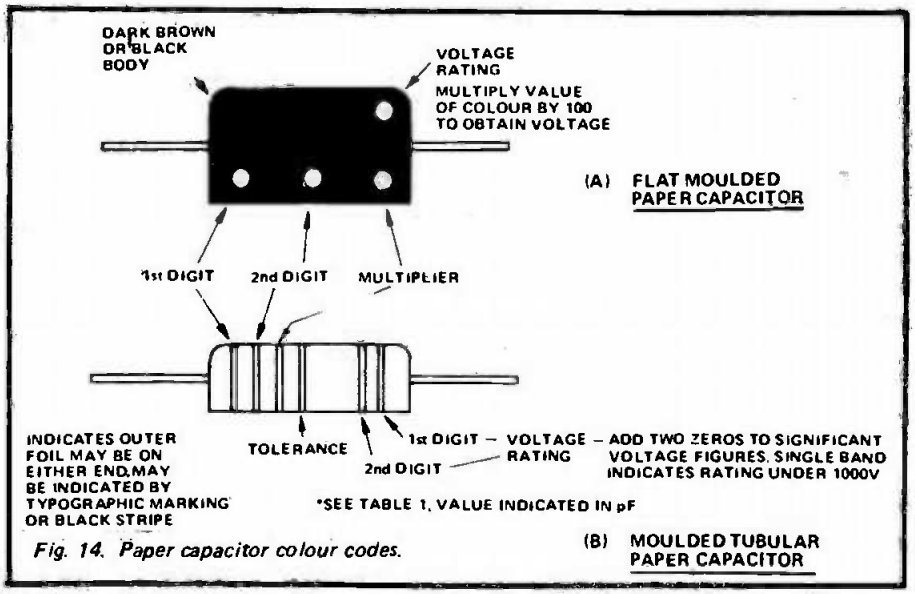


Fig. 14. Paper capacitor colour codes.

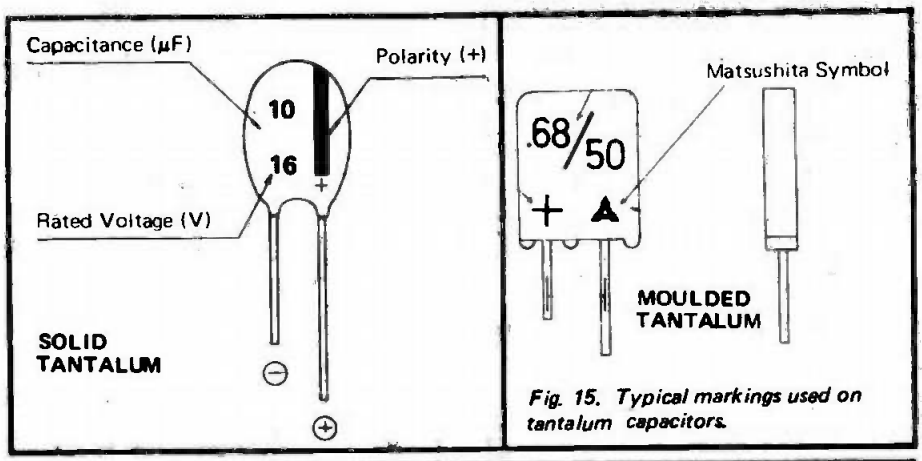


Fig. 15. Typical markings used on tantalum capacitors.

TABLE 7

COLOUR CODE FOR TANTALUM CAPACITORS

Colour	Voltage	Tens & Units	Multiplier
Brown	–	1	x 10
Red	–	2	x 100
Orange	35 V	3	–
Yellow	6.3 V	4	–
Green	16 V	5	–
Blue	20 V	6	–
Violet	–	7	–
Grey	25 V	8	x 0.01
White	3 V	9	x 0.1
Black	10 V	0	x 1
Pink	35 V	–	–

TABLE 6

Voltage rating code for Japanese ceramic capacitors

Code	Rating	
1E	25	Vdc
1H	50	"
2H	500	"
3A	1 kV	"
3D	2 kV	"
3F	3 kV	"
3G	4 kV	"
3H	5 kV	"
3J	6 kV	"
3M	7 kV	"
3K	8 kV	"
4A	10 kV	"
4B	12 kV	"
4C	15 kV	"
AL	1500	Vac
CL		
DS	2500	Vac

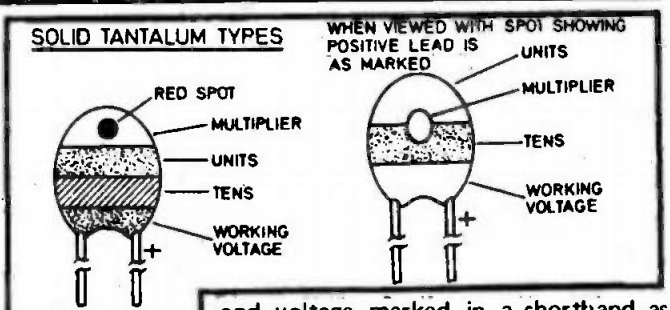


Fig. 16. Common colour code for tantalum capacitors.

and voltage marked in a shorthand as explained previously. The positive terminal is usually marked with a black stripe and/or a + symbol. The negative terminal is usually not marked. Markings on a solid tantalum and a moulded tantalum are shown in Fig 15. The solid tantalum type has the positive lead longer than the negative lead – the opposite with moulded tantalum.

TABLE 8

Working Voltage	Surge Voltage
3.15 volts	4 volts
6.3	8
10	13
16	20
20	25
25	32
35	44
50	63

Solid tantalum ('Tag') capacitors are also marked with a colour code. There are two systems in use, illustrated in Fig. 16. Table 7 gives the values and ratings for the colours.

Tantalum capacitors can withstand a surge voltage about 20-30% greater than their rated working voltage. Table 8 below lists the maximum surge voltage of a capacitor having the rated working voltage shown.

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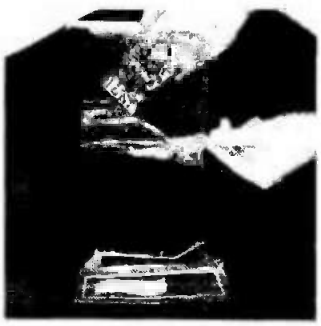

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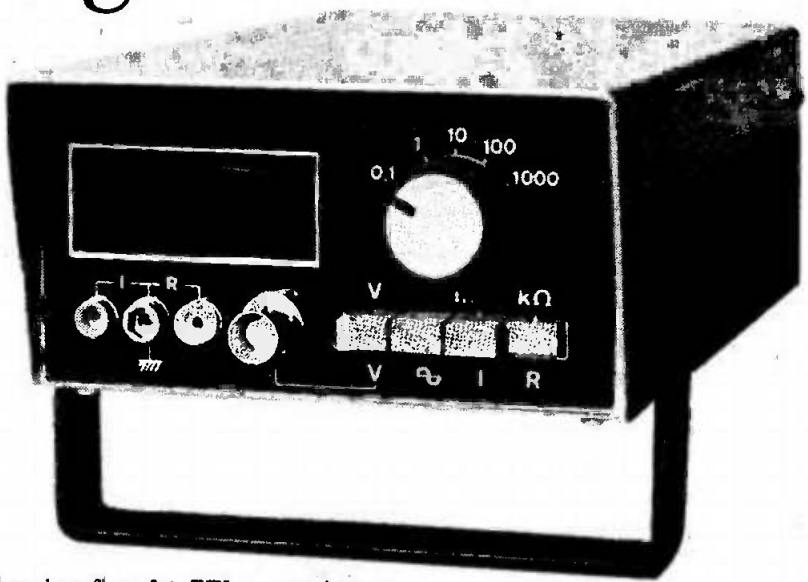

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Two matters which must be considered are (1) the alarm output from the CK 3000 clock chip is a pulsed audio tone, and (2), more importantly, the Pulsar uses a transformerless circuit, (Fig. 1) so that any switching output must be totally isolated from the clock circuitry.

As space inside the Pulsar case is limited, a further transformerless circuit has been designed, which offers two operating modes, (a) buzzer alarm, and (b) turn-on with buzzer silenced.

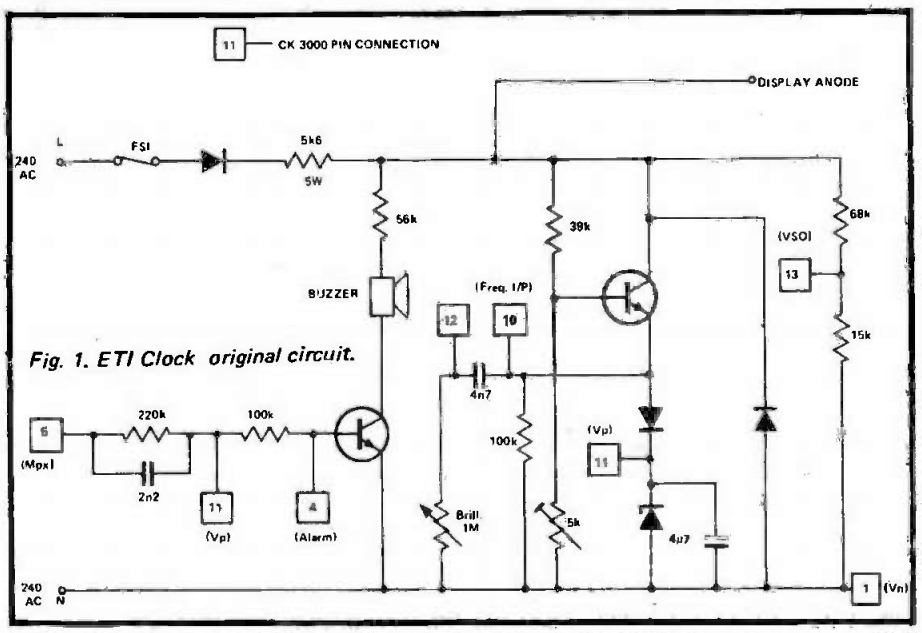


Fig. 1. ETI Clock original circuit.

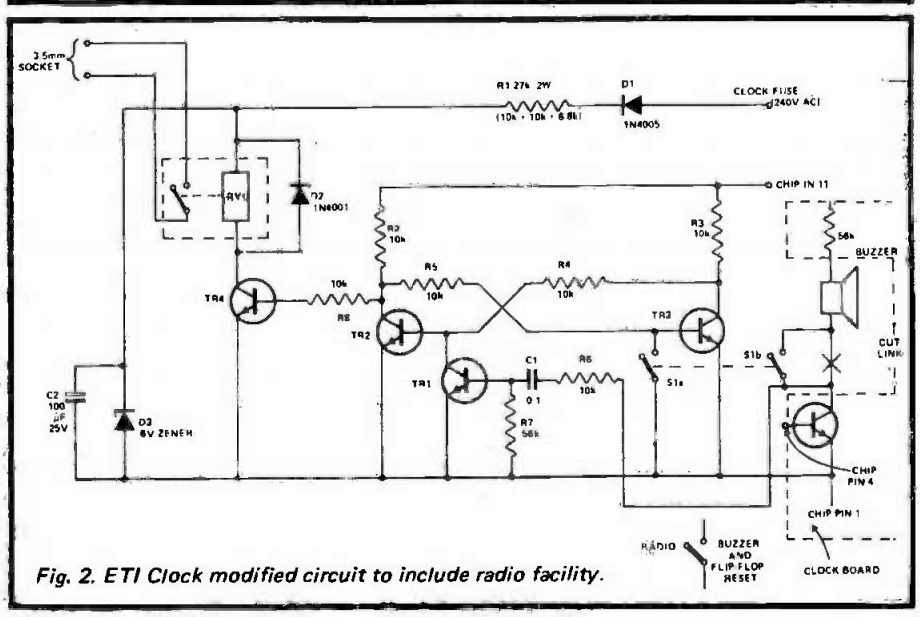


Fig. 2. ETI Clock modified circuit to include radio facility.

RADIO ALARM CIRCUIT

This consists of three sections, (1) a reed relay and its driver TR4, (2) a flip-flop (bistable) TR2 and TR3, and (3) a trigger transistor TR1. When TR2 is 'off', the high voltage at its collector turns TR4 'on', thus energising the reed relay. In the pre-alarm period, TR2 is 'on' whilst TR3 is 'off'. This state is set by temporarily closing S1a, which grounds TR3 base, turning TR3 off. The bistable is changed over by an AC signal from the buzzer switching transistor collector turning TR1 on momentarily, which grounds TR2's base. The blocking capacitor C1 ensures that the DC conditions of the clock chip are not disturbed.

Switch S1b is used to connect the buzzer to its driver transistor (the wire connecting the buzzer to the clock board must be cut to insert the switch). When S1 is in the 'radio' position, the buzzer is disconnected, and the flip-flop is free to toggle when the alarm output from the clock chip is energised. When S1 is in the 'alarm' position, the flip-flop is anchored in one state, and the buzzer can then operate.

Sufficient power is available from the clock chip power supply (pin 11) to operate the bistable, but not enough to energise the relay. If the relay is driven directly from the clock power supply, the ensuring voltage drop turns the clock off!

CONSTRUCTION

A separate transformerless supply D1, R1 stabilised at 6V with D2, C2 is used for the relay. To reduce the heat dissipation, the dropper resistance R1 was selected to pass 5mA, which is sufficient to hold the relay on. Power to energise the relay is obtained from the storage capacitor C2.

The circuit was fabricated on a piece of 0.1" pitch Veroboard 3" x 1½".

"We have previously sold this Digital Clock under the name Pulsar. At the time that this name was chosen by us we were unaware that the name Pulsar had been previously registered, but it has been drawn to our attention that this is the case. We have been asked to point out that our Digital Clock is not associated with Pulsar Watches, Time Computer Inc. or Pulsar S.A."

George Hanslip shows how to interface

CMOS...

THE ADVANTAGES OF CMOS, namely low power consumption, high noise immunity, tolerance of wide power supply voltage variations, and the relatively higher level of integration, i.e. circuit functions per package, make it the obvious choice of logic to use in not only battery powered designs but also mains operated equipment. This is particularly so if power for the circuit is to be derived from the a.c. mains by means of a mains dropper resistor — a much cheaper solution than a mains transformer. With CMOS the total current consumption of the logic will probably be below 5mA as opposed to about 100mA for a comparable TTL design and, therefore, a low power mains dropper resistor will suffice.

Problems will, however, arise when the logic circuit has to interface with a high power a.c. load such as a mains lamp or motor. Here, two solutions are possible: a relay or a triac. The first device, a relay, uses a lot of power and currents of the order of tens of mA are required to keep the relay energised, which defeats the original object and prevents the use of a power mains dropper resistor.

TRIAC TRIGGERING

To investigate the possibilities of using CMOS to drive triacs it would be helpful to state the triggering requirements of these devices. Triacs may be triggered into conduction on both positive and negative mains half cycles, with either polarity of gate current. They are, however, more sensitive (i.e. require less gate current) to negative gate current. Triac triggering requirements are, in fact, normally specified for gate current polarities which are in phase with the main terminal voltage, i.e. main terminal voltage positive with positive gate current and main terminal voltage negative with negative gate current. These and the gate sensitivity for the case of main terminal voltage positive with a negative gate current are equal. Triacs are generally much less sensitive to positive gate current on negative mains half cycles (i.e. main terminal voltage negative) and need to be selected for applications which require this mode of triggering. The gate current may be d.c. or a pulse since the triac will remain on once it has been triggered, until the end of the mains half cycle.

The current required to trigger a triac will depend on the type of device used as well as the temperature. Higher power devices of 25A or greater rating may require up to 100mA to trigger while low power devices, 4A and less, may need only 10mA or less. Manufacturers generally state the maximum current required to trigger. Thus a triac type TAG250-400, for example, has a maximum gate current of 50mA and this is guaranteed to trigger all devices of this type. There will, of course, be many TAG250 devices which require a good deal less but unless the constructor has many such devices and can choose those with lower gate current, for good reliability he should aim to provide a current of 50mA.

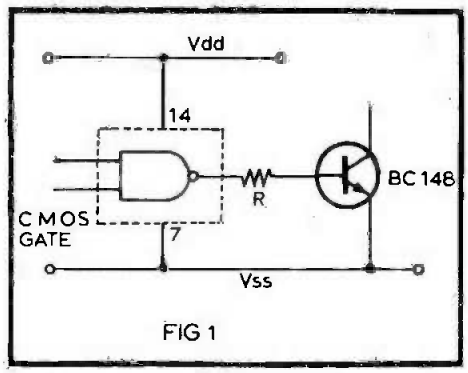


FIG 1

The maximum current which can be supplied by CMOS devices is 10mA. Exceeding this limit will probably destroy the device. With a 5V supply, the output of a CMOS gate may drive a transistor base directly as the device will limit its output current to below 10mA, but above about 8V a current limiting resistor R will be required (see Figure 1).

If the output of the gate is required to maintain a recognisable logic state when supplying output current, to drive another gate for example, then the current must be limited to below 1mA. Figure 2 shows a circuit for a bistable a.c. switch.

If input "a" is momentarily connected to logic 0 (negative supply rail) the transistor will turn on

Before gate current can flow, a certain voltage, the gate trigger voltage must be exceeded. This for the TAG250-400 is 2.5V maximum. Thus for a worst case device, the trigger circuit must provide a voltage of at least 2.5V plus the voltage required to drive 50mA through any reistance in series with the gate.

CMOS GATES AS DRIVERS

Unfortunately, CMOS gates, such as the 4001 or 4011, cannot provide anything like 50mA output current.

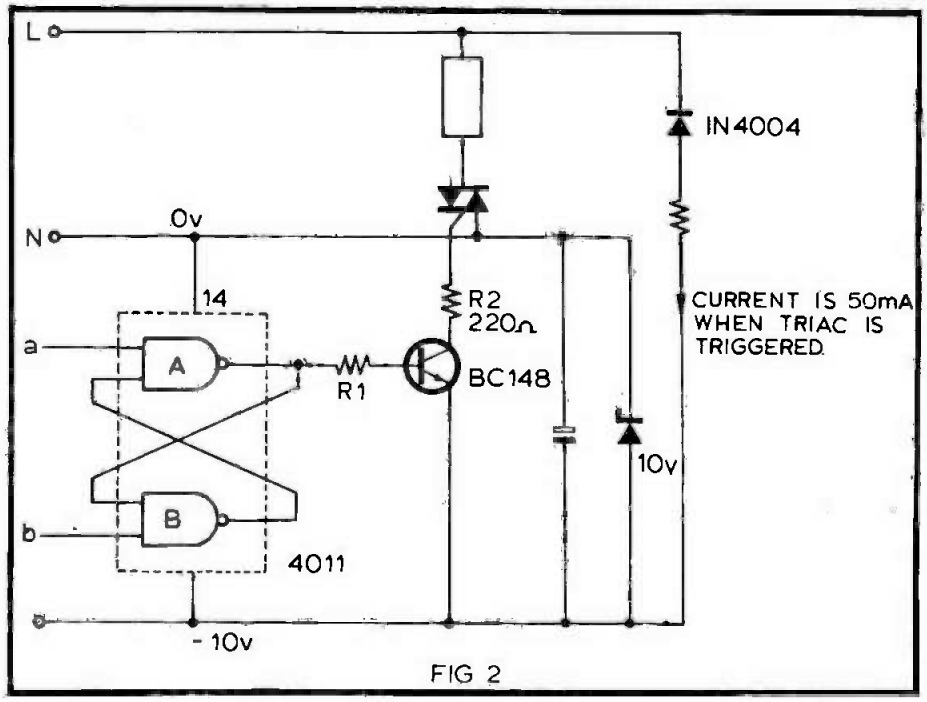


FIG 2

and trigger the triac, which will remain on until input "b" is connected to logic 0. Note that a negative supply is used to provide negative gate current for the triac. R2 is chosen to give the required 50mA gate current and R1 to give the required base current. Since gate A must drive both the transistor and present a defined logic level to gate B, the output current of gate A must be less than 1 mA giving R1 a minimum value of 10Kohm with a 10V supply. If the gain of the transistor is greater than 50, R1 may be increased in value, thus reducing further the current taken from the output of gate A.

This type of circuit, however, still draws a large current from the supply when the transistor and hence the triac is on. This current, about 50mA must, of course, come through the mains dropper and defeats the object of low current consumption. We get round this by

PULSE TRIGGERING THE TRIAC

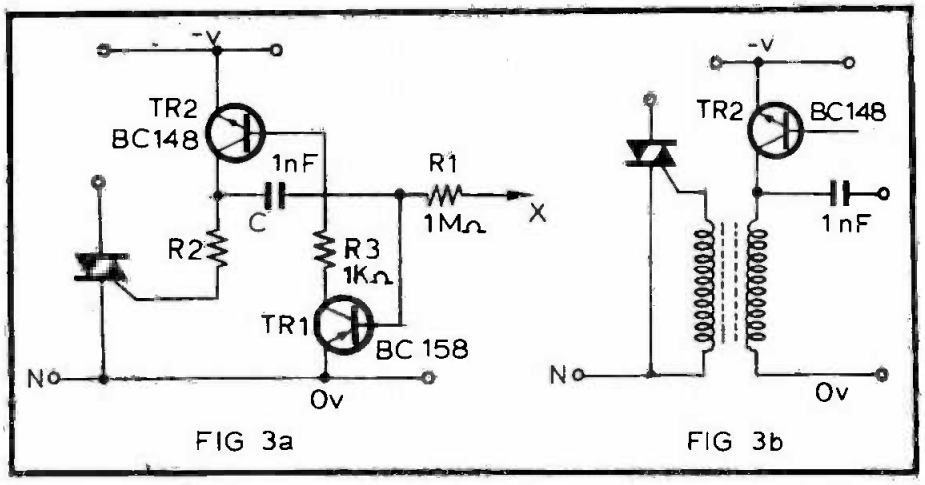
Use can be made of the fact that the triac will latch once it has been

..TO MAINS

triggered. Thus the trigger current of 50mA pulses of short duration, the duty cycle of which may be such that the average current is only a few mA. The supply smoothing capacitor thus supplies the 50mA peak current while the mains dropper replaces the charge over a longer period and, therefore, needs to carry a current of only a few mA.

This is the principle behind the circuit shown in Figure 3. Transistors TR1 and TR2 form a circuit which oscillates at a frequency determined by C and R1 when point X is connected to the negative supply line. This can be done by a CMOS gate. The loading on the gate is minimal; about 10μA, but the circuit can supply 50mA pulses to the triac gate while keeping the total current consumption below 5mA.

The circuit has been used on a range of supplies from 3 to 15V with success, although, of course, less trigger current will be available with the lower supply voltages. It is, therefore advisable to use a supply voltage of at least 5V. The frequency of oscillation is also slightly dependent on the supply voltage but this is of little consequence.



When the circuit is not oscillating it draws very little current, and so stand-by power will be minimal.

In a circuit like this it is desirable that the frequency of the oscillator be at least 5KHz. This ensures that the triac is triggered as early as possible in each half cycle, minimising radio interference.

If isolation of the trigger circuit from the mains is required, then resistor R2 may be replaced by a transformer. This may be wound on a 3/8" diameter x 1 1/4" ferrite rod and consists of 10 turns of 28 swg wire for the primary and 10 turns for the secondary, insulated by a layer of PVC insulating tape.

Table 1 lists the supply current (Is) the gate current (Ig) and the frequency oscillation (F) for the circuit of Figure 3 supply as measured on a prototype when the supply voltage was varied between —3V and —15V, and no voltage applied to the triac. The two cases are R2=100 ohms and 47 ohms.

The circuit together with the CMOS gates thus forms a useful a.c. power switch as shown in Figure 4. When the ON button is pushed, the triac is turned on a supplies power to the load. Since the circuit latches, the triac will remain on until the OFF button is pushed.

The negative d.c. supply for the circuit is derived from the a.c. mains supply via diode D1 and resistor R4. The zener and capacitor stabilise and smooth the supply. The zener and capacitor stabilise and smooth the supply. The zener may have a breakdown voltage of anywhere between 5V and 15V. Since the current drawn by the circuit is only 1.5mA, R4 need only be a 1/4 watt component.

If resistor R2 is replaced by a pulse transformer, then the current drawn by the circuit rises to about 2.5mA and resistor R4 may need to be reduced to 74Kohm.

APPLICATIONS OF THE CIRCUIT

The circuit of Figure 3 forms a low power trigger circuit for triacs and is, therefore, ideal for interfacing between these devices and CMOS digital integrated circuits. The cost of the extra transistor compared to that of Figure 2 is far outweighed by the reduced cost of the mains dropper. The difficulty of synchronising the circuit with the mains makes its use in phase control circuits (such as lamp dimmers) unattractive compared to programmable unijunction transistor (P.U.T.) trigger circuits, but in ON-OFF type switching applications it is superior.

By removing the push buttons and the 100Kohm resistors from the circuit of Figure 4, the load current may be switched on by a negative pulse to the input of gate A and off by a negative going pulse to the input of gate B. By suitably decoding the outputs of a digital clock and

TABLE 1

	Vs Volts	Is MA	Ig MA	Frequency KHz
R2=100Ω	3	0.15	20	5
	6	0.32	50	5
	9	0.45	70	5
	12	0.6	100	5.2
	15	0.85	120	6.25
R2=47Ω	3	0.25	35	5.3
	6	0.45	80	5.3
	9	0.6	140	5.3
	12	0.75	180	5.3
	15	1.0	200	6.0

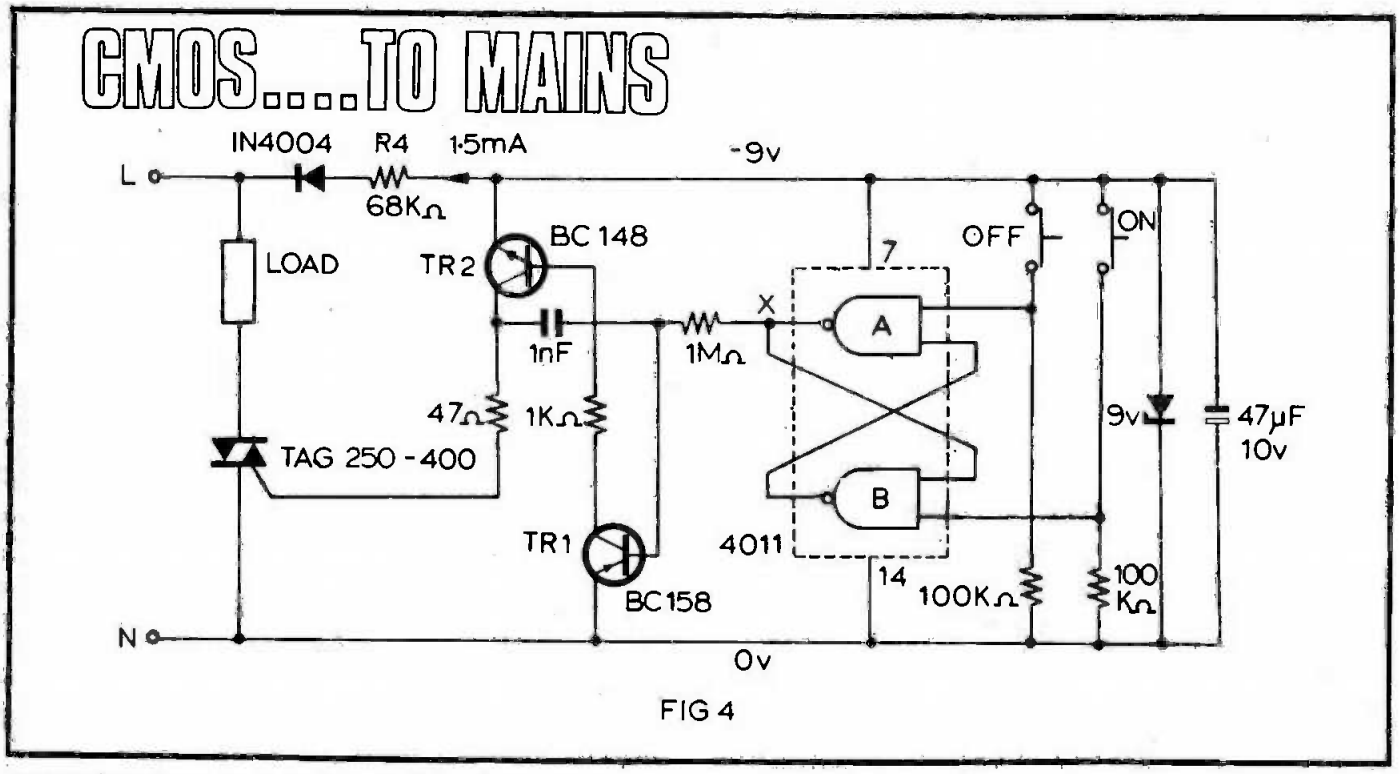


FIG 4

connecting these to gate A and B, the circuit could be used to switch mains and driven equipment such as lamps, tape recorders or central heating systems on and off at certain times. Power for the circuit could be obtained from the clock power supply line, as this would almost certainly be able to supply the small extra current required. The use of a pulse transformer (as shown in Figure 3b) would isolate the clock and decoding circuitry from mains.

Referring to figure 3, by making TR1 a BC148 (NPN) and TR2 a BC158 (PNP) and connecting the positive supply to the emitter of TR2 and negative to TR1 emitter, the circuit would produce positive going trigger pulses when X is connected to the positive line. The pulses applied to the triac gate could be made negative by correct phasing of the transformer windings. In this way the circuit may be used with a positive or a negative supply depending on which is available.

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100W STEREO DISCO PART ONE

A COMPREHENSIVE UNIT WITH BUILT IN LIGHT SHOW

ETI 458

THE DISCO UNIT to be described here reaches professional standards at a very moderate price, only about £130 for the electronics, plus whatever decks, cartridges, etc, you should choose to add. It is designed for the home constructor, and gives many of the features found on professional equipment.

DESIGN CONSIDERATIONS

It was decided to work as closely as possible to the following basic design parameters: the disco must be robust and simple to operate giving the deejay as much freedom as possible, whilst at the same time retaining full control. It should reach generally accepted high fidelity standards and be capable of stereophonic reproduction, to take advantage of the excellence and range of modern recording techniques.

The unit should be capable of producing continuous high sound levels to the loudspeakers, without distress to the power amplifiers. 100W per channel should be more than sufficient in any hall in which a portable disco is likely to be used, and thus meets this condition.

Designs of good quality 100W power amplifiers are infrequently found, but rather than start from scratch it was decided to use a tried and tested design. Our own design (originally published in February 1973) was employed, but the recommended power supply was modified slightly so that the amplifiers could deliver 100W continuous rms power with both channels driven simultaneously.

ETI 458 DISCO: PROTOTYPE SPECIFICATION

Output power:	**4Ω load both channels driven**	**100W RMS**
Frequency response:	**+0.25dB—1dB**	**30Hz to 20kHz**
	+0.25dB—3dB	**15Hz to 37kHz**
Total harmonic distortion at 100W:		**<0.2% at 1kHz**
Stereo separation:		**50dB**
Damping factor:		**80**
Sensitivity: (ref: 100W into 4Ω)		
	Ceramic PU	**:88mV (>2MΩ)**
	Tape	**100mV (50K)**
	Aux	**100mV (50K)**
	Mic	**75mV (50K)**
Pickup overload threshold: 1.3V		
Outputs:		**Tape: 1.7v into 10K**
		Pre-amp: 1V
Tone controls:		**Bass ±19dB at 65Hz**
		Treble ±20dB at 10kHz

A complete kit of parts for this project is available from Maplin Electronic Supplies (see their ad. on the back cover).

VOICE-OVER

In order to allow the deejay his freedom it was considered that an automatic voice operated fader was essential. The deejay does not have to be continually adjusting the microphone level, and provided that a uni-directional microphone is used he will only have to set up the microphone level at the beginning of the evening. The mic will only pick up sounds made within a few inches of it, and when the deejay speaks the volume of music from any other source will be automatically reduced to an adjustable preset level. As soon as the announcement is completed the music level is automatically restored to its previous level.

The microphone should be a uni-directional (cardioid) type in order to minimise acoustic feedback, it should be hard-wearing, resistant to damage and distortion when shouted at, whilst capable of faithfully reproducing soft sounds. After careful consideration it was decided that the microphone which best met these conditions (at a reasonable price) was the electret microphone. The input on the disco was specifically designed with this type of microphone in mind therefore.

DECISIONS DECISIONS

A decision had to be made over whether to design the disc inputs for magnetic or ceramic cartridges. After considering the advantages and limitations of both types it was

decided to design for ceramic cartridges since for the purposes of a disco they have several advantages over their rivals and their limitations can be largely overcome by careful design of the preamplifier.

Heavy stamping on the floor near the disco could cause light tracking cartridges to join in the fun and dance across the disc whilst the heavier tracking type will remain (hopefully) in the groove. The ceramic cartridge is more robust and replacement styli for them are considerably cheaper than magnetic, with the result that they are more likely to be regularly changed leading to less significant record wear despite the heavier tracking weight.

Many ceramic cartridge inputs on amplifiers do not provide the correct loading, resulting in woolly-sounding bass and coarse hissy treble. After experimenting with various types of equalisation an input using a field effect transistor was eventually adopted. The FET gives an input impedance in excess of 2MΩ and the difference this pre-amp made was spectacular. Listening tests, comparing the sound with that of magnetic cartridges and pre-amps showed that the ceramic cartridge coupled with its FET input sounded at least as good to the designer as many medium priced magnetic pickups and better than a lot of cheap ones. The bass is firm and tight and the treble clean and extended.

PARTS LIST FOR POWER SUPPLY

R_1	150R
R_2	150R
R_3	22K
All "STD RES" ½W carbon film	
C_1, C_2, C_3	1,000μF @25V axial electrolytic
C_4, C_5	150μF @25V axial electrolytic
C_6, C_7	10,000μF @100V can type elect
VR_1	Horizontal subminiature preset 22K
D_1, D_2, D_5, D_6	IN400 2
D_3, D_4	3A 50 PIV rectifier
BR_1	Bridge 10A 200 PIV
ZD_1, ZD_2	BZX61.C.15V
T_1	32-0-32 volts at 6½ amps plus 12-0-12 volts 1½ amps
FS_1	Fuse 20 mm 3A
$FS_{2,3,4,5}$	Fuse 20 mm 3A with 20 mm chassis holder
LP1	Square neon
SW1	DPDT rocker switch
PCB	Disco power supply p.c.b.
	Mains Skt SA1862
	Mains plug SA2190
	(5A 3 pin mains connectors)

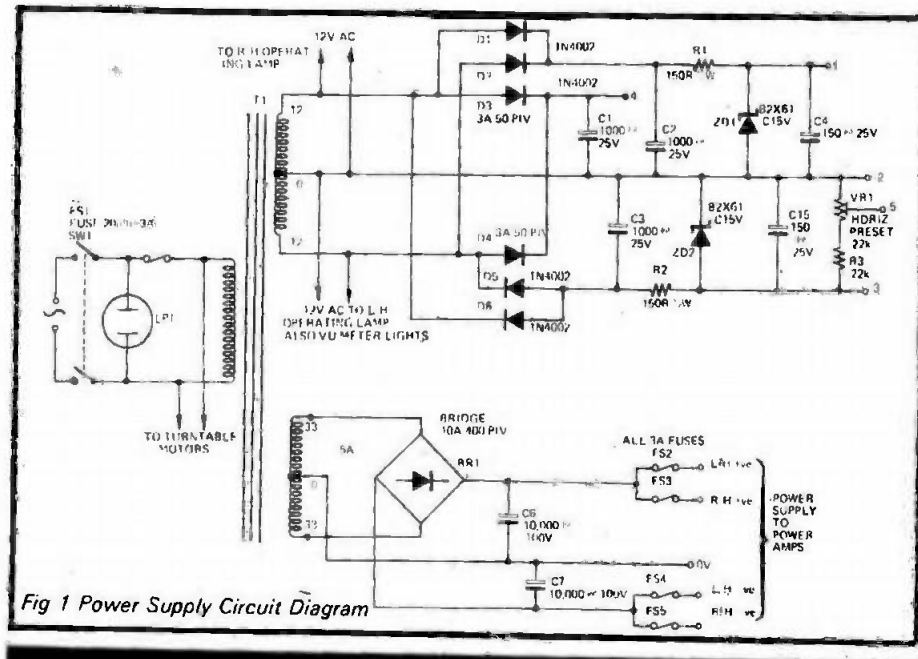
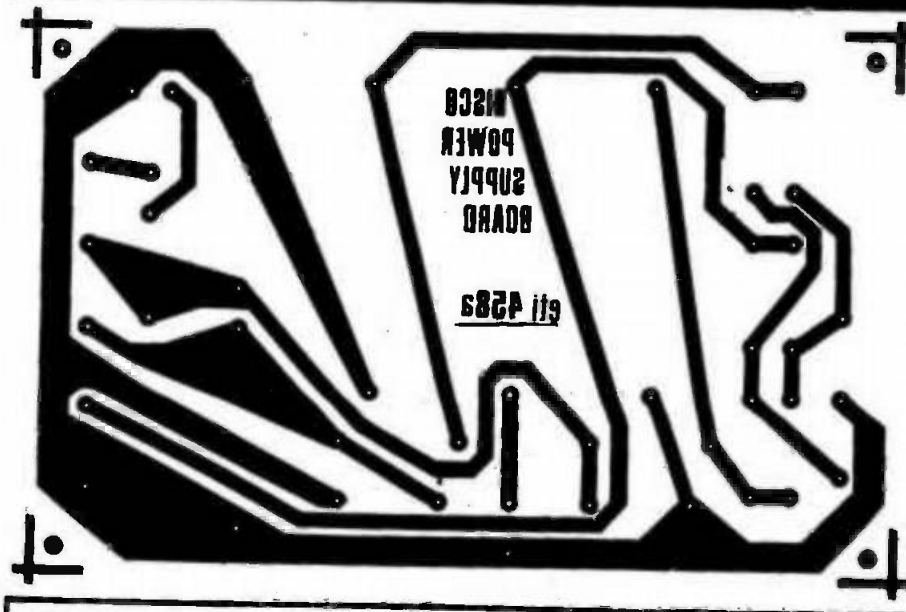


Fig 1 Power Supply Circuit Diagram

How it works

The power supply for the power amps is a simple, unstabilised, circuit which provides all that is required – a more sophisticated circuit would make no appreciable difference to the overall result due to the symmetrical nature of the power amp output stages.

The lower voltage supply is rectified by the bridge formed by D1, 2, 5 and 6 and stabilised by ZD1 and 2 to give the +15V and −15V supplies required by the pre-amps, monitor circuits and fader. A special negative supply for the FET's in the fader is derived from VR1 and R3. The power to the headphone amp is derived from a separate pair of rectifiers D3 and 4 in order to isolate the effect of its widely varying current requirements from the circuits requiring a stabilised supply.



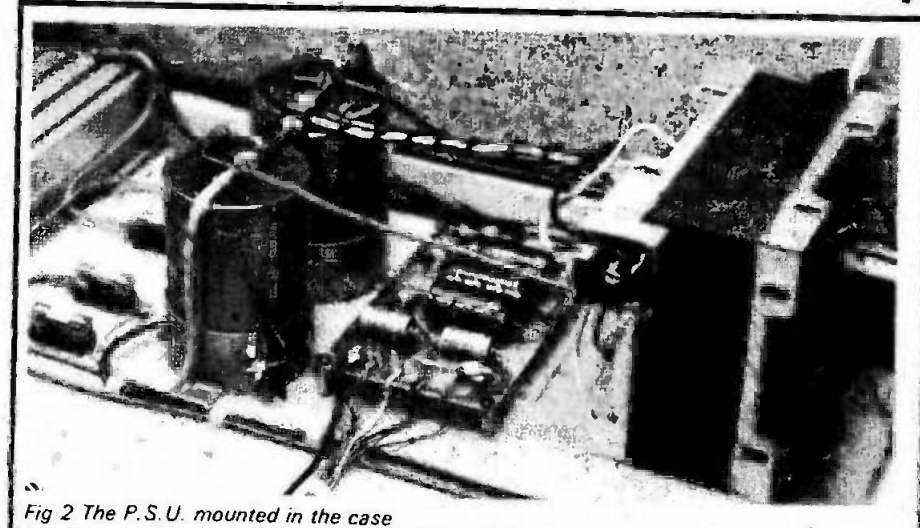


Fig 2 The P.S.U. mounted in the case

100W STEREO DISCO

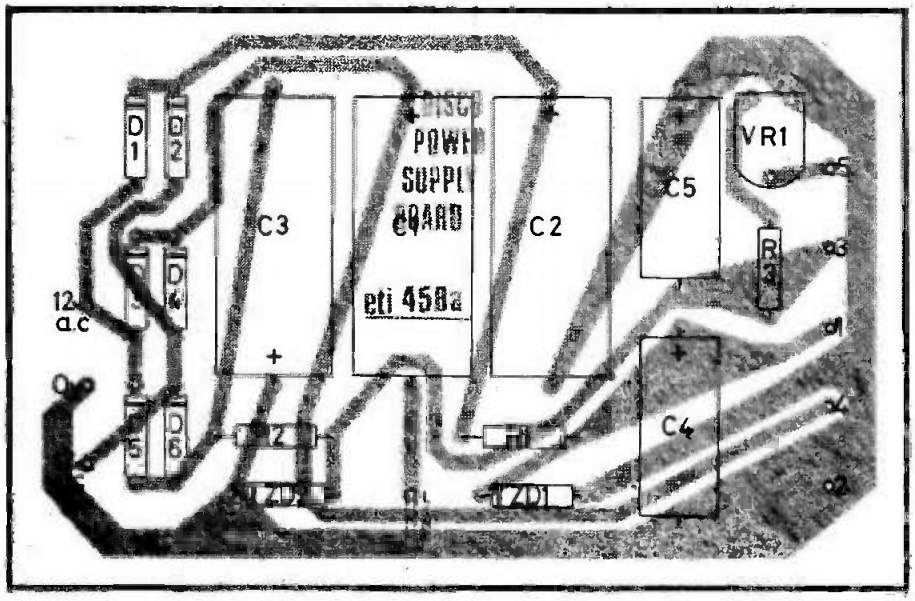


Fig 3 Component Overlay for power supply

CUE FOR A SONG

In order to give a really professional show, the deejay must have available ways of cueing the records accurately. The monitor facilities on this disco are quite extensive, providing a headphone output which may be switched between either turntable and peak reading VU meters which can monitor the signal on the input level controls of either deck or the signal level present at the input to the power amp. Thus the level controls and master volume control can easily be set for optimum performance.

The output of the pre-amplifier can also be monitored by the headphones so that an impression of what the music sounds like in front of the speakers can be obtained by the deejay for more accurate setting of the stereo balance and tone controls.

There are various ways of cueing records — the simplest being to lower the cartridge onto the record on one deck when the record already playing on the other deck is just about to end. With the VU meters switched to show the level from the new disc, when the pick-up reaches the start of the music the meters will be deflected and the cross-fade control can be pushed over. It is a rather hit and miss method, but any overlaps or gaps in the music when crossfading could be covered up by simply speaking into the microphone when the music will automatically be faded into the background.

A better method of cueing records with dramatic beginnings is to place the pick-up on the record being cued and revolve the turntable until the music starts (as heard on the headphones or seen on the VU meters). Turn the turntable back until the sound ceases, and then back a further one revolution. When the music on the other turntable ends push over the cross-fade and make any necessary announcement. About two seconds before you stop speaking flick on the power to the turntable motor which will pick up speed in the blank groove util reaching virtually full speed before the music begins. Switches for the turntable motors can be fitted at each end of the cross-fade control so that starting the new record can be accompanied with one hand.

TAPE MEASURES

The deejay may wish to use a jingle machine and / or tape recordings of hard-to-get discs so the disco is equipped with tape and auxilliary inputs. These are full stereo inputs (i.e. a mono signal applied to any one input will not reduce the stereo separation of the signal on any other input). Each has its own level control and feeds into an input mixer where the various inputs are combined.

Slider controls are used on the disco mainly for the reason that they can be adjusted accurately without looking at them. With rotary controls the deejay has to be continually looking down, and quickly loses the audience's attention.

An output socket is provided so that the deejay could tape record the evening's performance if he wished. It is unaffected by the settings of the master volume or tone controls.

Light work

Most professional discothèques employ a light show and it was decided to include a light show with this unit. A three channel circuit is used, each driving one 100W bulb in the rear of the console. The unit itself is capable of driving over 1.2kW (or 750W with spot bulbs) on each channel, but in this event it must be fed from a separate mains supply. It is not recommended that it be used to drive more than 250W per channel (including the 100W bulbs in the disco) if its mains is fed through the recommended plug and socket on the disco front panel, since this load added to the requirements of the amplifiers approaches the maximum current carrying capability of the plug and socket.

It is designed so that one channel lights when the music contains very low frequency signals, that is the light flashes in unison with the bass drum or bass guitar, one channel operates in the voice range and flashes in unison with the singer whilst the third channel flashes with the high frequencies — violins, etc. Sensitivity controls are provided on the front panel so that the on and off time of the lights can be adjusted. Three LED's are provided on the front panel and they flash in unison with the lamps so that the deejay can see immediately whether the sensitivity controls need adjustment.

Work light

When the music slows down and the lights get low, light will be needed so that the operator can still see what he's doing. Two lights on goosenecks are provided which can be swung round as required. They have adjustable hoods so that a narrow or wide area can be illuminated. (The VU meter faces are also illuminated.)

TURNING POINT

The choice of a turntable was governed by the consideration that it should be cheap, since two are required but should have some form of simple cueing facility with reasonable rumble and wow and flutter. With this in mind the BSR McDonald BDS80 was chosen as being the all round best buy.

Construction of Power Amps

The circuit of one channel is shown in Fig. 6. Fit the components to the pcb as shown in Fig. 4. Note that clip-on heatsinks are required for Q3, 4 and 5 and a special heatsink is required for Q6 and 7.

Note that Q6, 7, 8, 9, 10 and 11 must be mounted using mica washers and silicone grease. The pcb is fixed to the heatsink using three 19mm stand-offs. These slot neatly into the vanes of the heatsink so that it is not necessary to drill the heatsink to fit the board. The connections to the collectors of Q8, 10 and 9 and 11, are made by means of solder tags mounted under the nuts. The solder tags are then linked in pairs and the two wires taken through the 8mm hole in the centre of the transistors. The connections between the output transistors and the pcb should be as short as possible and use 32/02 wire. By mounting the pcb as shown in the photographs the wires can be kept very short.

The heatsink should be bent to fit the board and screwed down. A type 6W-1 heatsink is required for the four output transistors

HOW IT WORKS

The amplifier is of conventional design using a quasi-complementary symmetry output stage and a differential input stage.

Output transistors are paralleled for greater output capacity — and transistors Q6 and Q7 connected in a Darlington configuration provide current gain.

Q3 is a current regulator supplying approximately 10 mA. This controlled current passes through Q4, thus setting the bias for the output stage, and Q5. The voltage at the collector of Q5 is set by its own base-emitter voltage. Since this transistor is working with an almost constant current in its collector it has a very high voltage gain. This gain is attenuated at high frequencies by C7.

Transistor Q5 is controlled by the differential pair Q1 and Q2. Due to the negative feedback via R7 & R9, the action of Q1 and Q2 is that of an error amplifier. Thus it tries to keep the voltage at its two inputs (the bases of Q1 and Q2) constant. Because of this action, the output voltage is held equal to the input voltage multiplied by (R9 + R7)/R7. This gives the amplifier a voltage gain of approximately 22. This gain may be changed by varying the value of R7. An appropriate change must then also be made to C6 as R7/C6 determine the lower — 3dB point. The value of R9 should not be altered.

The output bias current — which is necessary to prevent cross-over distortion — is set by RV1.

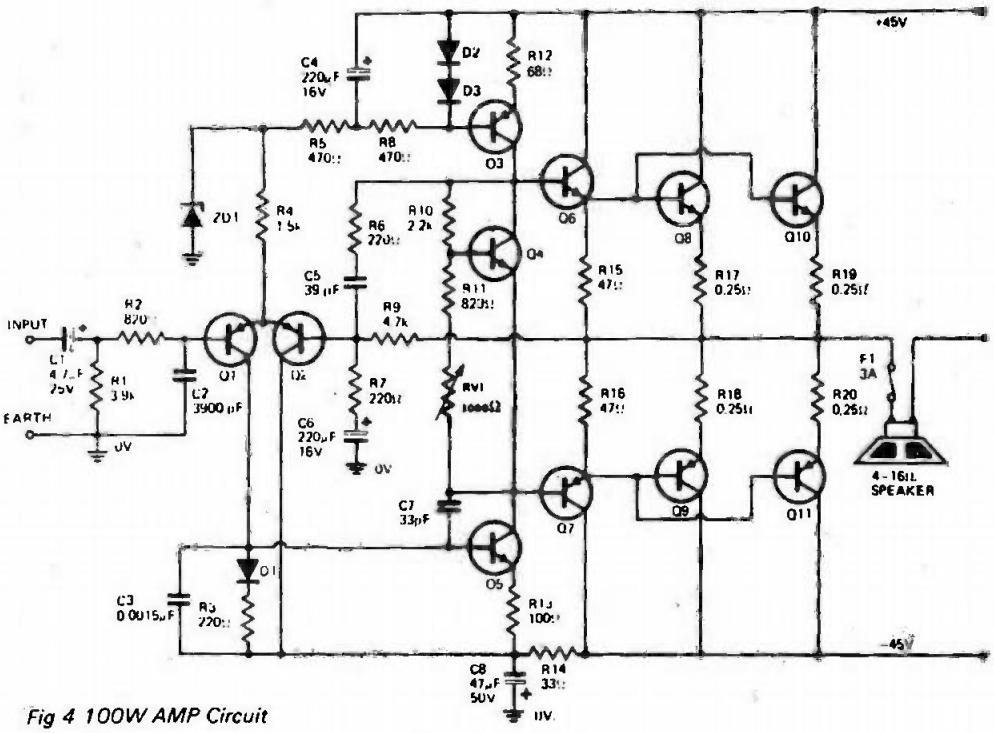


Fig 4 100W AMP Circuit

PARTS LIST FOR 100W amp

R_1	3K9	C_8	47μF 50V printed circuit
$R_{2,11}$	820R	$C_{9,10}$	0.1μF Polyester
$R_{3,6,7}$	220R	$D_{1,2,3}$	IN4005
R_4	1K5	ZD_1	BZx61 C15V
R_5	470R	$Q_{1,2,3}$	BFX30
R_9	4K7	$Q_{4,5}$	BFY 50
R_{10}	2K2	Q_8	BD139
R_{12}	68R	Q_7	BD140
R_{13}	100R	$Q_{9,10}$	2N3055
R_{14}	33R	$Q_{9,11}$	MJ2955
$R_{15,16}$	47R		

All "STD res" ½W carbon film resistors

$R_{17,18,19,20}$ 0.27R wirewound miniature 3W

RV1 Horizontal subminiature preset 470R

C_1 4.7μF @63V printed circuit electrolytic

C_2 3900pF ceramic

C_3 1500pF Polystyrene (ceramic)

$C_{4,5}$ 220μF 16V printed circuit electrolytic

C_6 39pF miniature ceramic

C_7 33pF miniature ceramic

MISC.

Some Veropins type 2141
P.C. board 100W amplifier p.c.b.
1x Jack SKT mono (plastic moulded)
Fuse 20 mm 3A

Chassis fuse holder 20 mm
3 "stand offs" 19 mm
3 "heat sink clip on" for TO5 case
1 heatsink 6W-1
1 heat sink type DR2 (see drawing)
4 mounting kits TO3
some heat conducting grease
2 mounting kits P Plas
Double all quantities for stereo pair

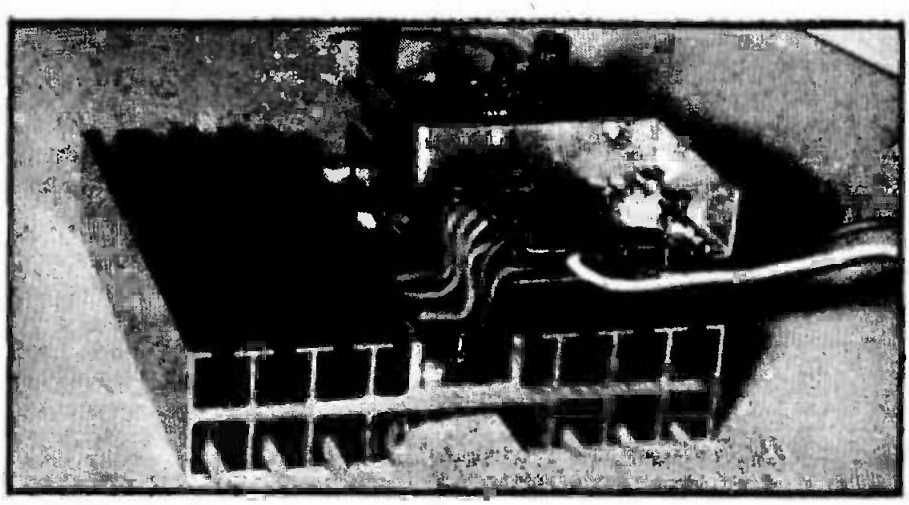
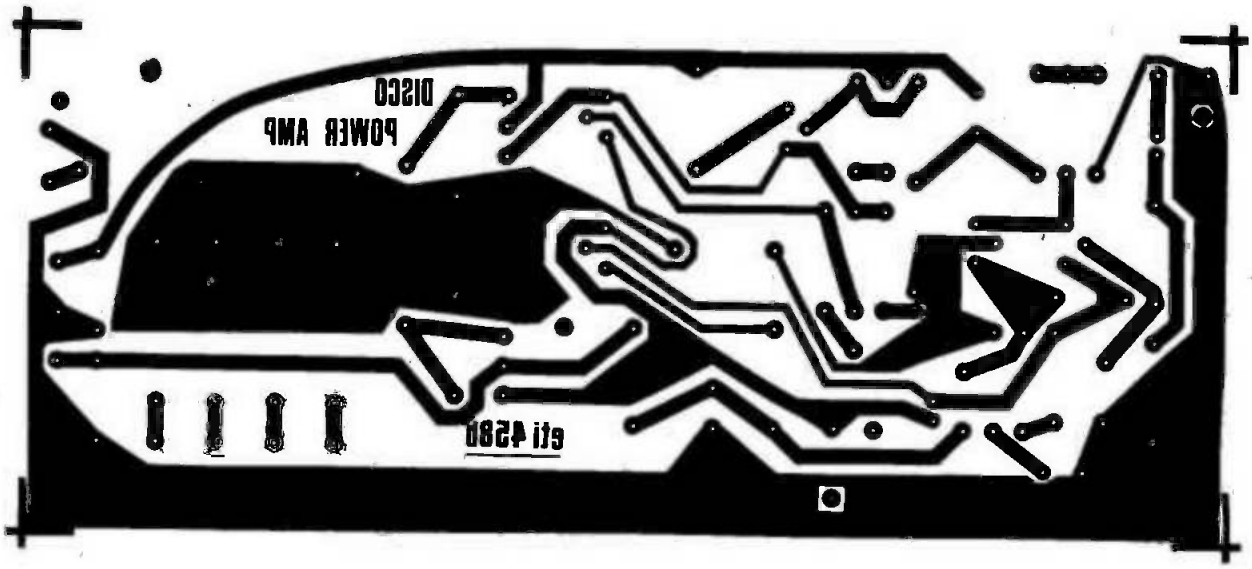


Fig 5 100W Amplifier complete and mounted

100W STEREO DISCO



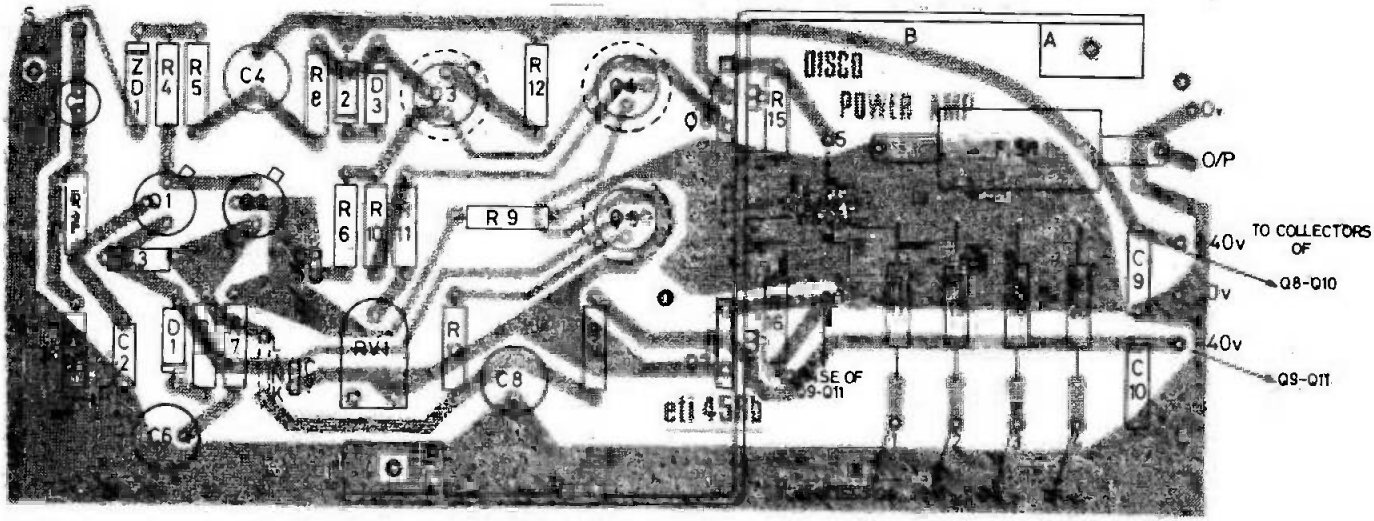


Fig 7 Component overlay for 100W Amplifier

Setting up the Power Amps

Remove the fuse FS2 (FS3 on other channel) and connect a milliammeter in its place. Adjust RV1 so that the wiper is nearest C7 (i.e. maximum resistance). Switch the unit on and adjust RV1 until a reading of 65mA is obtained. Allow the amplifier to warm up for about five minutes and then readjust the output current for between 70 and 80mA. (Note — the current will increase as the unit warms up.) Switch the unit off and re-insert FS2 (FS3). Switch the multimeter to the volts range and check the voltage between the outputs and OV. It should be within 200mV of zero (either polarity). If both measurements are correct the power amplifiers are working correctly.

Construction of Power Supply

The mains transformer which must be capable of delivering a full 32-0-32 volts at 6½ amps should be bolted to the base of the console using two plates to spread the load. The circuit of the power supply is shown in Fig. 5. Fit the components to the pcb as shown in Fig. 6. Although there are two points marked OV on the transformer these points must NOT be connected together in the power supply. The centre of C6 and C7 is the main OV earth point for the power amps and five wires are connected here. They should all be 32/02 wire except the transformer wire. The centre tap of the 32-0-32 tapping is connected here (regarded as one wire), a wire to each power amp OV and the return from each loudspeaker is returned to this point **NOT** to the power amp.

Fuseholders for fuses F2, 3, 4 and 5 are fixed to the baseboard close to the power supply pcb. These are separate fuses, one for each supply of each power amp. The power for the operating lights and VU meter lights is taken directly from the 12V AC supply on the transformer.

Before connecting the power supply to the power amps check the output voltages as follows.

The voltage at

pin 1 should be	+15V DC
pin 3	—15V DC
pin 4	+17 to +19V

Continued next month with pre-amp and light show . . . .

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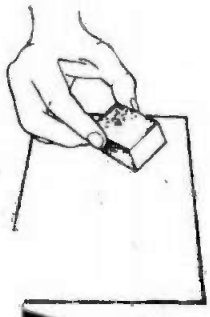
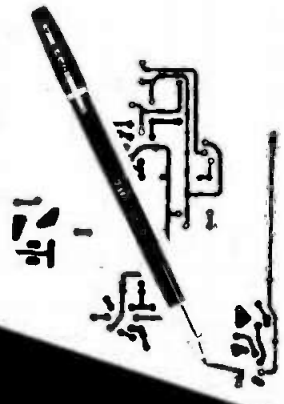


Polifix – a unique bonded abrasive block for the clean, simple, totally effective cleaning and polishing of copper laminated boards. Degreases, removes tarnish, and 'keys' the copper surface perfectly to accept etch resist. Pack of 2 blocks £1.50, 6 £4.20, 12 £7.70.

33PC



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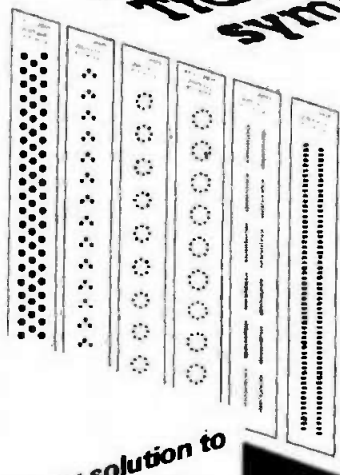
Seno Transfer symbols



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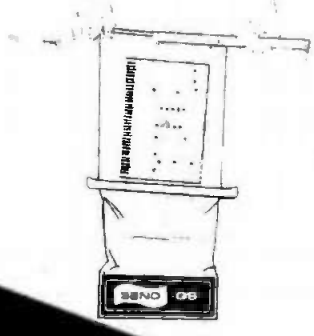

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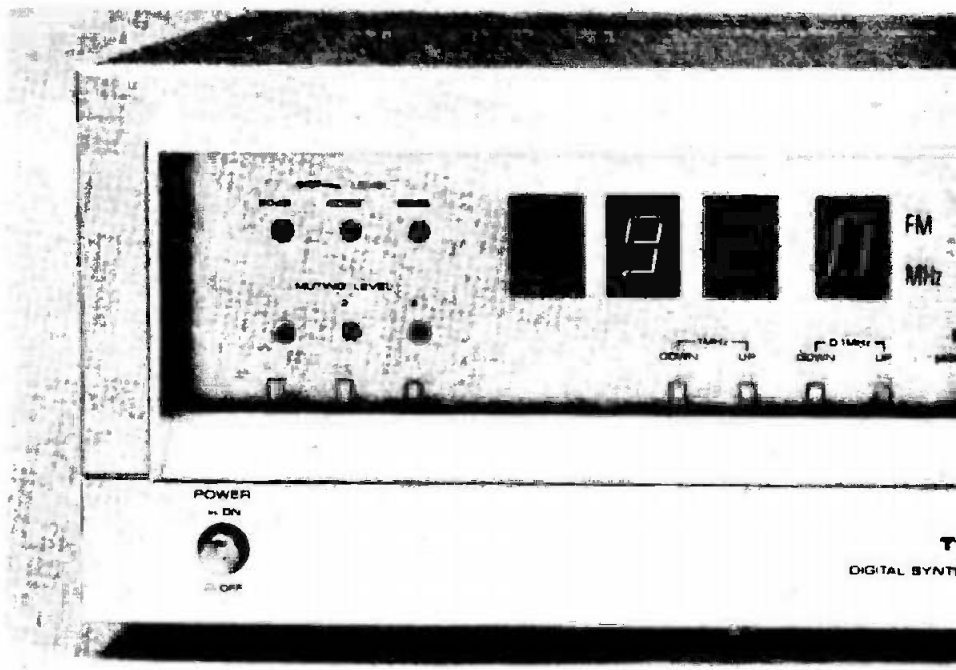
TOSHIBA ST-910

MEASURED PERFORMANCE OF TOSHIBA ST-910 FM TUNER S/N 52530001

Sensitivity (IHF Method)	1.5 μV
Distortion Factor (1500 Hz & 100% Modulation)	< 0.3%
Signal Noise Ratio	> 60 dB
Frequency Response	± 0.5 dB 20 Hz – 15 kHz
Selectivity	> 80 dB
Image Rejection Ratio	> 80 dB
IF Rejection Ratio	> 80 dB
Capture Ratio	> 1.5 dB
FM Stereo Separation	> 30 dB
Dimensions	450 mm x 136 mm x 340 mm
Weight	8 kg



The Toshiba ST910 is quite unlike any other piece of hi-fi equipment that we have previously seen. To start with there's not a single visible control apart from an ON/OFF switch. All other control functions are effected via capacitive touch switches, the positions for which are marked on the rear of the front glass panel forming most of the unit's front face.

The glass panel itself is divided into six sections which are from left to right; a signal level-indicating section consisting of six LED's, the top three being red LED's indicating signal level at +20 dB, +40 dB and +60 dB re 1 μV; whilst the lower three LED's (which are green in colour) indicate the muting level that has been selected as the threshold level for the receiver to respond to. These are activated by touching the capacitive switches indicated below them. To the right of this section is a four digit display of FM frequency. This uses 7-segment LED displays for showing the frequency to which the receiver is tuned. The first three digits indicate the frequency in MHz, whilst the last digit indicates the frequency in 100 kHz increments.

Immediately below the digital display are two capacitive touch switches which enable the frequency to be increased up or down by 1 MHz steps. Two further capacitive touch switches allow the frequency to be increased up or down by 0.1 MHz steps. Immediately to the right of these is a memory switch which allows subsequently required stations to be preset by a series of IC devices. When this switch is touched the green indicator lamp is turned on. It is also necessary to touch one of the adjacent sensor panel capacitive switches, whose indicating LED is turned on by the process. Thereafter, all that is necessary to recall the memorised frequency is to touch one of the seven selected sensor channels switches. We found however that the memory would only 'hold' preselected stations for about two days.

To the right of the sensor channel switch positions is the auto-tuning section. This has a down-start capacitive selector switch, an up-start capacitive selector switch, and stereo-only capacitive selector switch.

DOWN START

The down-start starts the receiver searching down in frequency till it finds a signal the level of which is above the muting level (or sensitivity level) which has been pre-set. The up-start button does the same, but in the reverse direction. The stereo-only selector accepts only those stations having a 38 kHz or 19 kHz sub-carrier signal in their format.

At the extreme right hand end of the escutcheon is the stereo/monophonic indicator. When the capacitive touch switch is activated the green monophonic light comes on, the red stereo light is extinguished and the

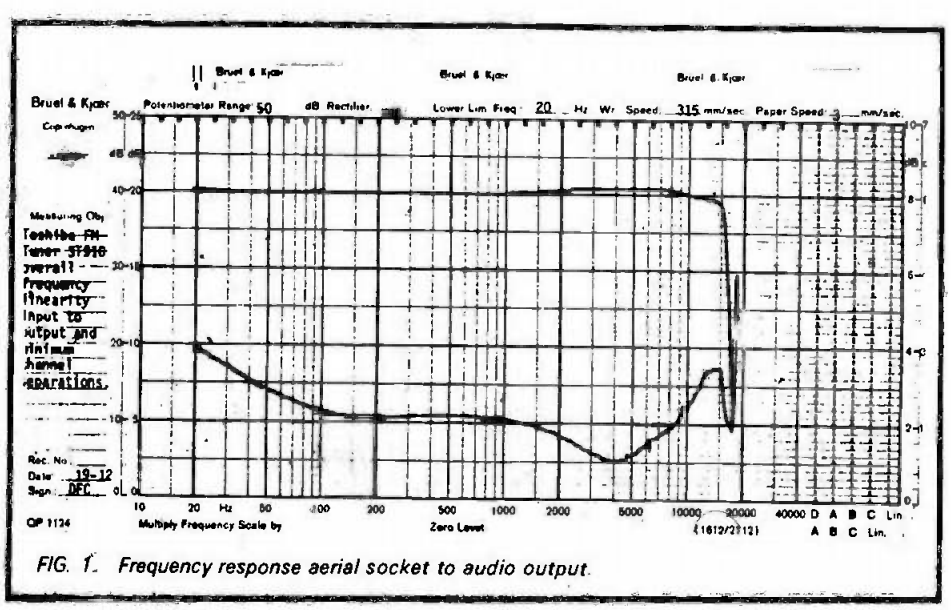
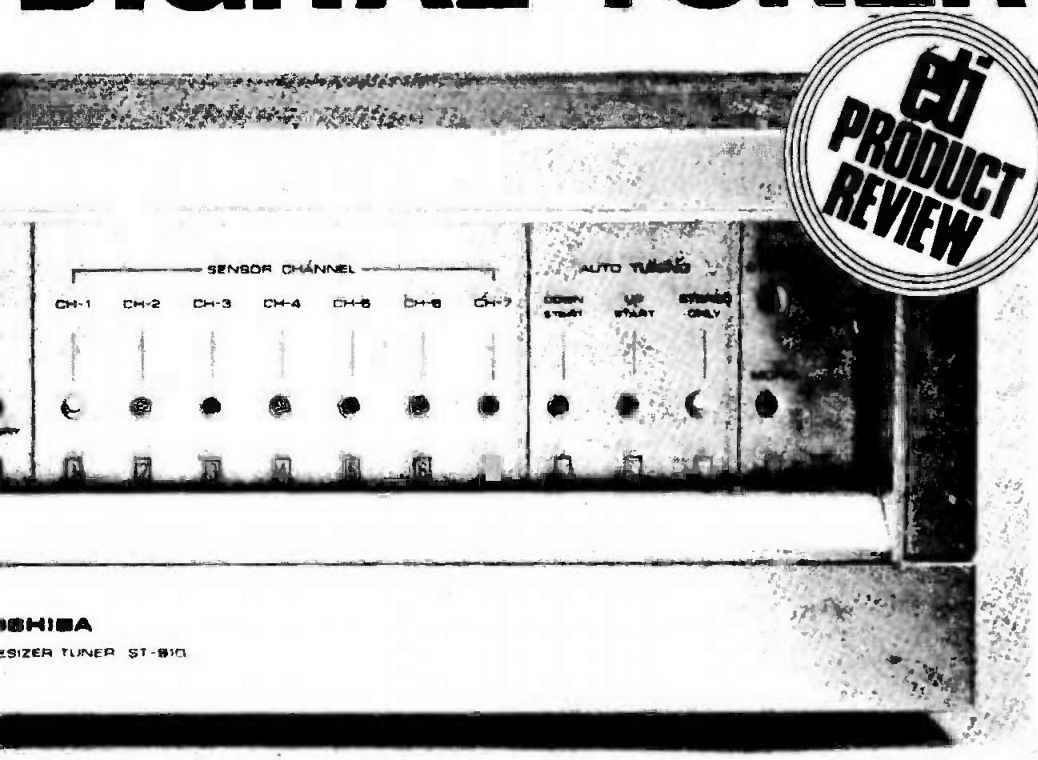


FIG. 1. Frequency response aerial socket to audio output.

DIGITAL TUNER



eti PRODUCT REVIEW

Toshibas £535 super-tuner under the microscope

tuner looks for monophonic stations only.

The back panel is a little different from other FM receivers in that as well as input terminals for either 300 Ω feeder cable or 75 Ω co-axial cable, it provides output terminals for left and right channels; a multiplex output terminal to facilitate four channel reception in the unlikely event that somebody proposes introducing it; a remote control DIN plug to facilitate the use of special remote control offered as an optional extra; an output level control which allows the setting of the audio line output levels; and a scanning speed control knob which allows the automatic tuning operation to vary between approximately 0.05 MHz/sec. to approximately 3 MHz/sec. scanning rate.

Another most interesting facility are two terminals which can be respectively connected to the horizontal and vertical axes of an oscilloscope to measure and minimise multi-path reception and thereby optimise signal quality. The handbook describes very simply yet practically, how this should be carried out.

DIGITAL FREQUENCY SYNTHESIZER

The heart of the ST910 is a digital frequency synthesizer based on a quartz crystal oscillator. This provides accurate and stable frequencies, replacing the normal variable frequency oscillator, to provide extremely accurate signal tuning. When used in conjunction with the phase locked loop, this provides an extremely precise and stable frequency tuning section. The great advantage of such a combined system is that the tuner receive frequency is extremely accurate (without the need for automatic frequency control) and nearly equal to the precision provided by the quartz crystal oscillator used in the original transmitting station.

Frequency stability claimed for the synthesizer section is better than 50 parts per 1,000,000 – subject to the period of operation and thermal conditions in which the receiver is used.

The inside of the receiver is more reminiscent of communication receiver construction and design than a piece of consumer electronics. Firstly, it makes use of a 300 mm x 240 mm mother card which is connected by plug-in sockets to the front circuit board on which are located the digital frequency display, the LED's and the capacitive touch switches. On the main section of the mother board are additional vertically mounted plug-in cards comprising the power supply, the digital memory sections, the frequency synthesizer and its crystal ovens and three cards on which are mounted the very high quality FM receiver.

An input pre-filter reduces the effect of unwanted high level AM signals on the following electronic circuitry.

PERFORMANCE CREDITS

Toshiba claim a frequency response of 20 Hz to 15 kHz ± 0.5 dB. And that is exactly what we found in our testing.

Image rejection ratios and IF rejection ratios of 100 dB are also claimed, we couldn't confirm that these *were* 100 dB but they were certainly better than 80 dB. Toshiba claim a capture ratio of 1.5 dB, we found it to be slightly better than this. They also claim a FM stereo separation of 40 dB in the range of 100 Hz to 8 kHz – we certainly measured better than 30 dB, and if allowance is made for the performance of our signal generator the claim of 40 dB separation would be very near the mark.

The calibrated sensitivity signal level LED's which are supposedly 20 dB, 40 dB and 60 dB re 1 μV are spot on at the 20 dB and 40 dB levels, and 57 dB for the 50 dB indicator. The major sensitivity on monophonic signals was 1.5 μV which is better than the manufacturers' claim. Total harmonic distortion was (delightfully) less than 0.3% which is as good as one could ask for.

After all this one might well ask how does the unit perform. Its listening performance is Grade A. We could in no way fault it, except for the minor possible criticisms that with digital frequencies set at 0.1 MHz intervals, one could possibly find oneself in a situation where the receiver was not tuned *exactly* to the station one was looking for and that on our review unit at least the preset tuning was effective for only a day or so before it needed to be reset.

We listened to all the available programme content we could find, the performance was in all respects almost perfect.

Is it really worth £535? This is for you to decide – but you'll buy nothing approaching it for less. ●

BREAKDOWN BEACON

AN ESSENTIAL DEVICE FOR ANY CAR OWNER.....

THE BREAKDOWN BEACON IS A dual purpose device. It can be used atop a disabled motor vehicle as a flashing warning to other traffic – a highly desirable safety device. Alternatively it can be used as a non-flashing trouble light for finding and fixing faults at night. Its three rubber-sucker feet will hold it to the roof of a car, to the underside of a bonnet, or to any other convenient flat surface.

The circuit operates from the vehicle's battery and, as all electrical parts are isolated from the metal case, the same circuit can be used for cars with either negative or positive earth wiring systems. The beacon is fed from a plug pushed into the cigarette lighter socket – however as this plug is polarised, a beacon with a plug for negative earth cannot be used in a car with opposite polarity unless the plug connections are reversed. Alternatively it could be powered from the car battery.

CONSTRUCTION

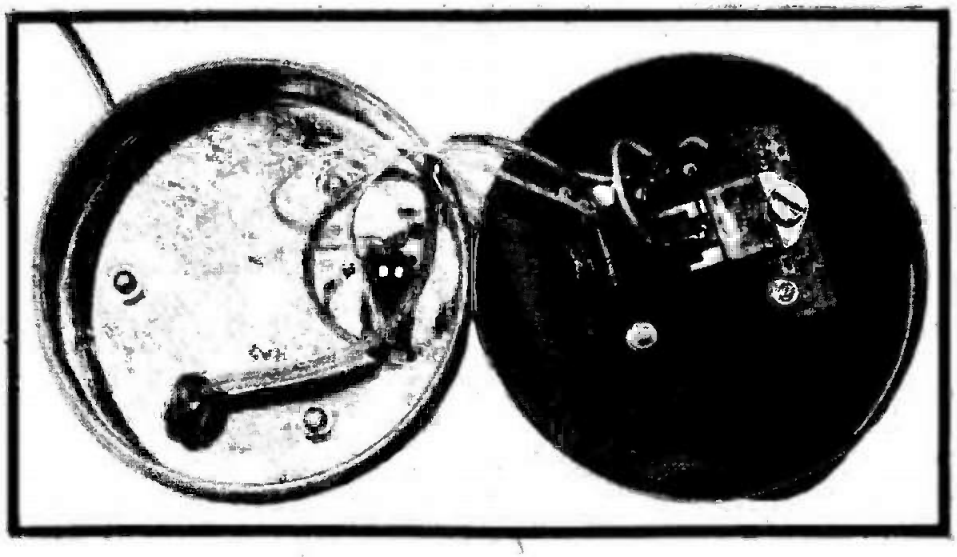
The nicest thing about the construction of this project is that first you have to eat half a pound of jam, in order to get the empty glass jar for the lamp housing. Other, jars about 70mm dia. and 70mm high with a twist off cap would do. You'll need also a round tobacco tin about 75–80mm dia. and 30mm high with a twist off cap. These two parts make up the case.

First solder the lids of the jar and the tin together, concentrically – outside to outside. Then before fitting the batten lamp holder fit the lamp to it and check that it will fit inside the jar when the jar is screwed into its lid. If it will, then mount the lamp holder by three bolts through both lids. Two of these bolts should be longer than the third as they will carry a piece of Veroboard. If the jar is slightly too short to accept the lamp holder and lamp – as was the case in the prototype – then cut a hole for the lamp holder through both lids, and fit the lamp holder so that its flange finishes up inside the tabacco tin. Spacing washers may be added if necessary. Again the lamp holder is secured to the lids with one short and two long bolts.

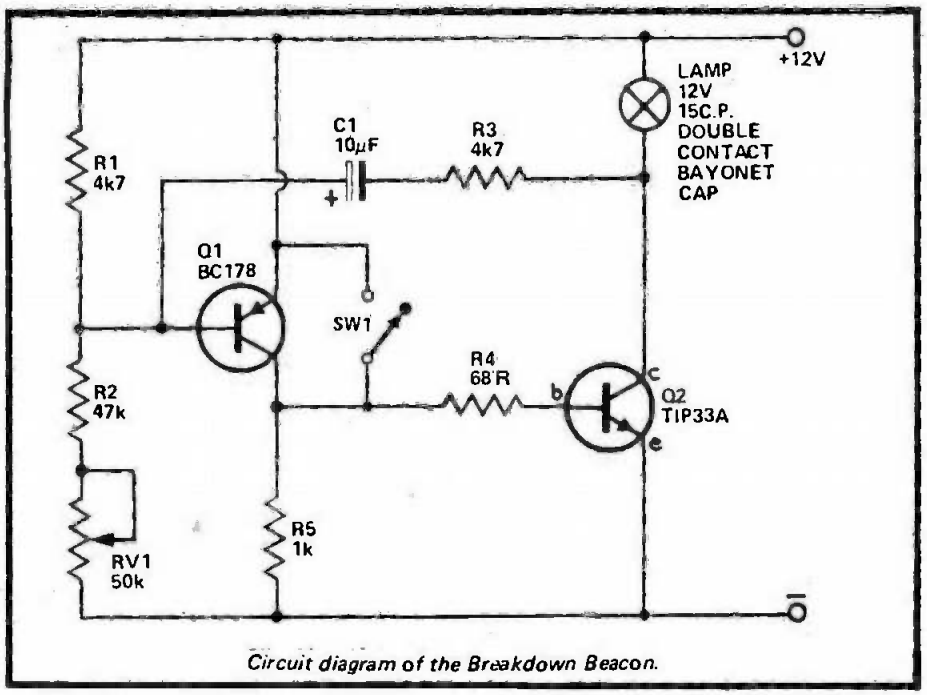
The electronic part of the beacon is constructed on 0.1 inch matrix Veroboard 45mm x 36mm. Only one break needs to be cut in the copper strips – between the two leads of capacitor C. Only the outer legs of RV1, are passed through the Veroboard. The centre leg is connected to either outer leg above the board and the excess cut off. Note that all resistors except R5 are vertically mounted. The upper end of R4 is soldered straight on to the base terminal of Q2, and the upper end of R3 is soldered straight on to the collector. A wire is also run from the collector terminal of Q2 through the board to the strip below it. Another wire is run from the emitter terminal of Q2 to the negative rail which is the copper strip just below.

The Veroboard is mounted into the case below the lamp holder, using two of the lamp holder mounting bolts.

The switch SW1 is mounted on the bottom of the tobacco tin where it is out of the weather. The switch must be positioned such that it does not clash with the components on the Veroboard when the tobacco tin is screwed



Inside view of the completed unit. Note the plastic disc used to replace the normal airtight seal of the jar.



Circuit diagram of the Breakdown Beacon.

PARTS LIST – ETI 239

R1	Resistor	4k7	¼ watt
R2	"	47k	"
R3	"	4k7	"
R4	"	68R	"
R5	"	1k	"
RV1	Preset pot	50k	
C	Electrolytic capacitor at least 15 volts	10 μF	
Q1	Transistor PNP BC 178 or similar		
Q2	Transistor NPN TI P33A or similar		
SW1	small on/off slider switch, single pole		

Lamp 12 volt automotive lamp 15 candlepower double contact cap.
Lampholder – to suit lamp, batten mounting, double contact bayonet catch type. (This is an electricians line not an automotive line. They are used for pilot lamps).
Tobacco tin, jam jar, or similar. Nuts and bolts, hook up wire.
Lead to battery – 7 m speaker extension lead.
Cigarette-lighter plug.

HOW IT WORKS

The circuit is an oscillator of a not very common type. It is *not* a multivibrator as both transistors conduct at the same time, rather than alternately as in a multivibrator. Most explanations of this type of circuit state that the circuit oscillates by a regenerative action from Q2 to Q1. This doesn't really explain how it works, so perhaps the following is a little clearer.

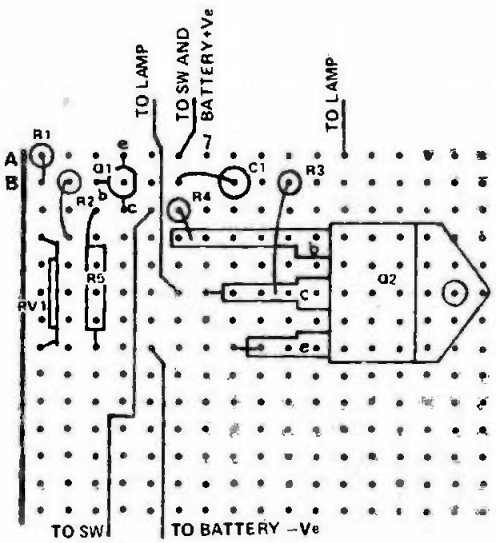
The setting of the pot RV1 is such that when power is first applied Q1 is turned on slightly. By varying RV1 the circuit can be made to 'lock' with the lamp on or off. In between these extremes the circuit oscillates. The setting of RV1 is not critical.

As said above, when power is applied Q1 turns on slightly. Current through Q1 feeds into the base of Q2 and turns it on. Capacitor C charges through R1, R3 and Q2. This increases the current through R1 and so lowers the voltage at the base of Q1 thus turning it on harder – hard enough to turn Q2 full on and light the lamp.

As C charges, the voltage at the base of Q1 rises and so tends to turn Q1 off, thus reducing the base current in Q2 and hence the current through the lamp. This increases the voltage across Q2 quite rapidly. As the voltage across the capacitor cannot be changed rapidly, the increase of voltage across Q2, i.e. the voltage change at the collector of Q2, is transferred through the capacitor to the base of Q1 – so turning it off. This turns Q2 hard off. The voltage at the collector of Q2 then rises rapidly to 12 volts, so the voltage at the base of Q1 is forced up through capacitor C, turning Q1 hard off.

Capacitor C then discharges round R1, the lamp, and R3 until, when fully discharged, Q1 turns on slightly and the cycle is repeated.

The switch SW1 (connected across Q1) is used to disable Q1 and so give a steady light when SW1 is closed.



Veroboard layout for the beacon circuit. The copper strips run from left to right across the board. Only one break is required, and this is at B7

together.

The long twin-lead to the battery is run through the bottom of the tin (to prevent moisture entering) and connected to a cigarette-lighter plug taking care to wire with a polarity to suit the car system (positive or negative earth). Speaker extension lead is good for this purpose as it has polarity marking.

It is likely tha the operation of soldering the two lids together will have destroyed the air-tight seals in the jar and tin; they should be replaced with a disc in the tin and a ring in the jar cut from fairly heavy plastic sheeting.

TESTING

Before connecting up make sure that switch SW1 is open – otherwise the unit will not flash.

Connect the unit to the battery by inserting the plug into the cigarette lighter socket. It may now be found that RV1 needs some adjustment to make the circuit operate correctly, so don't be disappointed if the lamp does not light at first or alternatively, stays on all the time. The flashing rate may be altered by changing either C or R3 if thought necessary. About 70 to 100 flashes per minute is right.

The value of R4 shown in the circuit was selected to suit the transistor Q2 used in our prototype. If the lamp lights at less than full brilliance then R4 may be reduced until Q2 saturates and the lamp is turned on fully.

USE

The illustration shows the prototype with a clear glass 'lens'. This is ideal when the beacon is used as a trouble light – turned permanently on. However, if it is thought desirable to have a amber or red colour when the beacon is flashing, then it is a simple matter to make a sleeve of suitable coloured material to be dropped inside the jar. ●

ETI DATA SHEET

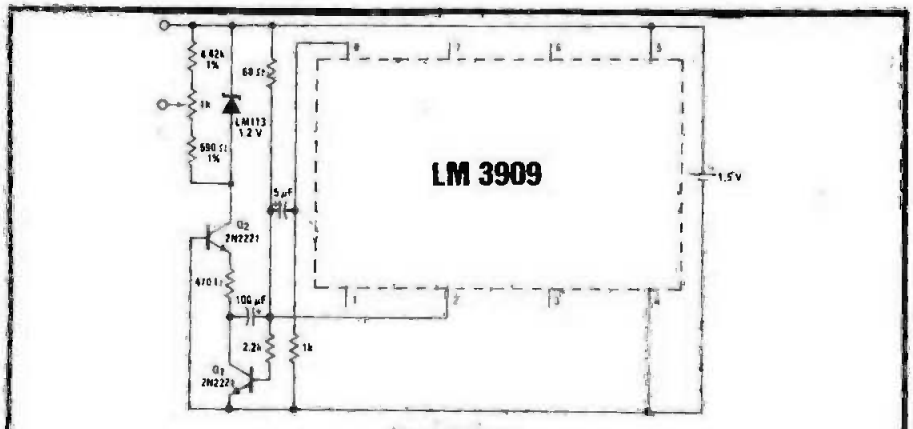
LM 3909 IC OSCILLATOR/FLASHER — NATIONAL

Most linear integrated circuits are designed to operate with power supplies of 4.5 to 40 V. Practically no battery/portable equipment is provided with indicator lights due to unacceptable power drain. Even LEDs (solid state lamps) won't light from a 1.5 V battery, and drain the common 9 V radio battery in a few hours.

The LM3909 changes all this. Obtaining long life from a single 1.5 V cell, it opens a whole new area of applications for linear integrated circuits. Sufficient voltage for flashing a light emitting diode is generated with cell voltage down to 1.1 V. In such low duty cycle applications batteries will last for months to years of continuous operation. Such flasher circuits then become practical for marking location of flashlights, emergency equipment, and boat mooring floats in the dark.

With 1.5 V supplies, certain problems can occur to stop oscillation or flashing. Due to the way gain is achieved and the type of feedback, too heavy a load may stop an LM3909 from oscillating. 20 Ω of pure resistive *load* will sometimes do it. Strangely enough, lamp filaments, probably because of some inductance, don't seem to follow this rule. Also in flasher circuits, an LED with *leakage* or conductivity between 0.9 and 1.2 V will stop the LM3909. Maybe 1% of LEDs will have this defect because they are not often tested for it.

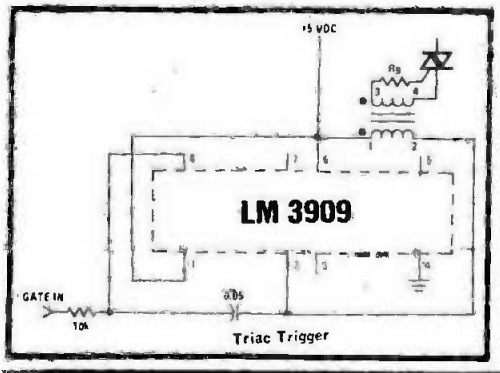
Great frequency stability was not one of the design aims of the LM3909. In LED flasher circuits it is better than might be expected because the negative temperature coefficient of the LED partially compensates the IC.



'Scope Calibrator

A useful electronic lab device is a precision square wave generator/calibrator. If the output is held at a few tenths percent of 1 V, peak-to-peak, it is useful in calibrating oscilloscopes and adjusting 'scope probes. Many lower cost or battery-portable oscilloscopes do not have this feature built in. Also it is useful in checking gain and transient response of various amplifiers including "hi-fi" power amplifiers.

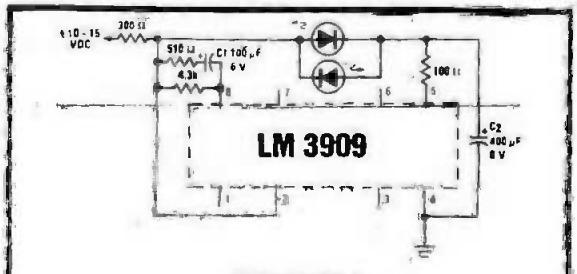
Output is a clean rectangular wave which can be adjusted to exactly a 1 V amplitude. A rectangular wave of approximately 1.5 ms "on" and 5.5 ms "off" was chosen for circuit simplicity and low battery drain. Waveform clipping is virtually flat due to complete turnoff of the current switch Q_2 and the typical "on" impedance of 0.2 Ω provided by the LM113. The 0.01% temperature coefficient of the LM113 at room temperature allows negligible drift of the waveform amplitude under laboratory conditions. Loading by a 'scope probe will also be insignificant.



Triac Trigger

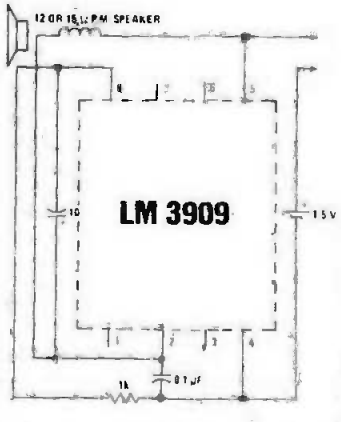
National Semicon.
Larkfield Industrial
Estate, Greenock
Scotland

Available from Marshalls Ltd 42 Cricklewood Broadway London NW2 3ET at a special offer price of 80p inc of V.A.T. and p&p



Alternating Flasher

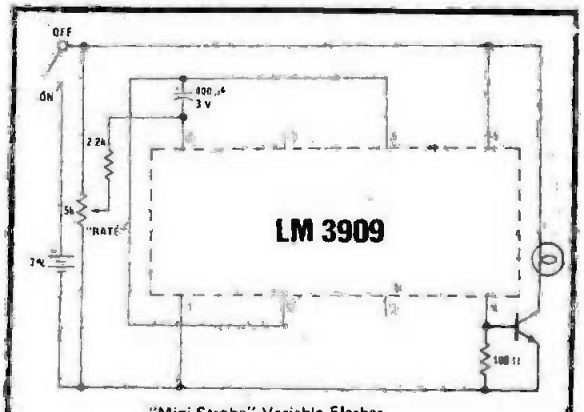
The circuit above is a relaxation type oscillator flashing 2 LEDs sequentially. With a 12 VDC supply, repetition rate is 2.5 Hz. C_2, the timing and storage capacitor. If a red/green flasher is desired, the green LED should have its anode or plus lead toward pin 5 (like the lower LED).



"Buzz Box" Continuity and Coil Checker

short, up to about 100 Ω, across the test probes provides enough power for audible oscillation. By probing 2 values in quick succession, small differences such as between a short and 5 Ω can be detected by differences in tone.

A novel use of this circuit is found in setting the timing of certain types of motorcycles. This is due to the difference in tone that can be heard from the tester depending whether there is a short or not across the low resistance primary of the cycle's ignition coil. In other words, the difference between a 1 Ω resistor and a 1 Ω inductor can be heard. Quick checks for shorts and opens in transformers and motors can therefore be made.



"Mini-Strobe" Variable Flasher

The 3 V "mini-strobe" may be used as a variable rate warning light or for advertising or special effects. The rate control is so wide range that it adjusts from no flashes at all to continuously on.

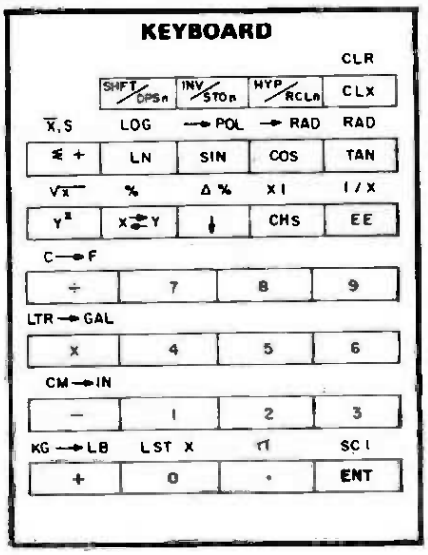
MK 50075 MK 50103 MK 50104 EXPANDABLE SCIENTIFIC CALCULATOR CHIP SET

The MK 50075, ALU circuit, combined with the MK 50103, 50104 ROM circuits forms a powerful twelve digit scientific calculator. The display format can be fixed point (user programmed) or floating point in either business or scientific notation. The calculator has four rotatable stack registers plus nine addressable memory registers. All entries use the reverse polish notation.

Effective combination of key functions on this calculator make it possible to offer fifty-five functions with thirty keys. Multifunction keys are accomplished by utilising the SHFT/DSP, INV/STO, and HYP/RCL control keys. SHFT (Function) enables the upper case key function while INV (Function) enables the inverse of a function. The HYP key is used in conjunction with hyperbolic functions while COS, SIN, and, TAN have hyperbolic, upper case, and inverse functions. The order in which the control keys are entered will have no effect on the function. For example, both the key sequence SFHT, INV, C → F and INV, SHFT, C → F will convert degrees Fahrenheit into degrees Celsius.

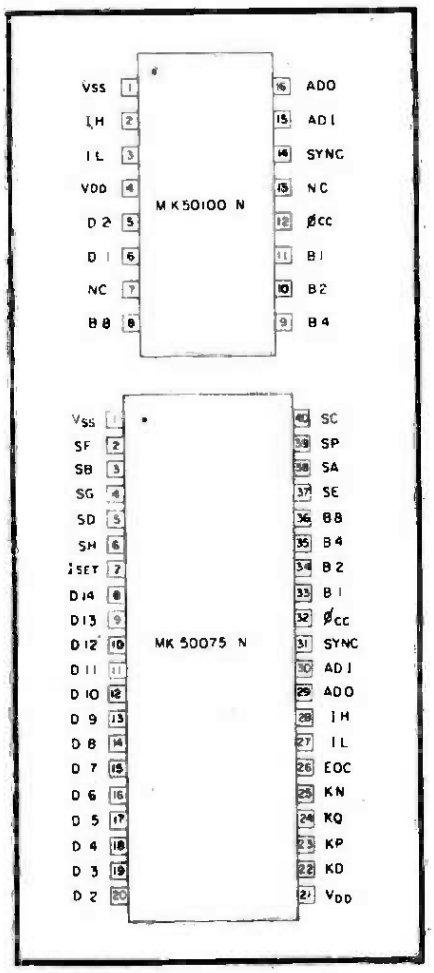
The calculator can work trignonometric functions in either degrees, grads, or radians. When in the radian mode an indicator is turned on. Switching between grads and degrees is achieved by a slide switch while switching from grads to radians or degrees to radians is a key function. The calculator can do the following transcendental functions: sinx, arcsinx, cosx, arccosx, tanx, arctanx, sinhx, arcsinhx, coshx, arccoshx, tanhx, arctanhx, e^x, lnx, 10^x, and logx.

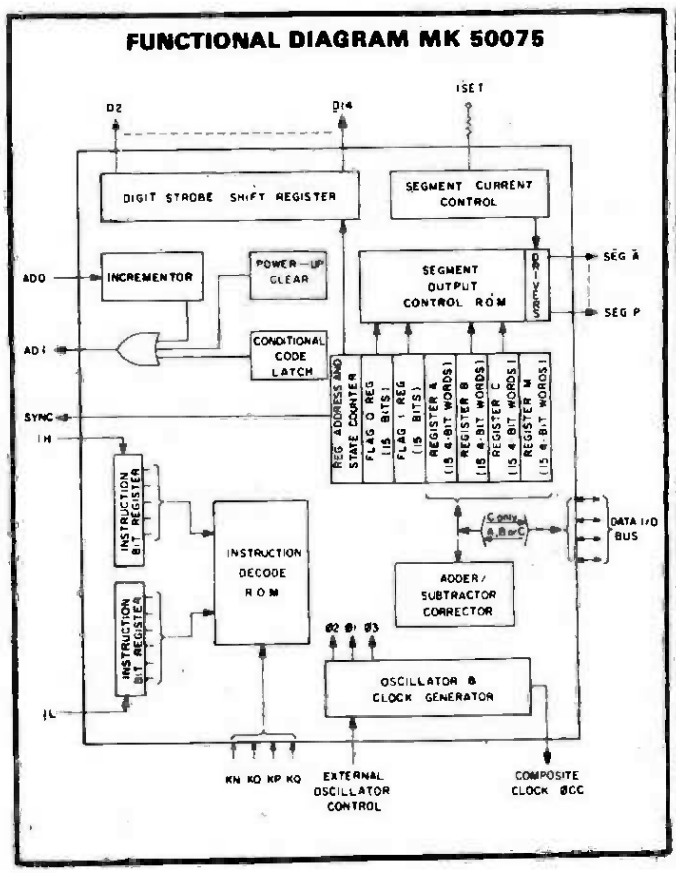
Besides transcendentals, it calculates the single variable functions of X!, 1/X, $\sqrt{X}$, and x^2 and the two variable functions of y^x, $\sqrt{Y}$, %, and Δ%. It has ten preprogrammed conversions which automatically change the contents of the display register into the desired unit calculates mean and standard deviation using the unbiased method.

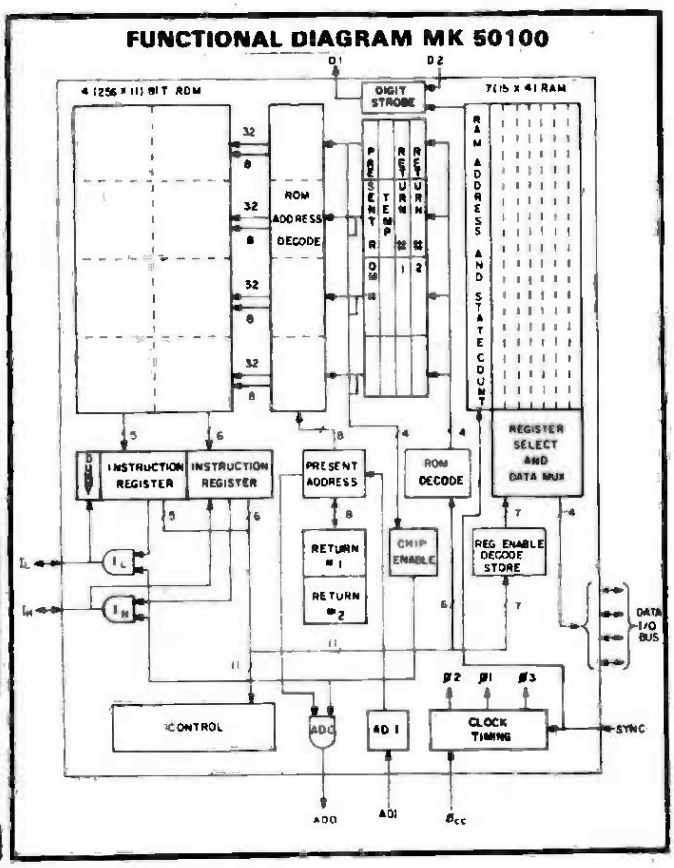


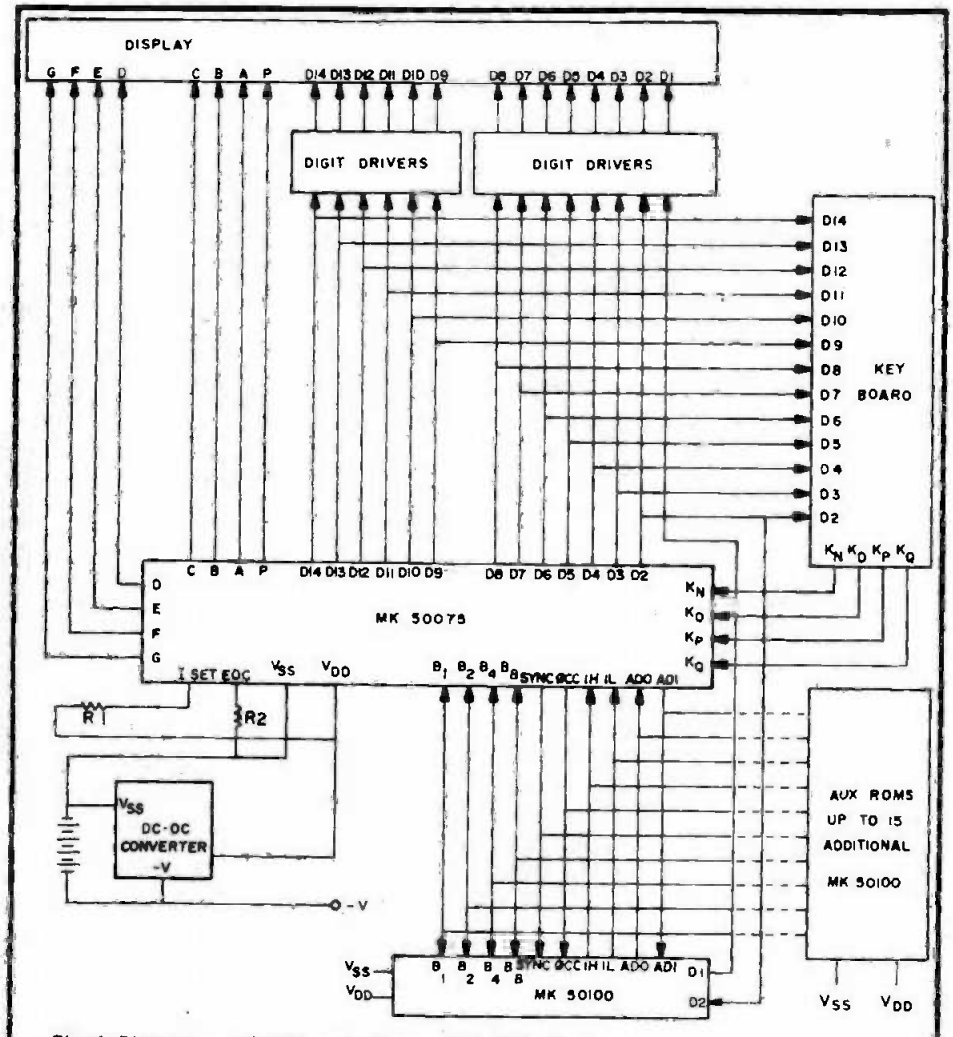
The chip set is available from Mostek U.K. Ltd, 240 Upper Street, London N.1. The price, inclusive of V.A.T. and p&p is £27.

A comprehensive data booklet is included with each set.







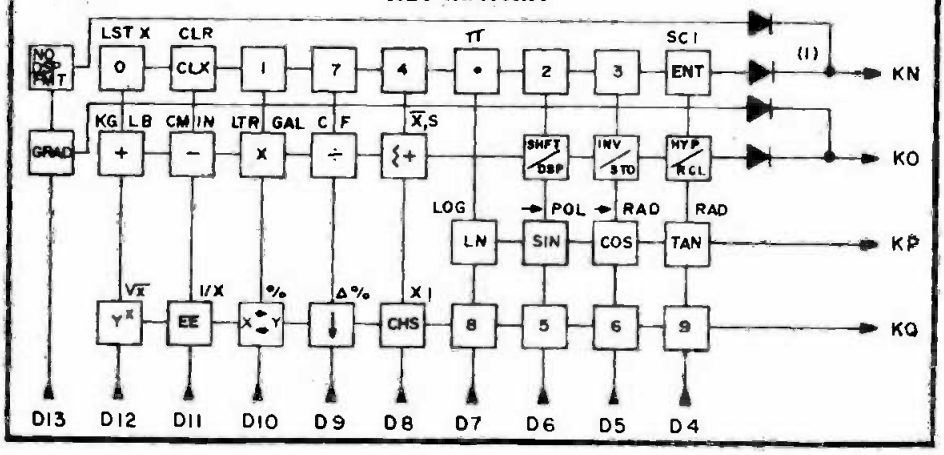


Circuit Diagram — scientific calculator with L.E.D. display

RECOMMENDED OPERATING CONDITIONS

	PARAMETER	MAX MK 50075	MAX MK 50100
V_{DD}	Supply Voltage	−18.0	−18.0
V_{IH}	Input Voltage, Logic "1"	V_{SS}	V_{SS}
V_{IL}	Input Voltage, Logic "0"	V_{SS} − 6	V_{SS} − 6
ϕ_{cc}	Clock Period	10	10

KEY MATRIX



Functions available:

Clear
Clear display
Add, subtract, multiply, divide
Scientific display format; 10-digit mantissa, 2-digit exponent, floating decimal
Mode set to radians
Fix decimal point (0-9) in display
Sine
Cosine
Tangent
Hyperbolic sine
Hyperbolic cosine
Hyperbolic tangent
Memory store, 9 registers
Memory recall, 9 registers
Memory exchange, 9 registers
X ↔ Y exchange
Common Log
Natural log
4-stack register
Rotate stack
Recall last X
Business display format; 12-digits, floating decimal point
Arc sine
Arc cosine
Arc tangent
Arc hyperbolic sine
Arc hyperbolic cosine
Arc hyperbolic tangent
Xth root of Y
Gross profit margin percentage
Summation minus for vector subtraction
Y to the X power
Reciprocal for all values exponent range from +99 through — 100
PI
Change sign
Square root
Factorials

Summation plus (adds X and Y to memory for vector addition, recalls sum of X and sum of Y)
Percentage
Percentage difference (Δ%)

Mean
Standard deviation

Centigrade to fahrenheit
Litres to gallons
Centimeters to inches
Kilograms to pounds
Degrees to radians
Set radian mode for trigonometric functions
Trigonometric rectangular to polar
Hyperbolic rectangular to polar
Anti log, natural (e^x) for all values from x = +230 through — 230
Anti log, common (10^x), for all values from x = +99.9 through —99.9
Trigonometric polar to rectangular
Hyperbolic polar to rectangular
Set degree mode for trigonometric functions
X^2
Fahrenheit to centrigade
Gallons to litres
Inches to centimetres
Pounds to kilograms

Part 7 Bits & Bats

A MONTH OF VARIETY, this month as we take the opportunity to cover one or two subjects and fill in a few gaps. Firstly

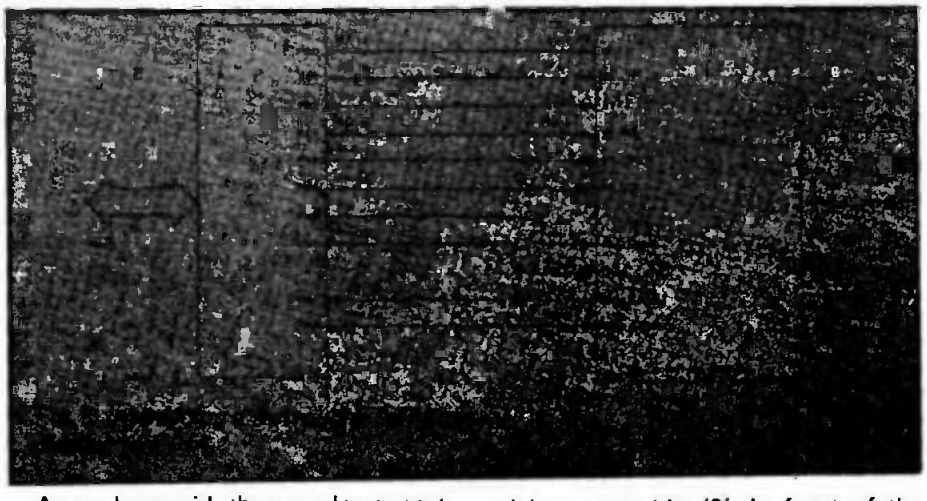
I/O HARDWARE

On the input side, keyboards such as the Clare Pendar types are available from firms like *Computer Sales and Services, 49-53 Pancras Road, London, NW1 2QB*. These keyboards usually have a ROM mounted on them to generate a parallel ASCII output, but some use a diode matrix for code generation. This can be an advantage, since diodes are more robust electrically than MOS devices and additionally offer you the facility of changing the coding if you wish. These keyboards are ideal for connection to one half of a PIA to make a simple interface, or can be used with a UART chip for serial I/O.

On the other half of the PIA you could hang a Burroughs Self-Scan display as shown in fig. 1. This is an alphanumeric gas discharge display available in 16, 32, and 80 character sizes and will display a single line of text. Further details from *Walmore Electronics Ltd., 11-16 Betterton St., Drury Lane, London WC2.*

A cheaper alternative to display up to 8 lines of 32 characters is to build yourself the ETI 560 VDU. A suggested interface is given in this month's article, but M6800 users (and perhaps users of other micros) will probably find that the simplest interface for their system is to use a PIA with one half outputting the address on the screen of the character and the other half handling the data. In use this is fairly simple from both the hardware and software points of view. You simply output data to the PIA 'B' half and then increment the 'A' side so that it is ready for another character. Handshaking can be done automatically by the PIA control lines.

If you require hard copy output from a serial interface, you could do worse than the Teletype 35RO available from *Chiltmead* who advertise in the mag. This is a heavy duty machine which should operate reliably if noisily. If you have a serial interface, but want blissful silence, then a VDU such as Computer Workshop's CT1024 is a good bet. Their address (which we forgot in the last issue!) is*174 Ifield Road, London, SW10 9AG*. Alternatively, you could stick the other side of that UART (Universal Asynchronous Receiver Transmitter) chip we mentioned earlier onto your 560 VDU.



As we have said, there are lower cost approaches to I/O such as hex keyboards and displays, or even switches and LEDs. The great advantage of this approach is that you can cheaply have a development system up and running, and then purchase or otherwise obtain whatever peripherals become available to you, since you can easily write the routines to run them.

THE ACIA

Although we have very briefly looked at the MC6820 PIA, we have only mentioned the ACIA (Asynchronous Communications Interface Adapter). This is another example of the move by manufacturers towards 'intelligent' peripheral adaptors/controllers, and in all probability, this chip is very nearly as complex as the MPU chip itself.

The ACIA (MC6850) is a very smart chip indeed, and can perform an amazing repertoire of functions. Its primary function is the conversion of parallel data addressed to it into serial data, but in addition it can generate a parity bit, either even or odd, for error detection and can also control the most sophisticated peripherals and modems through 3 control lines. On receive, it will perform the required serial to parallel conversion, and in addition, can check the parity bit of each byte, and flag an error if the parity is wrong, or if there is an overrun or framing error.

Since this chip is intended for asynchronous communication, it sticks a start bit, '0', in front of the byte it is outputting, and tags on 1 or 2 ones as stop bits at the rear. The ACIA can operate at any speed up to 500 kbps, so it is plenty fast enough to drive a teletype!

CASSETTE TAPE

Interesting application number 1 for the ACIA is to do with cassette tape. If you can't see the link, here it is.

If you are using a system based on switches and LEDs, or a hex keyboard – in fact no matter what you are using to get your program into the micro's memory, you will soon find it tedious loading programs by hand. You now have a choice of leaving your program permanently in memory with the power on (like the HP25C), or outputting it onto punched paper tape or magnetic tape or even onto a magnetic card (like the HP67). Which is where cassette tape comes in. Almost everyone has a cassette tape recorder these days, and you can put it to better use than recording Top of the Pops by using it to record, and later, reload the programs you have written on your micro. This is done by the (simple?) expedient of converting the digital data to audio tones which can

be directly recorded. In fact, a new standard has now been largely agreed between the computer manufacturers in the States for this low-cost method of data recording.

Known as CUTS (Computer Users Tape Standard) the system works by converting a digital '0' to 1200Hz and a '1' to 2400Hz, and recording these tones at 300 bits/second. However, as this is an asynchronous system, i.e. it does not require synchronisation with the micro system clock, it records the start bit and two stop bits, as shown in fig.2.

This, obviously, is where the ACIA comes in, as it can do this job almost entirely on its own. One neat trick lies in the fact that the chip which normally generates the ACIA's clock frequency, the MC14411 bit rate generator, is really just a crystal oscillator and a divider chain. Now two of the frequencies which are produced by this chain are: yes, you've guessed it, 1200 and 2400Hz. It doesn't take much thought to come up then with the set-up shown in fig.3. As can be seen the two signals are simply gated, rounded off by the LPF, and fed to the mic. input of your cassette recorder. To get the signals out again, possibly the easiest technique is to use a phase locked loop. This would feed straight into the Received Data input of the ACIA.

Whilst this circuit is not tried and tested, we can't see why it shouldn't be persuaded to work, and we intend to have a bash at it.

MORE MICROS

Whilst we have used Motorola's M6800 microprocessor as an example thus far in order to make the series consistent (and it may also have something to do with the fact that we're using 6800 in our own System 68!) we feel that it would be rather unfair not to wander off at some point and see what else is about in the microcosm(?).

Firstly, there's the company who really started it all, *Intel*. They produce a range of 4 and 8 bit MPUs, as well as the 3000 series bit slices, which are like TTL fast chunks of MPU. The 3002 is a 2-bit slice, so if you stick 8 of them in parallel with some other parts you get a 16-bit processor. But the best known of Intel's products is the 8080, which is an 8-bit MPU similar to 6800, and is the other 'industry standard'. The 8080 is comparable to 6800, it has, perhaps, some 'nicer' instructions, but some of its pins carry multiplexed signals, and so it requires a handful of external logic to make it go. You pays your money and you takes your choice.

Also of interest is the 8008, the forerunner of the 8080, which is slower and has only a subset of the 8080's instruction set, but is cheaper.

Fairchild, and their second source, *Mostek*, are going strong with their F-8 chip set, which is an 8 bit MPU, in two sections, the 3850 CPU and the 3851 Program Storage Unit, which carries the Program Counter, two 8 bit I/O ports, and 1k of ROM. Sounds great, but the snag is the ROM is mask programmed, which rules it out for the home constructor. But you will hear more of this device, as it forms the basis of Fairchild's new TV games, and has also been built into an electronic chess set.

Fig.2. Asynchronous Recording Format used in CUTS

A device which will almost certainly appear in educational environments is *Intersil's* IM6100. This chip is of interest on two counts; firstly it is a CMOS chip, and secondly, it obeys the instruction set of the well known, if not ubiquitous, PDP-8/E minicomputer, sothat programs written for the PDP-8/E will run on the IM6100. This means that there is a vast library of software available for this MPU, which makes it very attractive indeed. Like the 8/E, it has a 12-bit word length.

National Semiconductor are responsible for SC/MP, which they claim is 'enough to make any machine think'. A stroke of brilliance on the part of NS, who when other semiconductor manufacturers were falling over themselves to produce a really 'smart' MPU, came up with what most people really wanted: a stupid but cheap one. Don't be fooled, it's slow and it's got a small instruction set, but it can do things.

Also from NS is PACE, which is a

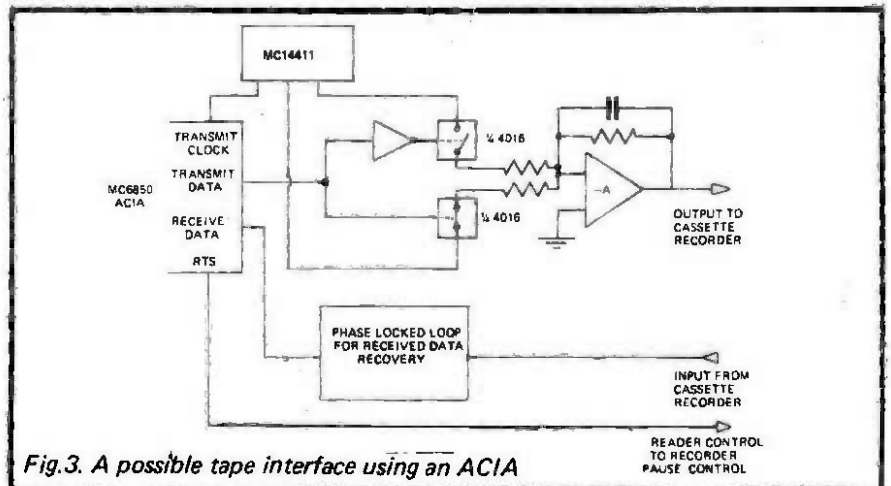
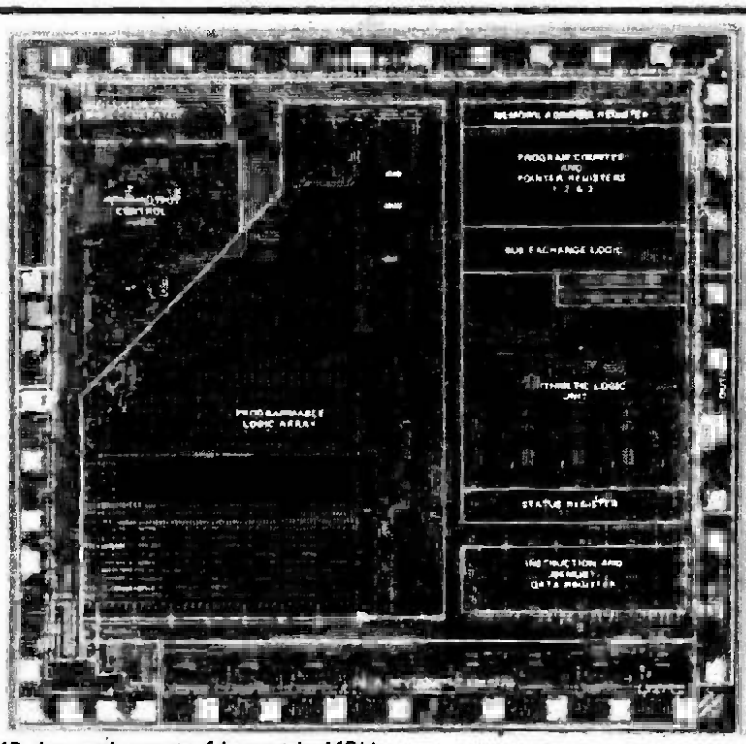


Fig.3. A possible tape interface using an ACIA



SC/MP shows the sort of layout in MPUs.

microfile

16-bit device with some nice features such as 4 levels of interrupt. It has it's nasties like every other MPU, e.g. the address and data busses are common, and the address has to be latched externally.

RCA are offering their CDP 1802 device which is a CMOS 8 bit micro. Despite RCA's attempts at the mating game, Synertek have been a bit coy, leaving Hughes holding the baby as sole second-source. Quite a nice device, this though a bit weak on decimal arithmetic, but nice from the point of view of power supply and clock requirements.

The PPS-8 from *Rockwell* has special I/O chips for just about every kind of peripheral. The power supply is a bit odd, being a single −17V, and the stack pointer is only 5 bits allowing for only 32 values on the stack.But without having used it, it's impossible to say what its good and bad points are.

That well known little company in Bedford, *Texas Instruments*, have a couple of nice products. The first is the SBP0400, which is a 4-bit bipolar bit slice built using IIL.

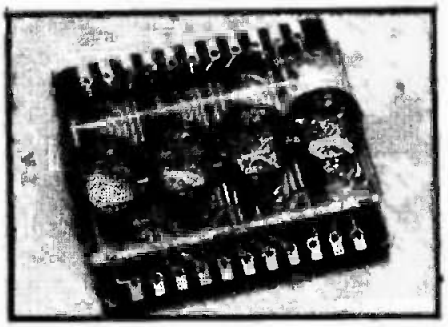
This is an interesting device that one doesn't hear too much of; somebody somewhere must be using, or planning to use, the SBP0400, but they're not saying anything. Not really suitable for the amateur, unless you want to get involved in microprogramming!

TI's other front-line device is the TMS9900, which is a 16-bit n-MOS machine with a very nice architecture and a big plus in the form of hardware multiply and divide. If the price comes down sufficiently this could be a very nice device for the amateur — but wait and see.

Finally, a device which a lot of people have been waiting with baited breath — the *Zilog* Z-80. This is basically a super 8080 in concept, with a much improved instruction set, and an extra turn of speed. Not yet readily available in this country, but when it is....

MICRO DATA

Getting hold of manufacturer's data sheets on MPUs isn't very easy for the home constructor who only wants to buy 1 micro, but fortunately many readers of this column will already have the data sheets on 6800. The trouble is that MPUs are complex devices and the data sheets are only the beginning of the story. If you want to 'read' further you have two options; you can play about with System 68 (next months ETI), or if you are in a hurry, buy the 3¾lb 'M6800 Applications Manual' which gives complete design details of a number of systems, including an absurdly complex Point of Sale terminal. A boring book to read, but good meaty stuff. It is available from *The Modern Book Company, 19-21 Praed Street, LONDON W2 1NP*, or from *Cramer Electronics, 16 Uxbridge Road, Ealing, LONDON W5 2BP*, who charge £7.50 + 50p p&p.



MICRO NEWS

ALPHA LED DISPLAY

Litronix have introduced a new low-cost alphanumeric display which contains four 16-segment LED characters. The DL-416 common-cathode display has integral magnifying lenses mounted on an an edge-connected, end stackable PCB. Intended for use in portable and hand-held equipment, the DL-416 offers high contrast daylight viewing and high legibility at distances up to 5ft. Typical operating characteristics are a forward voltage of 1.65V at 10mA, reverse current of 100uA at 3.5V, and a luminous intensity of 0.5mcd at 10mA. This looks like a pretty useful device for the MPU builder.

MORE ALTAIR IN UK

Altair's UK agents have released further details of their 680b microcomputer kit. This machine is based on the M6800 and comes complete with 1k of RAM, 1k of ROM (256 bytes pre-programmed with a monitor and loader), as well as an ACIA for teletype or VDU interface. The 680b with turnkey front panel (i.e. without the switches and lamps often found on more conventional minicomputers) is priced at £290. Also availalable is a 16k memory card, priced at £496. Free with this card is a copy of Altair's new BASIC compiler for the 680b. In addition, the system will run an assembler and text editor for 6800 Assembly Language.

Altairs other microcomputer system is the 8800, which is based on the Intel 8080. A very wide range of software is available for this system, including business and scientific programs, as well as games programs and even routines to play music. Also available is a wide range of peripherals, including a floppy disc memory system and a line printer.

Compelec Electronics, Ltd., 310 Kilburn High Road, LONDON NW6.

SERT SYMPOSIUM

The Society of Electronic and Radio Technicians are holding a residential symposium at Sussex University on 26th to 29th September on the subject of 'Microprocessors at Work'. The technical programme will consist of 25 contributions spread over 5 sessions which will cover: Devices; Evaluation, Testing and Diagnosis; Programming and Software; and two sessions on Applications. Each contribution will be followed by a discussion period.

The registration fee is £98 per delegate, unless you are an SERT member, in which case it is only(?) £82. This includes full board and conference documentation, as well as participation in all extra-curricular activities.

Associated with this symposium is a competition to find a working application of an MPU by a home constructor which is simple, economic, original, and useful or entertaining.

Further details on both these items are available from *The Microprocessor Secretary, SERT, Faraday House, 8-10 Charing Cross Road, LONDON WC2H 0HP*. First prize of the competition is £150, but you'll have to be quick, as the closing date is 19th September.

HP ADVANCE

Since many Microfile Readers are interested in, or own, programmable calculators, here is some news of the latest developments in this field from Hewlett Packard. HP have released 3 new machines, the HP25C, the HP67, and the HP97. The 25C is simply an HP25 which retains both program and data stored in it, even while switched off, thus saving the repeated entry of often-used programs. The HP67, however, represents a considerable advance on the HP65, in that it has around 3 times the program storage and 3 times the data storage. In addition, it has 20 user definable functions, 3 levels of subroutines, label, indirect and relative addressing, and 14 conditional execution functions. One important key is the Write Data key, which outputs the data register contents onto a magnetic card. The card reader is 'smart' in being able to detect whether a card carries program or data. If there is information remaining on the other side of the card to be read, it will prompt the user by displaying 'CRD'. Also included are pause and automatic register review instructions. The HP97 is a printing portable version of the hand-held HP67. Prices: HP25C; £155, HP67; £349, HP97; £590. The price of the HP21 has been reduced to £56.

KITS - CMOS - DISPLAYS - MEMORIES - BOOKS - MODULES

Components from leading manufacturers only

KITS

ACK

ATTRACTIVE 6-DIGIT ALARM CLOCK KIT

With optional CRYSTAL CONTROL for high accuracy and battery back-up (see below). Complete kit including attractive slim case with deep red panel for 6-digit alarm clock with bleep alarm, snooze, automatic intensity control and high brightness display driving. Uses MK50253 IC and Jumbo 0.5" red LEDs. 12 or 24-hour format (easy to add a switch to switch between them). Optional "touch switch" for snooze (extra). Order as "ACK" **£26.80**

Complete kit as above, plus CRYSTAL CONTROL and BATTERY BACK-UP. If mains power is disconnected (through a power cut, accidental switching off or moving clock) the clock will keep perfect time. Accuracy to within a few seconds a month. The extra components, with two PP3 batteries, all fit in the same case. While on back-up, the displays are off to conserve battery life but the alarm remains fully operational. Order as "ACK + XTK + BBK" **£33.58**

SLIM GREEN CLOCK

GCK £12.90

Complete kit for this attractive 4-digit **Mantlepiece Clock** with bright 0.5" GREEN display. While constructing, select 12 or 24 hour format, flashing or fixed colon. Kit includes miniature transformer. Housed in a new all-white slim case with green perspex front panel. Easy to build. Order as "GCK" **£12.90**
Kit as above, but less case and perspex. Order as 'GMK' **£11.14**

CRYSTAL CONTROL and BATTERY BACK-UP can be incorporated in this clock too. No need to reset your clock each time power is disconnected. For the complete kit including this feature, order as "GCK + XTK + GBBK" **£18.65**

Crystal Controlled 6-Digit CAR CLOCK Kit With Independent Journey Timer

Runs off 12V (car) battery — protected against low voltage drop-out — display comes on with ignition — internal battery back-up allows temporary disconnection. 6 digit timer times journeys up to 24 hours in hours, minutes and seconds — automatic intensity control (essential for car use) — uses 0.5" red LED digits. Same external appearance as our ACK but with 8 push-buttons for setting time, starting, stopping and resetting timer, selecting display to show "time" or "journey time" — all control buttons functional *irrespective* of display mode selected. Complete kit including case. Order as "CCK" **£39.50**

CMOS

CMOS from the top manufacturers — nearly all RCA and Motorola

CD4000	0.15	CD4033	1.21	CD4066	0.61	CD4520	1.08
CD4001	0.15	CD4034	1.65	CD4067	3.12	CD4527	1.37
CD4002	0.15	CD4035	1.02	CD4068	0.18	CD4532	1.25
CD4006	1.02	CD4036	2.23	CD4069	0.18	CD4555	0.78
CD4007	0.16	CD4037	0.83	CD4070	0.48	CD4556	0.78
CD4008	0.83	CD4038	0.93	CD4071	0.18	MC14528	1.01
CD4009	0.48	CD4039	2.23	CD4072	0.18	MC14553	4.07
CD4010	0.48	CD4040	0.92	CD4073	0.18	MC14566	1.21
CD4011	0.16	CD4041	0.73	CD4075	0.18	MCM14552	8.05
CD4012	0.16	CD4042	0.73	CD4076	1.34		
CD4013	0.48	CD4043	0.87	CD4077	0.48	**Clock Chips**	
CD4014	0.87	CD4044	0.81	CD4078	0.18	AY51202	2.89
CD4015	0.87	CD4045	1.22	CD4081	0.18	AY51224	3.50
CD4016	0.48	CD4046	1.16	CD4082	0.18	MK50250	5.00
CD4017	0.87	CD4047	0.78	CD4085	0.62	MK50253	5.60
CD4018	0.87	CD4048	0.48	CD4086	0.62	MM5314	4.44
CD4019	0.48	CD4049	0.48	CD4089	1.34		
CD4020	0.97	CD4050	0.48	CD4093	0.69	**Flat Cable**	
CD4021	0.87	CD4051	0.81	CD4094	1.62	20-w 1m.	1.00
CD4022	0.83	CD4052	0.81	CD4095	0.91	10m. for	8.00
CD4023	0.16	CD4053	0.81	CD4096	0.91		
CD4024	0.67	CD4054	1.01	CD4097	3.12	**Other ICs**	
CD4025	0.16	CD4055	1.14	CD4099	1.59	CA3130	0.88
CD4026	1.50	CD4056	1.14	CD4502	1.07	75491	0.96
CD4027	0.48	CD4057	21.56	CD4510	1.18	75492	1.22
CD4028	0.78	CD4059	4.77	CD4511	1.36	3CA741	
CD4029	0.99	CD4060	0.97	CD4514	2.72	Mini-DIP	
CD4030	0.48	CD4061	18.92	CD4515	2.72	4 to	1.16
CD4031	1.92	CD4062	7.77	CD4516	1.18		
CD4032	0.92	CD4063	0.95	CD4518	1.08		

50Hz CRYSTAL TIMEBASE KIT: provides an extremely stable output of one pulse every 20msec. Uses. May be added to all types of digital clocks to improve accuracy to within a few seconds a month ● If used with battery back-up also makes clocks power-out or switch-off ● Replacing 50 Hz signal on battery-powered equipment ● Providing film synchronisation ● Monitoring or improving turntable speed. Complete kit. Orders as "XTK" **£6.28**

STOPWATCH KIT

Complete kit for stopwatch (as in Dec. ETI): choose 6 digit range from tens of hours to milliseconds. Uses 6 x MAN3M displays. All necessary parts, including case and Manganese batteries **£31.80**
STOPWATCH WITH ONE LATCH: As above, but kit also includes facility to repeatedly freeze the displays with count continuing **£43.23**

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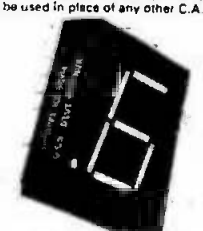
BARCLAYCARD

DISPLAYS

These Jumbo LED displays take no more current than 0.3" types. All our Common Cathode (C.C.) digits can be used in place of any other C.C. display (DL704, DL750, MAN3640, etc.) as they are all electrically identical (but may have different pin-outs). Similarly our Common Anode digits may be used in place of any other C.A. types (DL707, DL747, RS/Doram 586/699, etc.).

FND500

TIL321, TIL322



XAN652, XAN654

Part No.	Manufacturer	Colour	Type	Size	Price
FND500	Fairchild	Red	Common Cathode LED	0.5"	**£1.02**
TIL 321	Texas Instr.	Red	Common Anode LED	0.5"	**£1.30**
TIL322	Texas Instr.	Red	Common Cathode LED	0.5"	**£1.20**
XAN652	Xciton	Green	Common Anode LED	0.6"	**£1.75**
XAN654	Xciton	Green	Common Cathode LED	0.6"	**£1.75**
MAN3M	Monsanto	Red	Common Cathode LED	0.13"	**48p**
5LT01	Futaba	Green	Phosphor Diode	0.5"	**£5.80**

Display PCBs (each fits neatly into Verocase 751410J). All are for multiplexed arrays, all are suitable for FND500, TIL321, TIL322
D500-4 (for 4 digit clock) **90p**; D500-6 (for 6 digit clock) **£1.35**
D500-8 (for counter, up to 8 digits) **£1.35**

Display-holding PCBs are available for multiplexed arrays using our LED digits. PCBs also available for displays with TTL and CMOS Count/Latch/Decoder drivers. See our catalogue for more details (free on request — send sae).

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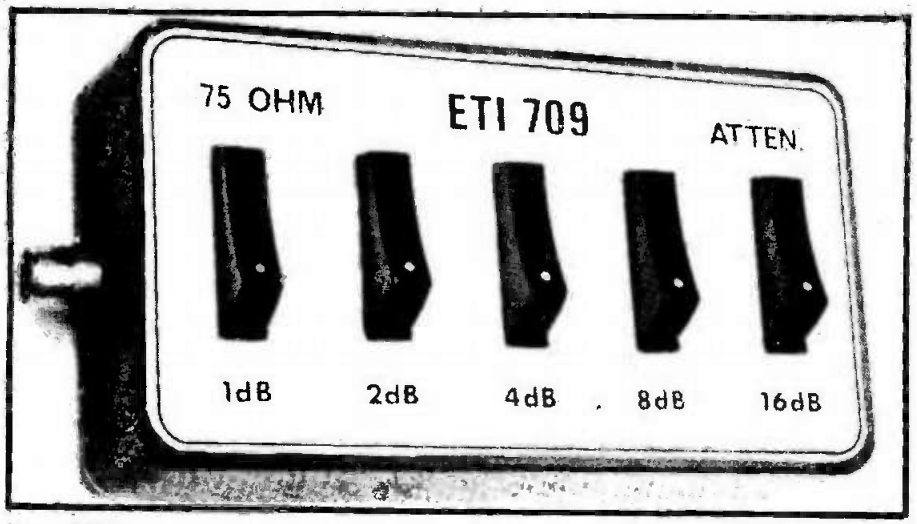
RF ATTENUATOR

0 to 31 dB attenuation in 32 steps of 1 dB – useable to more than 200 MHz.



EVERYONE experimenting with RF circuitry will sooner or later need an RF attenuator. Some of the typical uses of such attenuators are listed below.

- Checking intermodulation on HF, FM, and TV receivers.
- Checking if incoming signals are high enough to allow splitting – to feed more than one receiver.
- Changing signal levels when checking the performance of receivers.
- Evaluation of filters, RF amplifiers, and other electronic devices.
- To find the loss in coaxial cable by the substitution method (as well as the gain of amplifiers). This method is convenient as a calibrated detector is not required: merely one that will give the same reading for two successive inputs of the same level.

DESIGN FEATURES

An RF attenuator should have a useable frequency range of dc to 200 MHz. It is also necessary for the attenuator to be adequately shielded so that signals may only enter or leave via the coaxial connectors. For this latter reason a diecast box has been used to house the attenuator.

To obtain the wide frequency response required it is necessary to use resistors that have low inductance and capacitance – ¼ to ½ watt carbon types are the most suitable. If higher power handling is required one or two watt carbon types may be used but with these accuracy will start to fall off at around 100 MHz.

The switches should also have low inductance and capacitance but specially designed switches are prohibitively expensive. Many Japanese slide switches were evaluated and initially gave good results. However the ingress of dust and dirt was found to cause faulty operation after a time.

CONSTRUCTION

Construction is simple and straight forward but to obtain optimum results we suggest that you follow our method as closely as possible.

Examine the photographs carefully, the method of construction may readily be seen from them. The unit is housed in an Eddystone diecast box having dimensions of 110 by 62 by 31 mm. The switches are mounted flush onto the bottom of the box. Those at either end of the box are mounted so that the centre pin of the switch is in contact with the centre pin of the socket. This allows the connection to be made without the

HOW IT WORKS – ETI 709

The ETI 709 attenuator works by switching into the signal path a selected network or group of networks that reduces the signal strength by known amounts. The networks are specially designed so that they do not disturb the characteristic impedance of the line. That is, they appear to both the source and the load as a single parallel resistor equal in value to the respective source or load impedance. In our case the networks have been calculated to provide matching to 75 ohm impedance.

As can be seen from the circuit diagram each section of the attenuator has a characteristic shape that has led to the use of the name 'pi network' for this attenuator section.

The steps of attenuation are expressed in decibels. The voltage attenuation in decibels is equal to $20 \log \frac{V_1}{V_2}$. Where V_1 equals the input voltage and V_2 equals the output voltage. Thus if the output is half the input voltage then $\frac{V_2}{V_1}$ equals 0.5 and 20 log 0.5 equals – 6.02 dB. (the minus sign indicating attenuation).

The use of decibels is very convenient as it allows the combined value of two or more attenuators to be found by simply adding their separate values rather than by multiplying the separate attenuation ratios.

Each succeeding attenuator is chosen to be twice that of the one previous. This binary form allows us to obtain a range of 0 to 31 dB in 32 steps with only five switches. Thus for example if we require 5 dB we depress SW1 and SW3 to give us 1+4=5 dB.

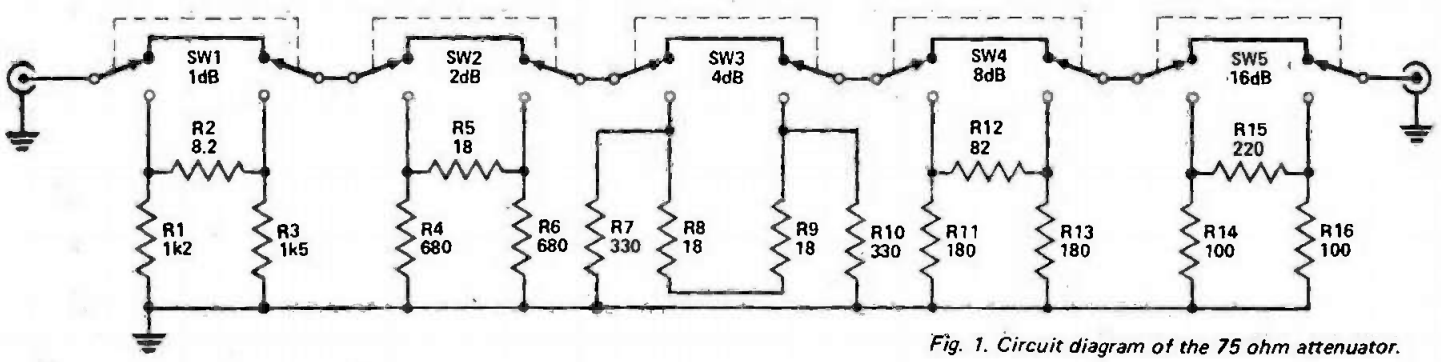
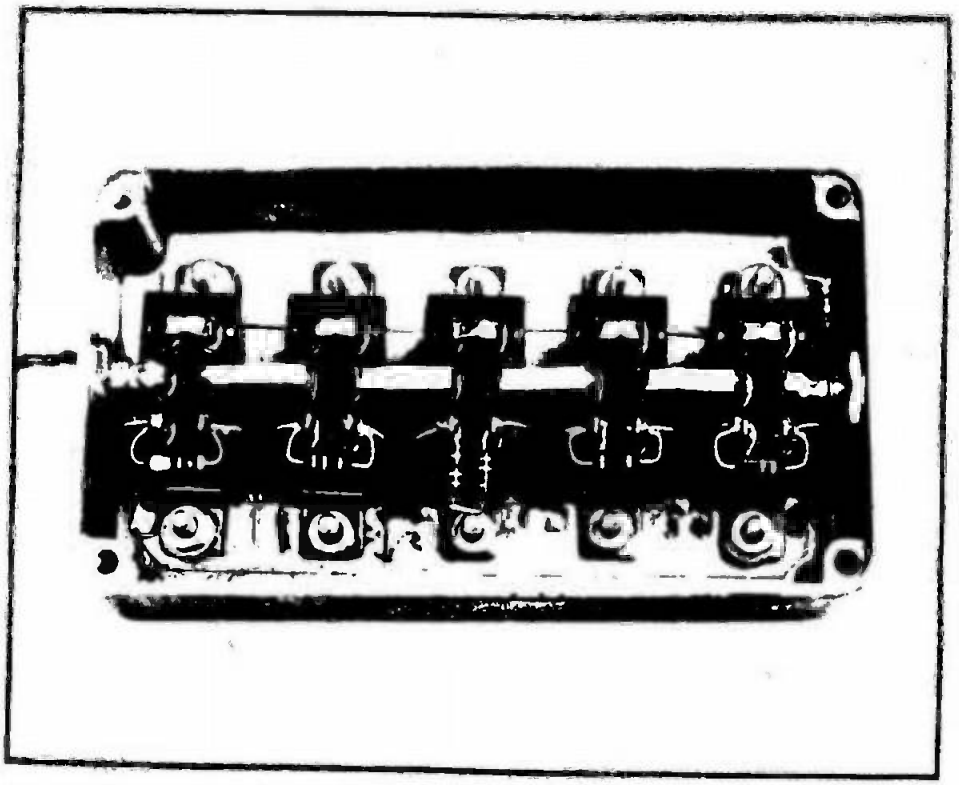


Fig. 1. Circuit diagram of the 75 ohm attenuator.



PARTS LIST ETI 709

R2	Resistor	8.2Ω	¼W	5%
R5,8,9	"	18	"	"
R12	"	82	"	"
R14,16	"	100	"	"
R11,13	"	180	"	"
R15	"	220	"	"
R7,10	"	330	"	"
R4,6	"	680	"	"
R1	"	1k2	"	"
R3	"	1k5	"	"

SW1-5 Slide Switch min DTDP

2 RCA Phono Sockets (see text)
Die cast box Eddy stone 7134P
110mm x 60mm x 30mm

TABLE 1

ATTENUATION	R*	ACCURATE VALUES 75 OHM	ACCURATE VALUES 50 OHM	CLOSEST PREFERRED VALUE 50 OHM
1 dB	R1	1304	869.6	820
	R2	8.8	5.8	5.6
	R3	1304	869.6	820
2 dB	R4	654	436	470
	R5	17.4	11.6	12
	R6	654	436	470
4 dB	R7	331.6	221	220
	R8	35.8	23.9	12 + 12
	R9	0	0	0
	R10	331.6	221	220
6 dB	R11	174.2	116	120
	R12	79.3	52.8	27 + 27
	R13	174.2	116	120
16 dB	R14	103.2	68.6	68
	R15	230.7	154	150
	R16	103.2	68.8	68

* All values in ohms

use of hookup wire. Evenly space the remaining three switches between the two outer ones. Note that a thin strip of tin plate is run the full length of the box and is held in place by the lugs and screws at one end of each switch. To this strip are soldered the ends of the resistors which go to ground. The resistors are held in such a position by their leads that the metal body of the switch acts as a shield between the resistors mounted on either side of it.

The centre poles of the switches are interconnected by first bending the centre lugs of the switch outward towards the next switch and then by soldering lengths of 3 mm wide tinplate between them as shown in the photos.

ELECTRONICS —it's easy! PART 31

Concluding counting and D/A conversion

BLANKING

In normal writing practice we do not write the '0's that appear at either end of a number, for example, 0001357.0 as could be held in an eight digit display, is better presented as 1357 or as 1357.0. A facility is sometimes provided in display-counter systems that blanks unnecessary zeros. Leading zero suppression is performed within the decoder stages of Fairchild seven-segment decoders by connection of the ripple blank output RBO (ripple because each stage connects to the next) of the decoder stage to the ripple blank input RBI of the next lower decoder stage. Blanking of least-significant zeros is not usually included. The actual arrangement for blanking control varies from maker to maker. Fig. 1 shows a method using ripple blanking.

The blanking facility can also serve other purposes. It can, in certain applications, be used to blank-out illegal display values resulting from incorrect codes. The RBO output also provides a detection output indicating when the decoder stage is at the BCD zero state.

INTENSITY CONTROL

Displays are usually manufactured to supply one value of output brightness. When brightness is to be tailored to particular ambient light conditions an appropriate kind of display can be selected that provides the desired luminance level. This however, does not always lead to a satisfactory choice when other considerations are taken into account.

Intensity of any display, however, can be controlled in a digital manner (that most desirable in digital systems) by turning the display on and off with an appropriate duty cycle (ratio on to off period). This is called pulse-duration intensity modulation. Provided the repetition rate exceeds 100 Hz the eye cannot detect that the radiation source is being modulated. Modulation may be achieved with any of the blanking methods given above. The schematic of Fig. 1 includes an intensity modulation facility.

With LED displays, intensity modulation can actually increase the apparent brightness. The human eye has a characteristic response to radiation that has greater sensitivity to the peak value of modulated light, rather the average or rms power. LEDs can be pulsed at high frequency with high peak currents because of their nanosecond response time. The net result is apparently higher brightness for a given amount of power.

STROBING OR SCANNING

Displays which generate characters in the 7 x 5 dot matrix or seven-segment formats require decoding logic which energises the correct dots or segments. If each character has its own decoder we would need 7 lines for each digit of a seven-segment display. And 35 lines for each digit of a 7 x 5 dot-matrix display!

Obviously a method is needed to reduce the number of lines and circuitry required for multi-digit displays.

One such method is called strobing where lines of dots or segments are illuminated sequentially. The 7 x 5 array can be either strobed as lines horizontally or as rows vertically as illustrated in Fig. 2. Each row is selected one by one in sequence and the appropriate diodes in the row energised. Provided each row is returned to at no greater than 10 ms intervals the characters will be flicker free.

A diagrammatic illustration of how specific diodes are selected in a row is given in Fig. 3. The row switches are scanned in turn to cause a vertical scan. Simultaneous excitation of the other switch sets decides which diodes in the row are to be illuminated.

A strobing system requires a

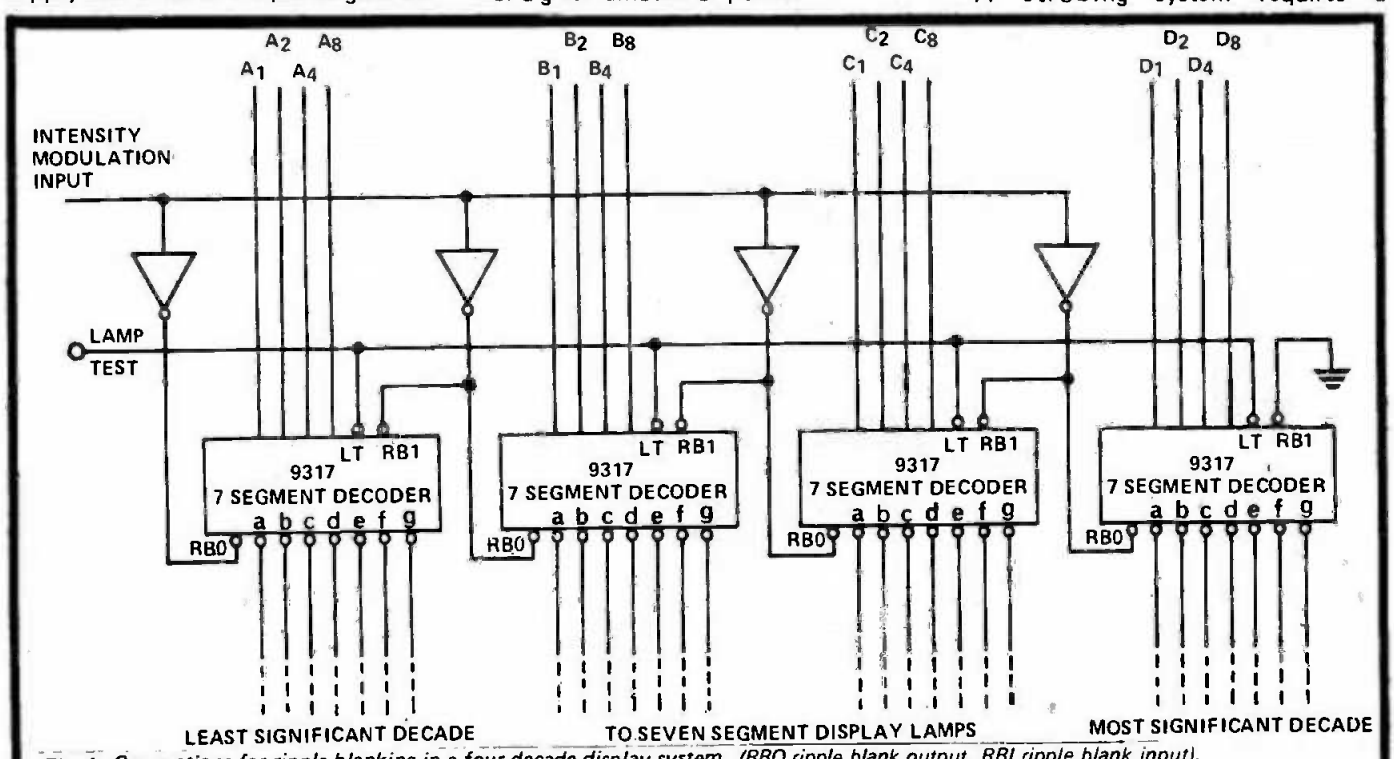


Fig. 1. Connections for ripple blanking in a four-decade display system. (RBO ripple blank output, RBI ripple blank input).

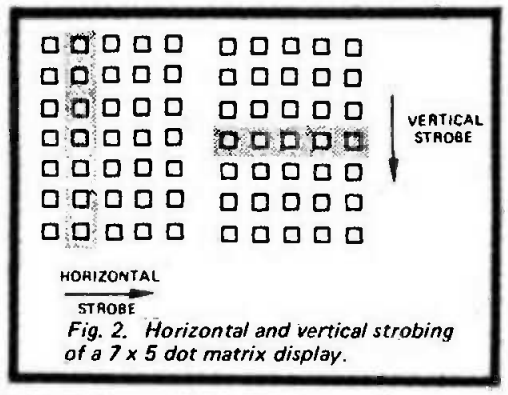


Fig. 2. Horizontal and vertical strobing of a 7 x 5 dot matrix display.

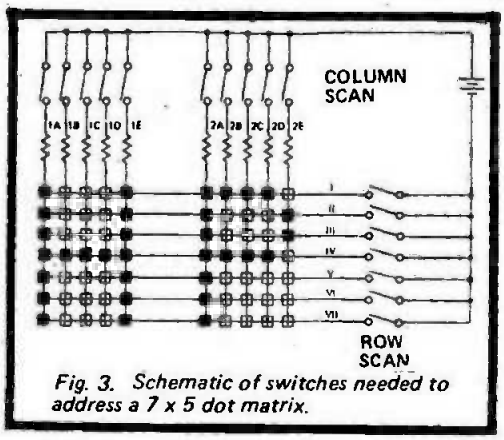


Fig. 3. Schematic of switches needed to address a 7 x 5 dot matrix.

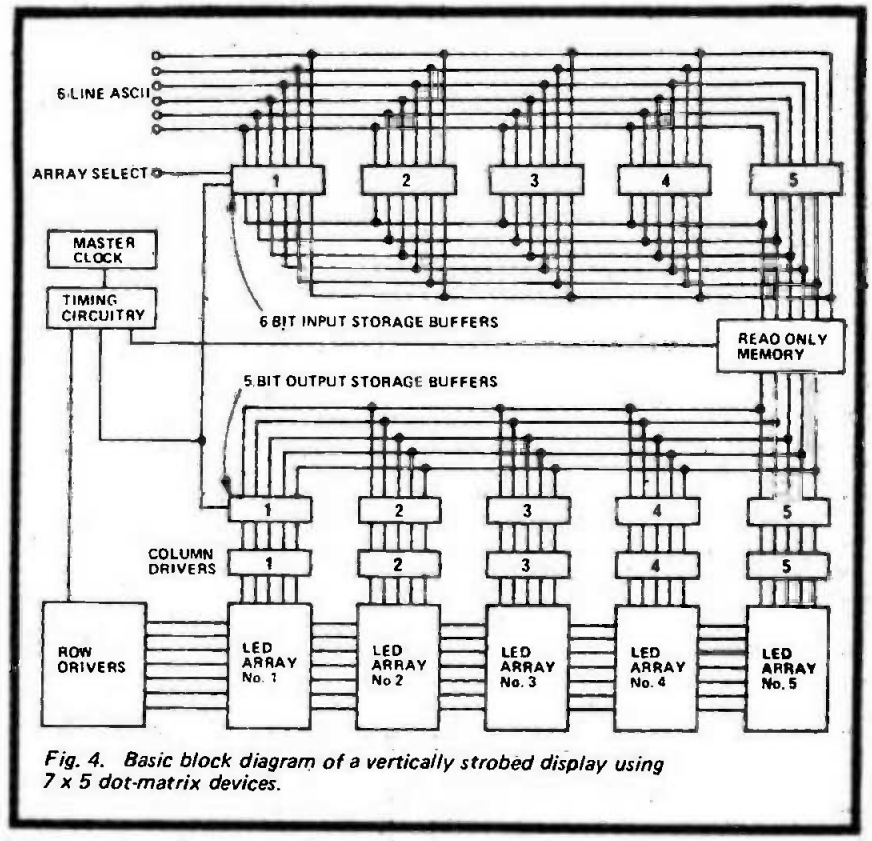


Fig. 4. Basic block diagram of a vertically strobed display using 7 x 5 dot-matrix devices.

procedure to sequence the scanning action and a method of setting the selection switches that corresponds to the characters needed. The whole is controlled by a clock and timing generator. Storage buffers are also required to store the sequentially generated information. The task of creating the appropriate character timing codes is performed by a read-only-memory ROM. Clearly this method adds up to a complex system . . . really beyond this course's purpose. A schematic block diagram of a vertically-strobed five-digit LED display is geven in Fig. 4. Although of apparently great complication this method is less expensive to employ than direct actuation through fixed gates. (Considerably more detail is to be found in the suggested reading list).

Another scanning method scans the matrix as a raster – across a row, one by one, and then to the next row. Strobing obtains its advantages by time-sharing common elements in a time-multiplexed manner.

MULTIPLEXING

When the input data to be displayed appears in serial form or when large numbers of displays (over four digits) are involved, multiplexing (selection of complete digits sequentially) becomes advantageous for driving seven segment and one-of-ten displays. The basic multiplexing system requires the main system units shown in Fig. 5. An upper limit to the number of digits is around 12 and higher for LEDs. There are disadvantages; namely, a higher voltage is required in the display to achieve the same brightness (LEDs are not so critical as other forms of display); the scan frequency must be at least 100 Hz to prevent flicker; transients must be carefully decoupled; and a clock failure (which stops the scan) may produce partial display failure because of excessive dissipation brought about by the increased voltage applied. (It is usual to include a failsafe protection circuit).

Again, the complexity appears great but in practice the multiplexed system is simpler to build. For example, a multiplexed, seven-segment display, with storage for eight digits, involves around 10 dual-in-line packages and a few discretes which compares with about 16 ICs for a non-time shared system.

To further reduce the connections that must be made upon assembly, manufacturers offer multi-digit displays in which the anodes and cathodes of the LEDs are internally connected ready for multiplexed operation.

OTHER CONVERTERS

Apart from digital-code converters, other converters are required in instrumentation: for example, when interfacing different systems of logic, eg TTL to CMOS, it is necessary to alter the dc levels of signals so that the output of one system provides the logic levels required by that following. This may require amplification or attenuation or shifting of a level.

However specific ICs are marketed to suit various interfacing requirements. Other converters are needed for sending digital signals through standard transmission lines in communication links, for receiving signals from lines, for increasing the logic level differences to increase noise immunity (again for transmission), and units that drive peripheral devices such as relays and indicators. Signal inversion may also be necessary – we

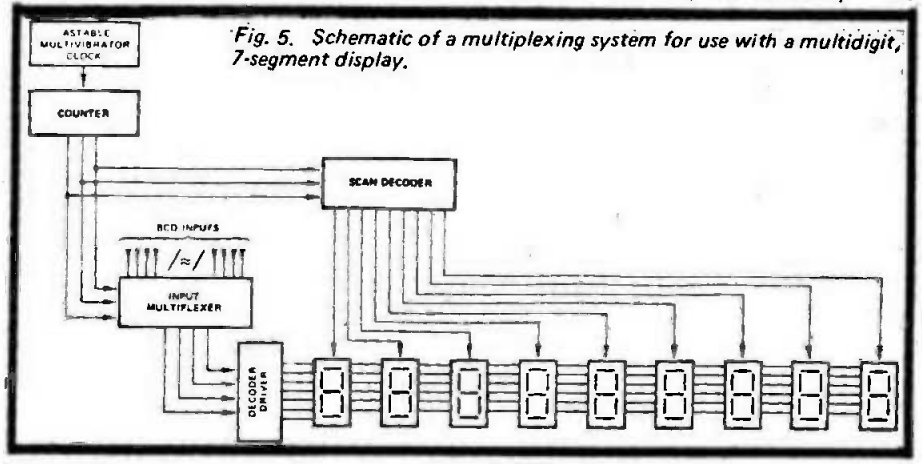


Fig. 5. Schematic of a multiplexing system for use with a multidigit, 7-segment display.

have already dealt with the inverter block earlier in the course.

Another class of converter is needed for converting digital signals to analogue voltages (D to A) and analogue voltages (and currents) into digital form (A to D). Such converters will be dealt with in the next section.

D TO A AND A TO D

In order to control or modify the physical world around us we must first measure what is happening. The measurement data is almost always in analogue form, as is the actuation required for control. Between measurement and control some kind of electronic system is needed to amplify and shape the data.

We have seen that electronic systems may be of either analogue or digital form and it would seem best to use an analogue system between inputs and outputs that are both of analogue form. But not necessarily so – analogue systems are plagued with problems such as noise, dynamic range limitations, accuracy and linearity. Digital systems, as well as offering improved performance in the above areas, offer more economical processing of data, the ability to store data as long as needed, and more readable displays of data held within the system.

Thus there is much to be said for converting primary analogue signals into equivalent digital forms that are processed and stored etc until conversion back to analogue form becomes a necessity. Electronic sub-systems that perform these conversions are called Digital-to-Analogue Converters (DAC's or D/A converters) and Analogue-to-Digital Converters (A/D converters).

We will see that these are quite complicated systems in themselves – their design a skilled task. Nevertheless, many such sub systems are now marketed as single, largish circuit blocks that are wired into the total system in the same way as other complicated system building-blocks we have already encountered. It is, however, important to understand the basic techniques used if not so much the refinement of actual practice.

By use of certain input combinations DAC's can also be used as multiplier/dividers of two signals and as summing/subtraction units. It is also

Fig. 6. Typical A/D converters.

relevant in this part to deal with multiplexers in a little more detail and with the so-called sample-and-hold circuit. These are often used in conjunction with DAC's.

Figure 7 illustrates the basic requirements of a typical data-acquisition system in which a number of physical variables are measured and processed to provide digital signals for storage. It uses multiplexer, sample-and-hold, and A/D converter sub-systems to form the whole.

Also pertinent, because similar techniques are involved, is the method for converting an analogue voltage to a signal of proportional frequency (which is a form of digital signal) – the Voltage-to-Frequency or VF converter.

The uses for A/D and D/A converters are limitless. Their application is ever-increasing as the unit cost falls to undreamed-of prices. Extreme complication using digital techniques often costs far less than simpler but less accurate analogue alternatives. Hence D/A and A/D converters will be found in digital panel meters, digital multimeters and data acquisition systems. They are also found in industrial plant; in process control of chemical and other manufacturing plant; in telemetry systems and other data transmission applications; in the interfaces (units matching the output signal requirements of one system with the input requirements of another) found between sensors and computing units; between stages of hybrid computers; and the like. Although highly accurate DAC's may cost as much as £1000 the great universal demand has resulted in lower performance units being available for as little as £5.

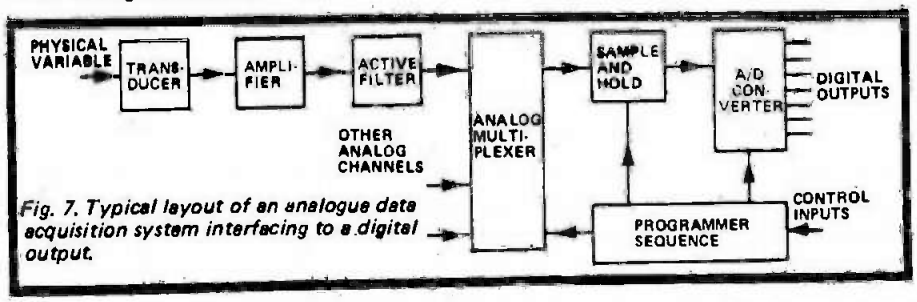


Fig. 7. Typical layout of an analogue data acquisition system interfacing to a digital output.

DIGITAL-TO-ANALOGUE CONVERSION

We begin with Digital-to-Analogue converters because they are the simplest in concept and use only one basic technique.

You will remember that each digit position of a binary number (held in a register, counter or other form of storage) has a weighting factor, eg 1:2:4:8 etc. An analogue signal equivalent to the binary number can be obtained by using each digital digit position to switch an amount of current (proportional to the position weighting) to a common summing junction. This system concept is shown in Fig. 8. When voltage output is needed the currents feed an op-amp The detail of a precision ladder network is shown in Fig. 9 – it is set to convert the input digital number 11010001 by appropriate positioning of the digit position switches. When at 0 input the inputs to the summing op-amp are held to ground; when at 1 to an appropriate stabilized voltage.

The simplest form of ladder is used in the circuit of Fig. 9. It arises from the use of a binary weighted resistor sequence shown in Fig. 10. The actual values of resistors are selected to obtain adequately sized lowest and largest values, for at either end the op-amp loses accuracy due to imperfections of resistance ratios. It can be seen from the circuit of Fig. 9

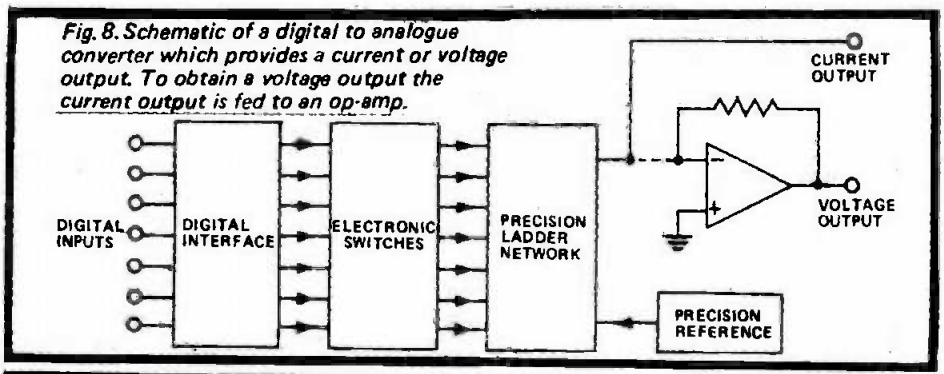


Fig. 8. Schematic of a digital to analogue converter which provides a current or voltage output. To obtain a voltage output the current output is fed to an op-amp.

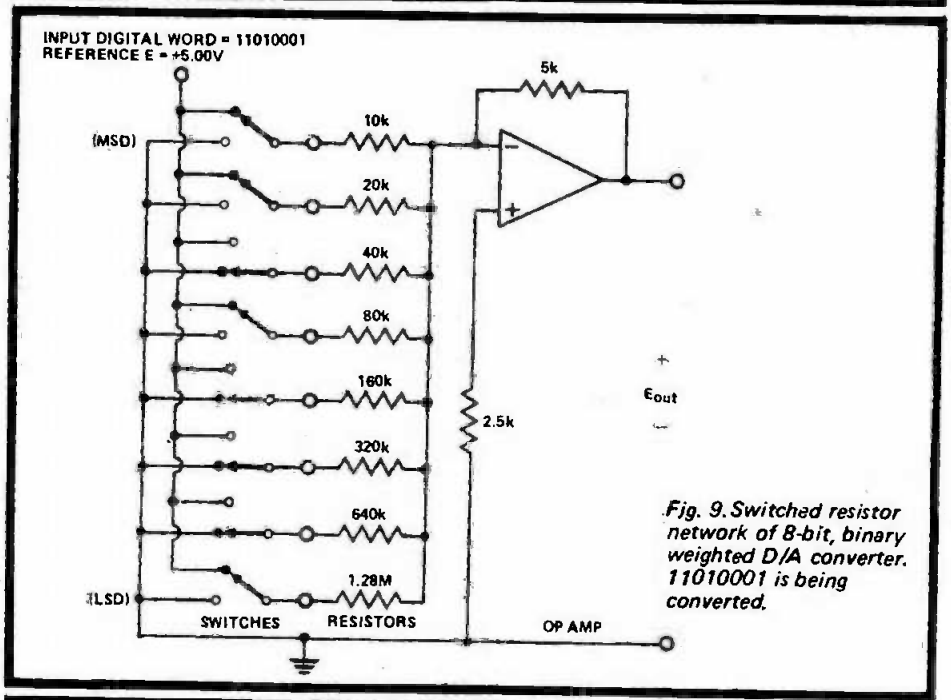


Fig. 9. Switched resistor network of 8-bit, binary weighted D/A converter. 11010001 is being converted.

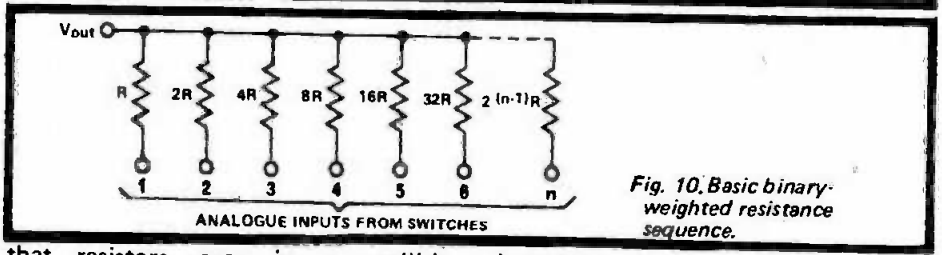


Fig. 10. Basic binary-weighted resistance sequence.

that resistors, even in a smallish capacity 8 bit converter, can extend to extreme values. The least significant bit must be clearly resolved when its switch operates, implying that all other resistors must have precision of absolute value and constancy with time that rises very rapidly with the number of bits required.

In practice this simple form of ladder is not used beyond about 8 bits conversion due to the cost of the precision resistors required.

The disadvantages of the simple ladder method are mostly overcome by the use of the R-2R ladder network shown in Fig.10. The through leg of the chain is permanently grounded, each spur is switched as needed to a reference stabilised voltage level. The features of this method are that only two values of resistors are needed (an easier practical problem) and that the absolute range seen by the op-amp varies much less than the above method for a similar bit capacity – it presents a virtually constant impedance regardless of the binary code sequence switched in. With the R-2R ladder it is routine to provide 12 bit conversion.

It is probably obvious that other forms of digital-coding conversion can be handled by the use of appropriate resistor weightings. For example it is often necessary to chart-plot the output of a digital instrument. Thus a BCD to analogue converter is required for such applications. Figure 12 shows the weighting sequences for the simple and the R-2R ladder DAC's needed to convert BCD inputs to an analogue output.

Resolution and accuracy – DAC's rarely go beyond 12 binary bits (or 3 digit BCD) because the output analogue signal for greater bit-ranges must be of high stability. A 16 binary bit (or a 4 digit BCD) unit could provide ± 0.005% full scale linearity and accuracy, a performance requirement that is best avoided where possible because of the high cost of the DAC. By contrast 8 bit DAC's can be obtained with accuracies ranging from ± 0.2% full scale to ± 0.01% full scale. It is important, however, to realise that whereas analogue resolution, see Fig. 13, is a function of the number of bits that are equivalent to full scale, the accuracy and linearity of DAC's depend upon the tolerances and stability of resistors used in the conversion networks, for these decide the value of the slope and straightness of the slope – Figs. 14a, 14b. It is, therefore, possible to have an highly accurate converter that has quite coarse resolution – in which case the resultant analogue output signal will consist of very large step changes. This step form of signal defect is called quantum or quantization noise. In practice resolution and accuracy are tied together keeping quantum noise to an acceptable level.

Conversion and settling times – As both D/A and A/D conversion are dynamic processes, a finite amount of time is required for each conversion point to reach its final value. In DAC's the switching and settling times of the op-amp largely dictate the time for a bit change to finally appear as a steady-state analogue signal level. Early DAC systems using mechanical switches were slow indeed – today output settling times range from a slow 25μs for very-low power consumption units to ultra-fast 25ns units.

Temperature coefficient – Each subsystem of a DAC has a temperature coefficient; resistances alter with temperature and the op-amp characteristics deviate. Both the overall conversion gain and the dc zero will be affected.

Gain will be affected due to the temperature coefficient of resistors which is typically from 50 to 100

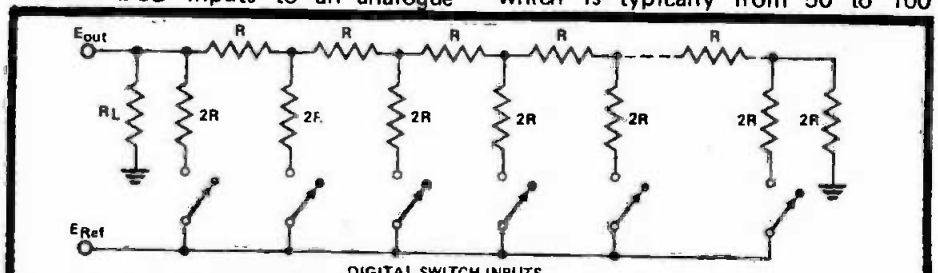


Fig.11. The R-2R ladder network requires only two values of resistance and presents constant impedance to the output.

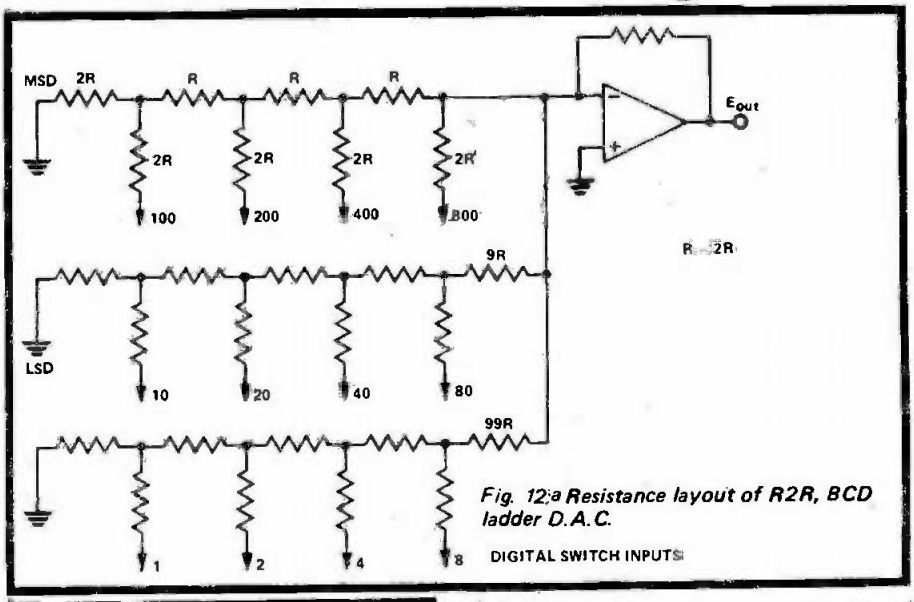


Fig. 12a Resistance layout of R2R, BCD ladder D.A.C.

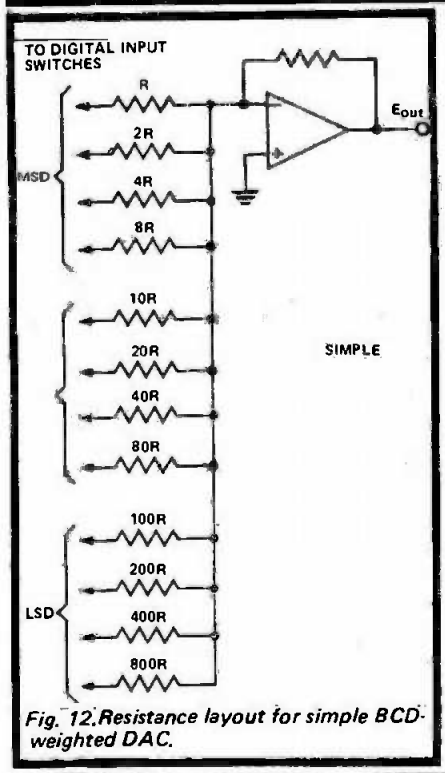


Fig. 12. Resistance layout for simple BCD-weighted DAC.

PPM/°C (100 parts per million, PPM, is equivalent to 0.001% change per degree Celsius). The main op-amp characteristic which affects performance is offset-voltage drift – typically 30 microvolts per degree Celsius.

For each particular type of DAC it is necessary to consult the makers' specification sheets, for no general rules apply for these parameters.

DAC's are available as either current or voltage output systems. Typical outputs deliver around 3 mA and 10-20 V swings.

Further explanation of terms used is to be found in the articles listed in the further reading section.

Glitches – Certain digital input states, whilst in a transient state, can cause the output to produce noticeable transients to the smooth, stepwise analogue – signal progression. These are known as glitches; examples are shown in Fig. 15. If the output is only to be observed after the system has settled, these matter little. In dynamic use of DAC's however, they may well excite unwanted behaviour in the system they are driving.

Deglitching in DAC's is not feasible with a low-pass filter on the output, for glitches vary widely in nature. The best solution is to use adequately fast and matched switching coupled with special deglitching, (sample-and-hold) circuits, that hold the output fixed during unwanted switching – transient conditions. Glitching states are, however, known states and are quite unlike random noise which defies prediction. ●

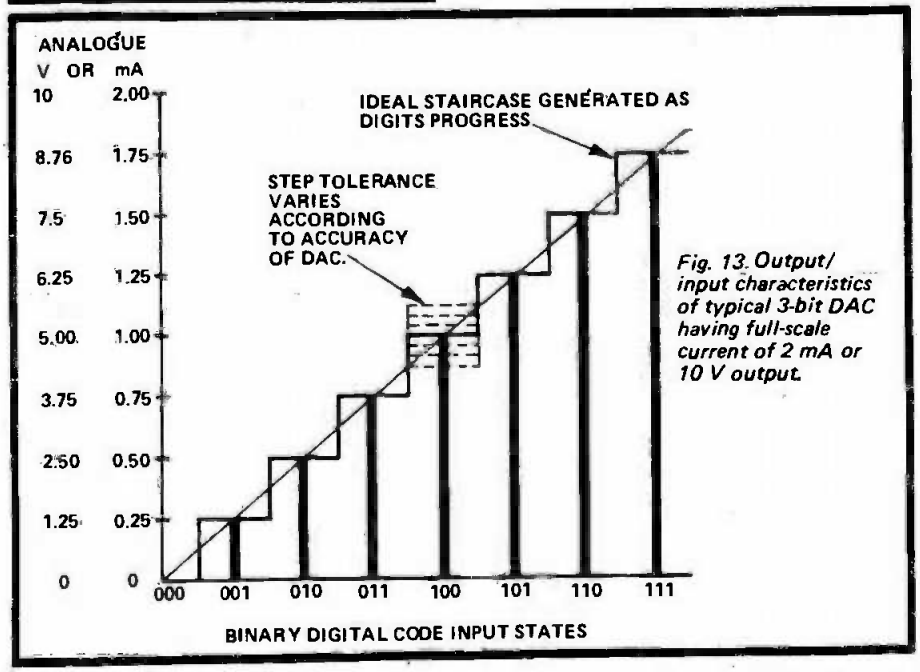


Fig. 13. Output/input characteristics of typical 3-bit DAC having full-scale current of 2 mA or 10 V output.

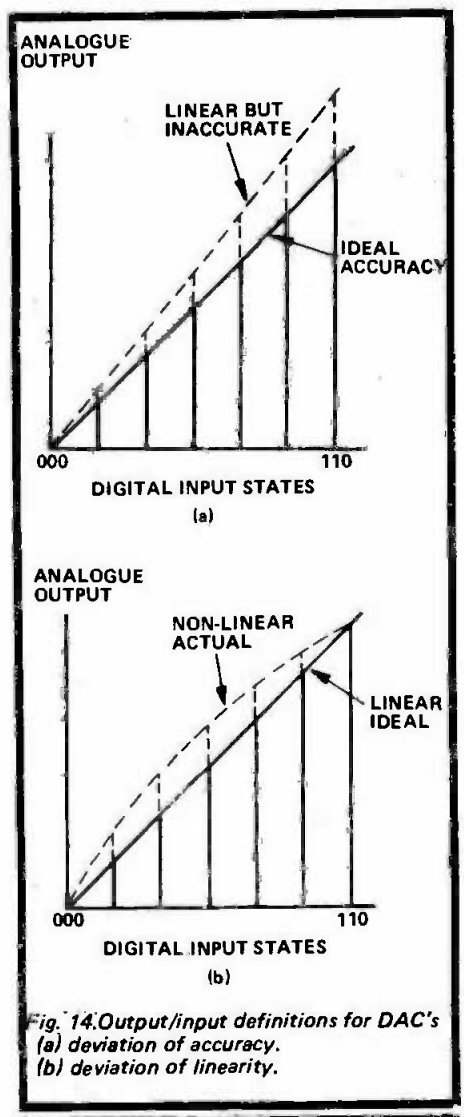


Fig. 14. Output/input definitions for DAC's (a) deviation of accuracy. (b) deviation of linearity.

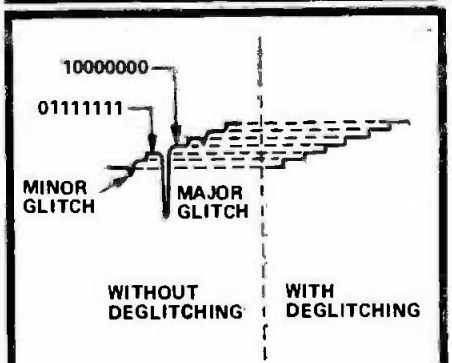


Fig. 15. Glitches occur in basic DAC's due to certain transient dynamic error conditions. They are eliminated by deglitching circuitry.

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ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

LAST MONTH I, very foolishly, announced that the SC/MP Introkit was priced at £50 (which it isn't!). It is REALLY £54.50 plus 8%. The WORST thing that I did was to mention the pseudo-TTY unit called the Telekit which was also supposed to be about £50. It isn't. The prices being quoted for it are in the range £160-£200 and you can build your own for less than that!

One of the main problems with all of the instant MPU kits on the market is that they all require a TTY teletype in order to communicate with the KITBUG or BUGBUG program supplied with the kit. These programs are supplied in PROM form and thus it is rather difficult for the average user to reprogram the kit, especially as you have not been able to practise programming because you cannot communicate with the MPU (except through a TTY which costs nearly £1,000). National Semiconductor came up with an answer to this problem for their own use, teaching people to use SC/MP in their educational courses.

As each course might have 50-100 people, the cost in normal teletypes would be enormous and so the brains at NS in Germany modified a calculator to a very simple TTY compatible unit to talk to the Introkit. Apparently they made about 25 of these units, considered production, then (in the USA) pulled the calculator which they had used out of production. Disheartened, it seems that they gave up for the time being as nobody can quote a delivery date or price for the unit although NS distributors have taken orders for it.

SECRET REVEALED

Now we tell you the secret -- you can make one for yourself! If SC/MP is intelligent enough to be able to talk to a TTY then conversely SC/MP is intelligent enough to BE a TTY. So you buy two Introkits and reprogram one of them to be a very simple TTY device. I know I mentioned earlier that it was difficult to program when you have not been able to practise, but the point is that NS already have a TELEKIT program and if they want to sell SC/MP units they MIGHT make this program available.

It only needs one person to have a suitable program, and anybody else can have a copy of the PROM with the program in it.

N.B. If you send PROMs through the post, especially abroad, put a big notice on the outside of the packet about X-raying as this can be a good cheap way to clear U-V erasable PROMs.

KIT INTROS

Fig 1 shows the components used in addition to an Introkit. Flag 0 and Sense B are used for the I/O, buffered through a pair of opto-isolators. The PROM is programmed to put one "1" and seven "0's" out on the SOUT line and to shift the one bit across the keyboard matrix using another Flag as a clock. Any key pressed will connect the bit in the DM8546 shift register to an input on the 74C175 register.

This register is eventually read back into the CPU chip, and can be used to decode which of the keys was pressed. The code generated by the key is used to look up a table in the PROM to decode it into an alpha-numeric character displayed on the seven segment calculator display (NS have worked out a 40 character set which can be displayed using 7-seg plus a DP). This character is now output to the character register which will eventually direct it onto the display.

PROGRAMME TIMERS

The other half of the program accepts any keyboard entry and outputs it with all stop bits etc. to FLAG O, and eventually to the pseudo-TTY output pins. Similarly, any input at the TTY pins is detected by SENSE B, decoded and checked internally then output to the display.

The 9 digit output is enough for most programming applications, but is not so good for normal I/O requirements. However, if you are using SC/MP for a complex timer, such as a traffic light controller or similar, this does not need to communicate with people via the alphabet, and thus Telekit is great for programming this application.

So off you go to buy two Introkits and reprogram one of the PROMs -- can't afford two plus a calculator, etc? Well, how about programming into RAM instead of PROM? Introkit comes complete with a KITBUG PROM and very thoughtfully a listing of KITBUG, the listing can be used to study programming by working out what the KITBUG program is doing. The PROM comes complete with socket so it can be removed and replaced with RAM chips in a PROM simulator.

SIMULATOR PLUG

This can be simple to build and requires four MM2112 256x4 RAMS plus a MM74C00 (CMOS 7400) to replace the 512x8 bit PROM plus about 20 switches and buttons and some LED lamps. The Simulator is made to plug into the 24-pin socket normally used by the PROM and looks like a PROM to the CPU chip.

The difference is that this 'PROM' can be programmed by 9 address toggle switches, 8 data switches and a 'program' button connected to the R/W pins. Power for the unit is derived from the socket, but it may be an idea to include a large storage capacitor to allow for temporary disconnection without loss of memory.

If you really want low power you can use some of the new CMOS RAMs available which will store the memory for several days from a small battery or for a couple of hours from a large capacitor. Cost of such a simulator would be about £20 for MOS 2112 RAMs, or £50 for CMOS RAMs. This plus an Introkit allows you to program your own MPU for less than £100.

DO IT WITH YOUR MPU!

We now have an MPU kit which can be programmed to your own

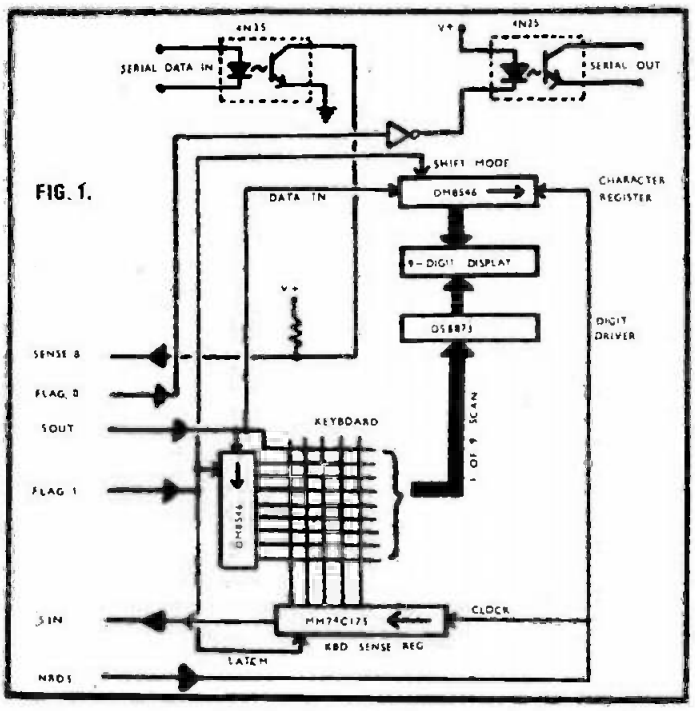


FIG. 1.

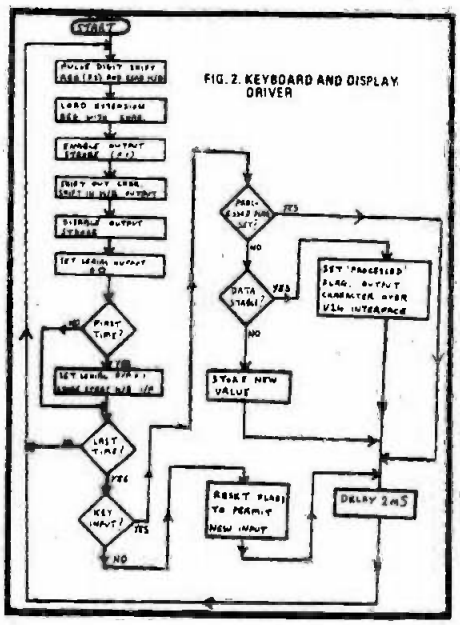


FIG. 2. KEYBOARD AND DISPLAY DRIVER

requirements (you could even copy most of the KITBUG program if you so wished) so now what can you do with it?

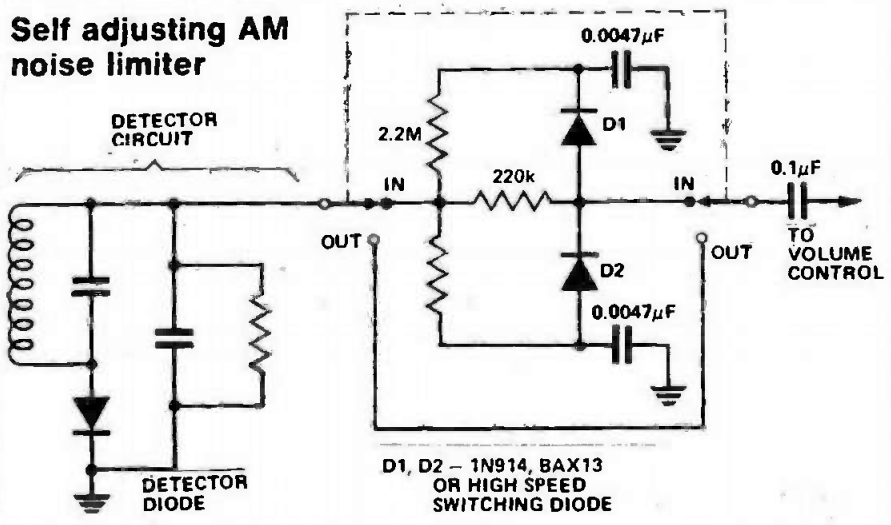
How about using the ETI 560 VDU to enable you to play games on your own TV set? Total cost is in the area of £150 we know, but for this you have a unit MUCH more sophisticated than any other TV game. You could play Draughts, Nim, Scrabble, Chess, Go, Backgammon, Monopoly etc with the CPU generating the dice.

Invent NEW MPU games -- after all **you** are the programmer.

If you come up with any programs, or with a TELEKIT program for SC/MP or 6800 let us know at ETI -- then we can pass this information onto other readers, in MICROFILE perhaps. ●

tech-tips

Self adjusting AM noise limiter



This is a very effective self-adjusting positive and negative peak noise limiter. The detector diode is part of the usual detector arrangement in a receiver and provides a negative bias which varies with the average signal strength (bias provided by D1 and D2). When a noise spike appears on the positive swing of the demodulated audio wave form, D1 conducts flattening out the spike. Similarly when a noise spike appears on negative swing of the audio, D2 conducts flattening out the spike.

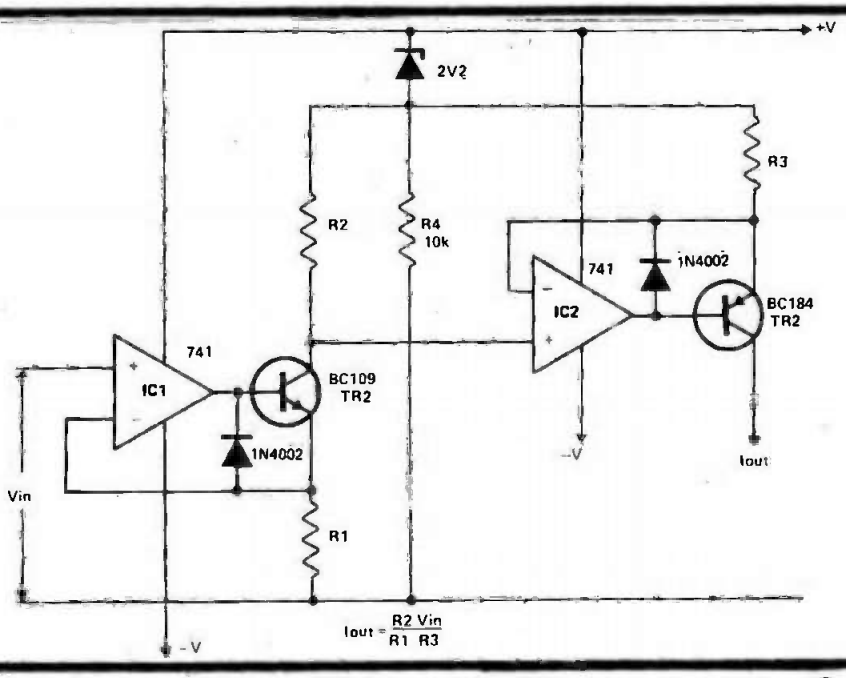
The circuit causes considerable reduction in audio output when in circuit and cuts the high frequency response.

VOLTAGE CONTROLLED CURRENT SOURCE

The voltage follower IC1, buffered by TR1 provides a current at the collector proportional to the input voltage due to R1. This current is applied to R2 which means that the voltage across it will be Vin $\frac{R2}{R1}$.

IC2 forces the voltage across R3 to equal that across R2. The zener prevents IC2's inputs from operating at the supply rail.

In this circuit the input voltage is generated relative to the 0V rail. For maximum output voltage capability the voltage across R2 and R3 at the maximum proposed output current should be kept small. However offsets in the IC's have more effect on the linearity as the max resistance of VR2 becomes smaller — these should be nulled out.

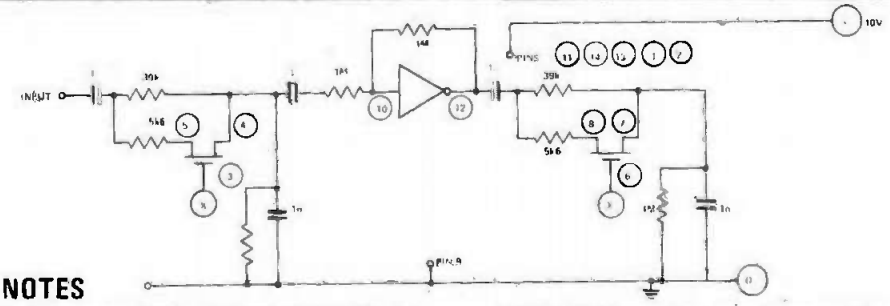


CHEAPO VCF!

Readers intending to build the dynamic noise limiter may be interested in the following circuit.

The circuit consists of two RC low pass filters connected by a unity gain buffer (inverting).

The n-channel MOSFETs are used as voltage controlled resistors to vary the cut-off frequency of the two filters which are controlled by a voltage entered at points X – The additional resistors limit the variation to limits of 5 and 50kHz.



NOTES

1. The control voltage should be positive-going, not negative-going as in the original.
2. Signal input should be restricted to 50mV, when distortion will be low.
3. The cut-off is less sharp than the DNF VCF so less trouble can be expected from changes in bandwidth, as such changes will be less obvious.
4. A high impedance buffer is required at the output.

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 ETI TECH-TIPS, Electronics Today International, 36 Ebury Street, London SW1W 0LW.

SELF-CLEAR

The network consists of two resistors R2 and VR1 arranged as a potential divider, the latter being shunted with a non linear load Q1 whose value depends on the voltage developed across R1. This is related to the charge of the capacitor C1. The resistor VR1 was made variable to make the design less critical.

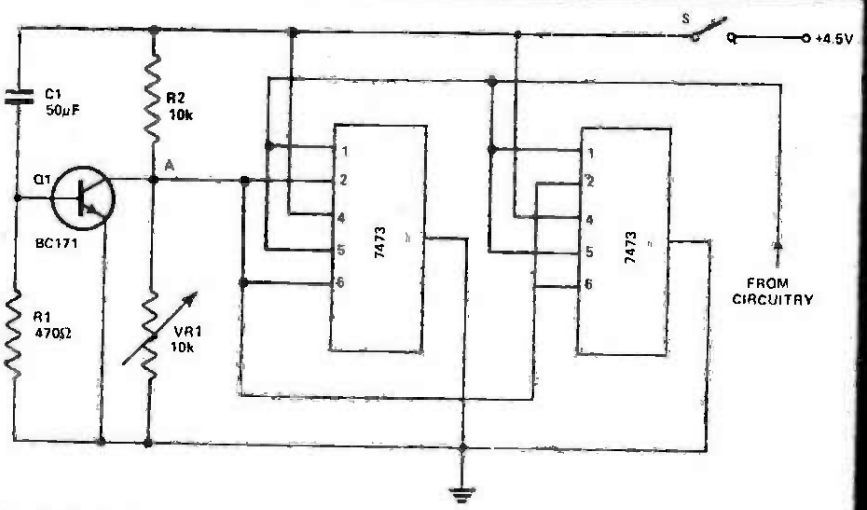
As soon as S is closed, C1 starts charging; at the same time the base-emitter junction is being forward biased and Q1 conducts, bypassing VR1. Voltage at point A is "low" and a set pulse is produced, therefore.

When the charge on C1 reaches a given value, Q1 stops conducting and voltage at point A rises to a stabilized value which is approx. 4.5 VR1/(R2 + VR1).

Component values are not critical although R1 and R2 must be close to the indicated values.

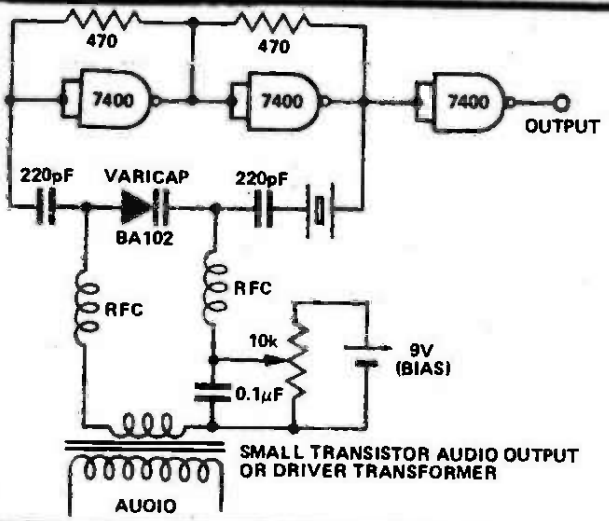
Any NPN silicon transistor will work the prototype being assembled with the BC171.

VR1 adjustment depends, amongst other things, on the number of flip-flops and must be adjusted in each particular case to give best results.



FM modulated TTL crystal oscillator

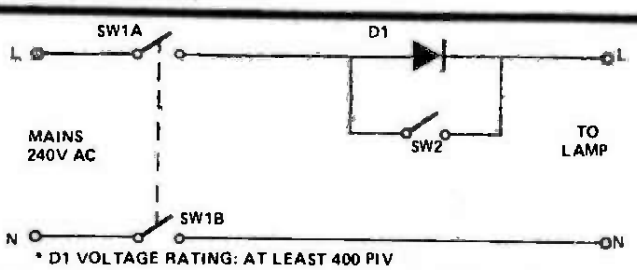
This TTL crystal oscillator is useful for checking FM receivers or to drive multipliers-amplifiers for an FM transmitter. It will accept crystals between 1 and 18 MHz. Output level is quite high and rich in harmonics. Audio can be provided at a low level from an audio oscillator or a microphone amplifier.



SIMPLE AND CHEAP LIGHT DIMMER

More than one lamp may be "dimmed", but the total wattage ratings should not be exceeded. The current ratings in the table are minimum values.

With SW1, the normal mains switch, "On" and SW2 closed, the lamp operates normally. But with SW1 "On" and SW2 "open", only half the mains waveform is allowd to energise the lamp, the other half being blocked by D1. This is the "Half-on" mode. Orientation of D1 does not matter.



* D1 VOLTAGE RATING: AT LEAST 400 PIV

D1 ..... BY126, BY127, ETC. (see table) SW2 ..... SPST MAINS SWITCH (see table for current rating)

LAMP WATTAGE:-UP TO:-	100W	250W	500W	1kW
D1 & SW2 CURRENT RATING:	½A	1½A	2½A	5A

Being small, the unit could be mounted in a normal double wall-switch, utilising both switches as SW1 and SW2, or inside a table lamp.

tech-tips

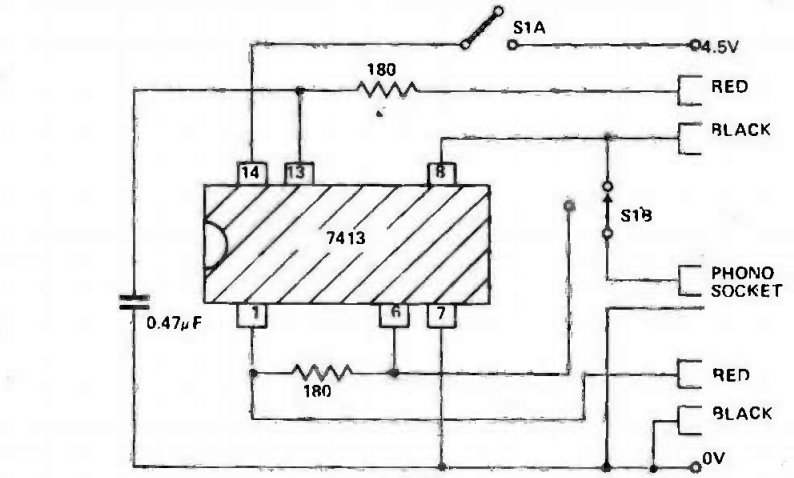
MULTIPURPOSE AUDIO TESTER

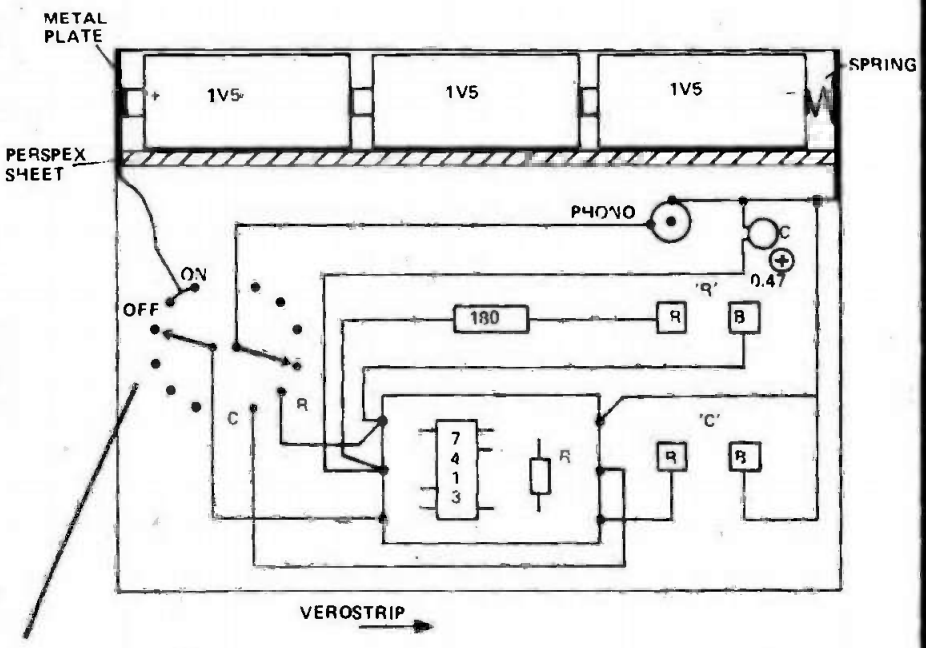
The instrument is designed primarily to provide a cheap and reliable method of testing for wiring faults in projects. As a secondary use it may be used as a capacitor checker. Additionally the apparatus may be used as a ready made siren. The output from this instrument may also be fed to an external source, such as an amplifier.

Each circuit can be made to oscillate at audio frequencies using simply a capacitor connected from input to ground and an resistor connected between input and output. The output is detected using a crystal earpiece. Thus, simply completing the resistive arm of the circuit via the "R" sockets, causes oscillation to commence, at a frequency governed by the resistance between the sockets. Similary, by completing the other circuit by means of connecting a suitable capacitor across the "C" sockets, the other circuit is set into operation at a frequency dependent on the unknown capacitance. Thus we have an instrument which provides a "go/no go" indication of a circuit or a component. In addition a rough order of value of the component may be obtained from the frequency of oscillation.

For use as a continuity tester, probes are simply inserted into the "R" sockets and the instrument used as a conventional "ohmmeter". The maximum detectable resistance would be of the order of 1k. Similarly, these sockets may be used to check diodes and transistors.

Using the "C" sockets for checking capacitors, observe polarity when using electrolytics. The range of checkable capacitors is large varying from .22μF to 5000μF.

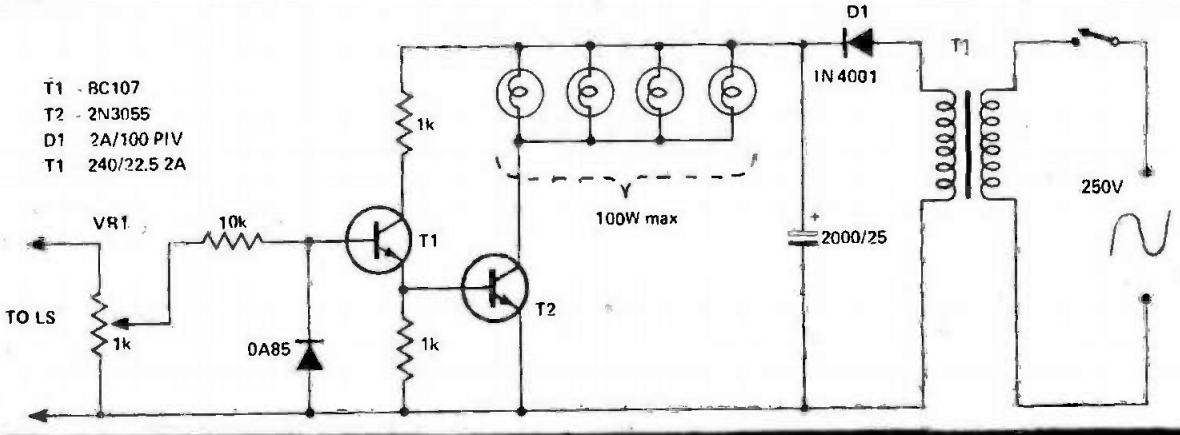




DANCING LIGHTS

This device will produce a shifting light display in time to the signal from a loudspeaker. Setting will vary according to the volume at which the music is played. When VR1 is at maximum the lights remain lit most of the time. At minimum the lights may not come on at all. A suitable position can be established in between these two extremes.

The bulbs used can be any number at 25V each and the total should not be more than 100W. A heatsink should be used for the power transistor.



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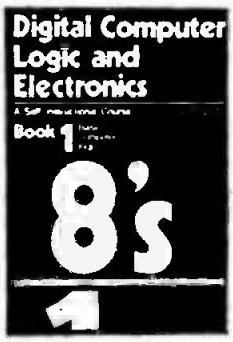

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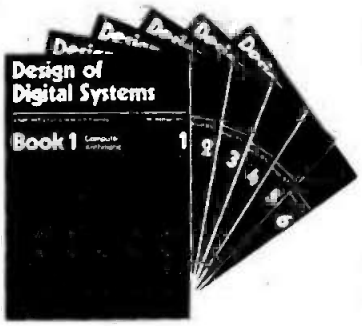

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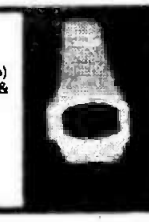

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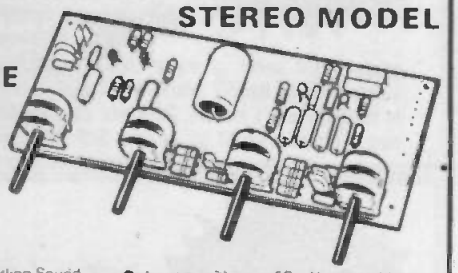

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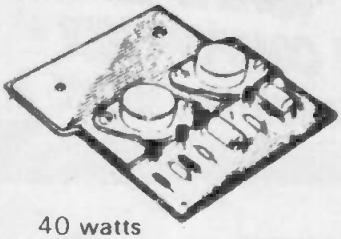

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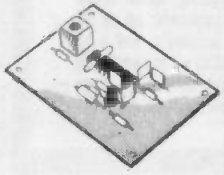

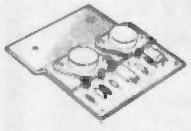

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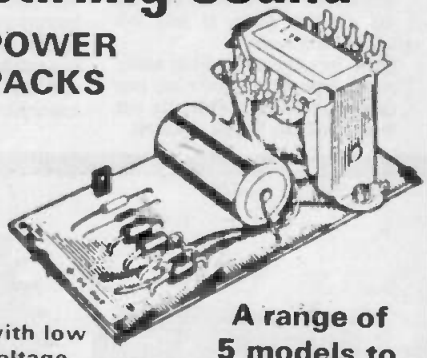

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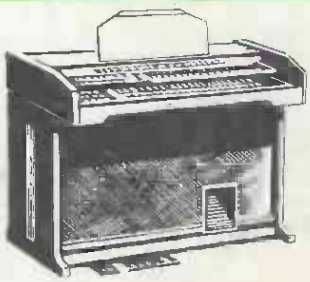

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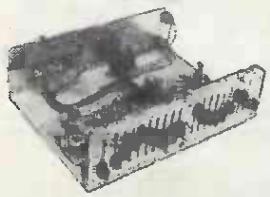

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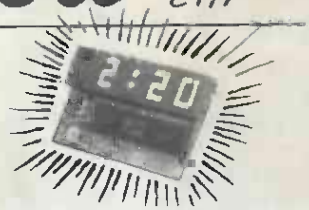

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