

electronics today

MARCH 1978

INTERNATIONAL

45p

Avoid howlround with our
FREQUENCY SHIFTER

INSIDE VCT

**LCD PANEL
METER**

**AUTO
ELECTRONICS**

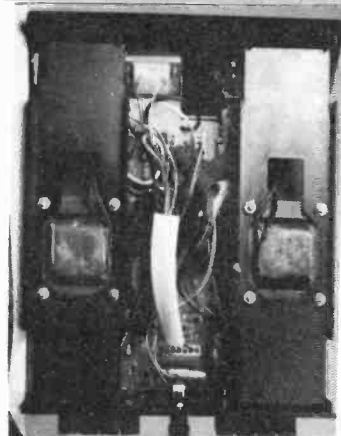
**TRUE RMS
VOLTMETER**



electronics today

MARCH 1978 VOL 7 NO 3

INTERNATIONAL



Inside a head p.63

FEATURES

- INSIDE VCT **19** A look beneath the plastic
AUTO ELECTRONICS **31** Mixing electrons with Escorts!
OP AMPS PART 2 **49** Circuits galore
DIGITAL ELECTRONICS PART 6 **66** Do-it-yourself digits
TECH TIPS **78** More from you to us

PROJECTS

- TRUE RMS VOLTMETER **13** This meter won't lie to you
LCD PANEL METER **26** Easily built, widely applied
FREQUENCY SHIFTER **40** Move up in the world (by 5 Hz)
LIGHT DIMMER **55** Tone down the glare
SYSTEM 68 **59** Software and all that

NEWS

- NEWS DIGEST **7** Who's up to what and where
DATA SHEET **53** Intersil 7106/7107 display driver
AUDIOPHILE **63** The best in heads
MICROFILE **71** Womp Rats and Mark 14s
ELECTRONICS TOMORROW **75** Walk in the MPU jungle

INFORMATION

- ETI PRINTS **9** PCB's the easy way
SUBSCRIPTIONS **10** Save yourself the heartache
ELECTRONICS TOMORROW **37** A very special special
ETI APRIL PREVIEW **39** What's in next month
ETI CLOCK **72** Our longest running special offer
BOOKS FROM ETI **80** Wide range to choose from



Feel like a move? p.40



Get into top gear p.31

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No THY3A/400	3Amp	400 volt	T064	40p
No THY5A/50	5Amp	50 volt	T066	25p
No THY5A/400	5Amp	400 volt	T066	40p
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TRIAC

SB4 8Amp	400 volt	T0220 Plastic (Non Isolated Tab)	80p
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DIACS

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D32	15p

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16218	40 ½W	1K-2K		
16219	40 ½W	10K-82K		
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AC126	14p	BC178	12p	BF195	9p	TIP41A	34p	2N2218	15p
AC127	16p	BC179	12p	BF196	12p	TIP41B	35p	2N2218A	18p
AC128	16p	BC182	9p	BF197	12p	TIP41C	36p	2N2219	15p
AC128K	24p	BC182L	9p	BF200	25p	TIP42A	36p	2N2219A	18p
AC176	16p	BC183	9p	BFX29	22p	TIP42B	37p	2N2221	15p
AC176K	24p	BC183L	9p	BFX84	18p	TIP42C	38p	2N2221A	16p
AC187	16p	BC184	9p	BFY50	12p	TIP295S	85p	2N2222	15p
AC187K	26p	BC184L	9p	BFY51	12p	TIP3055	42p	2N2222A	16p
AC188	16p	BC212	10p	BFY52	12p	ZTX107	6p	2N2369	10p
AC188K	26p	BC212L	10p	MPSA05	22p	ZTX108	6p	2N2904	14p
AQ161/162MP	80p	BC213	10p	MPSA06	22p	ZTX109	7p	2N2904A	15p
AF139	30p	BC213L	10p	MPSA55	22p	ZTX300	7p	2N2905	14p
AF239	30p	BC214	10p	MPSA56	22p	ZTX301	7p	2N2905A	15p
BC107	6p	BC251	10p	OC44	12p	ZTX302	9p	2N2906	12p
BC108	6p	BCY70	12p	OC71	9p	ZTX500	8p	2N2906A	14p
BC109	6p	BCY71	12p	OC72	12p	ZTX501	10p	2N2907	12p
BC118	10p	BCY72	12p	OC75	10p	ZTX502	10p	2N2907A	12p
BC147	8p	BD115	40p	OC81	14p	2N697	10p	2N2926G	9p
BC148	8p	BD131	35p	TIP29A	35p	2N706	7p	2N3053	12p
BC149	8p	BD132	37p	TIP29B	36p	2N706A	8p	2N3055	35p
BC154	16p	BF115	17p	TIP29C	36p	2N708	8p	2N3702	7p
BC157	9p	BF167	19p	TIP30A	36p	2N1302	12p	2N3703	7p
BC158	9p	BF173	20p	TIP30B	37p	2N1303	15p	2N3704	6p
BC159	9p	BF180	25p	TIP30C	38p	2N1304	15p	2N3903	11p
BC159C	10p	BF181	25p	TIP31A	32p	2N1307	18p	2N3904	11p
BC170	6p	BF182	25p	TIP31B	33p	2N1308	22p	2N3905	11p
BC171	6p	BF183	25p	TIP31C	34p	2N1309	22p	2N3906	11p
BC172	6p	BF184	25p	TIP32A	34p	2N1613	15p		
BC173	7p	BF185	25p	TIP32B	35p	2N1711	15p		

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	BAX16/7	5p	BY217	28p	OA91	7p
AA213	4p	OA202	7p	BY218	28p	OA95	7p
BA100	6p	BY100	15p	BY219	28p	IN34	5p
BA115	6p	BY127	10p	OA47	5p	IN60	6p
BA144	5p	BY210	32p	OA70	5p	IN91A	4p
BA148	10p	BY211	32p	OA79	7p	IN4148	4p
BA173	10p	BY212	32p	OA81	7p	1S44	3p
BAX13/7	5p	BY213	30p	OA85	7p	IN5400	10p
OA200	5p	BY216	30p	OA90	6p		

LINEAR I.C.'S

TBA800	12 pin QIL	75p*	UA711C	T099	25p	UA748	T099	28p
TBA810	12 pin QIL	£1.00*	UA703	T099 (Plastic)	20p	72558	(Dual 748) T099	45p
TBA820	14 pin QIL	80p*	741P	8 pin DIL	18p	MC1310P	14 pin DIL	£1.25*
LM380	14 pin DIL	80p*	72741	14 pin DIL	20p	76115	14 pin DIL	£1.25*
LM381	14 pin DIL	£1.35*	UA741C	T099	20p	NE555	8 pin DIL	32p
72709	14 pin DIL	28p	72747	14 pin DIL	55p	NE556	14 pin DIL	60p
UA709	T099	28p	748P	8 pin DIL	28p	SL414A	10 pin	£1.80*

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LED'S		50p	LED CLIPS			5 for 12p
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No S52	Red FLV117 (5 x 2")	50p	1508	2.7		
No 1502	Green 125"	18p each	SPECIAL REDUCTIONS			45p each
No 1505	Green 2"	18p each	1514	NORP 12	5 for £1.00	
No 1503	Yellow 125"	18p each	S76	OCY17		
No 1506	Yellow 2"	18p each	S83	5 NIXIE Tubes ITT 5870 ST	£2.00	
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			S77 Neon Indicator Lamps 230 V AC			
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No 16131	150 Germ. Point contact diodes like OA70 81	40p
No 16132	100 200mA Sil diodes like OA200	40p
No 16133	150 75mA Sil Fast switching diode like IN4148	40p
No 16134	50 750mA Sil top hat Rects	40p
No 16135	20 3 amp Sil stud Rect	40p
No 16136	50 400mw Zeners D O / case	40p
No 16137	30 NPN Plastic trans like BC107 8	40p*
No 16138	30 PNP Plastic trans like BC177 8	40p*
No 16139	30 NPN trans like 2N697 2N1711	40p
No 16140	25 PNP Trans like 2N2905 To 39	40p
No 16141	30 NPN Trans like 2N706 To 18	40p
No 16142	30 NPN Plastic trans like 2N3908	40p*
No 16143	30 PNP Plastic trans like 2N3905	40p*
No 16144	30 PNP Germ trans like OC71	40p
No 16147	10 NPN To 3 Power trans like 2N3055	80p

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No S68	9 x 16 pin D.I.L. Sockets	£1.00
No S69	4 x 24 pin D.I.L. Sockets	£1.00
No S70	3 x 28 pin D.I.L. Sockets	£1.00

TRANSISTOR SOCKETS

No S71	15 x T018 Sockets	£1.00
No S72	10 x T05 Sockets	£1.00

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No S73 50 Mixed Transistor Pads T018 and T05 40p

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20 Assorted types T01, T05, T018, T092
Our Mix 60p
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NKT302	40	60	50-150 35p per pair
NKT303	20	30	30-100 25p per pair
NKT304	20	30	50-150 25p per pair

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No S56	20 mixed values 400mW Zener diodes	£1.00

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16191	6 x 470 Ohm LIN Single	1891	10 ohms
S24	6 x 1K LIN Single	1893	47 ohms
S25	6 x 5K LIN Single	1894	100 ohms
16192	6 x 10K LIN Single	1895	220 ohms
S26	6 x 10K LOG Single		
16193	6 x 22K LIN Single		
16195	6 x 47K LOG Single		
16194	6 x 47K LIN Single		
S27	6 x 100K LIN Single		
S28	6 x 100K LOG Single		
S29	6 x 500K LOG Single		

60 mm. Travel

S30	6 x 2.5K LOG Single	40p
S31	6 x 10K LIN Single	40p
S32	6 x 50K LIN Single	40p
S33	6 x 250K LOG Single	40p
S34	4 x 5K LOG Dual	40p
S35	4 x 10K LIN Dual	40p
S36	4 x 100K LOG Dual	40p
S37	4 x 1.3 MEG LOG Dual	40p

S38 MIXER SLIDER POTS.
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S39 6 x CHROME SLIDER KNOBS
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A range of wirewound single gang pots with linear tracks of 1 watt rating.

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1893	47 ohms	1897	1K
1894	100 ohms	1898	2K2
1895	220 ohms	1899	4K7

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SALE PRICE 40p

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S3	4 x Std. Plastic Jack Plugs	50p
S4	2 x Stereo Jack Plugs	30p
S5	5 x 5-pin 180 Din Plugs	50p
S6	8 x 2-pin Loudspeaker Plugs	50p
S7	6 x Phono Plugs Plastic	50p
S8	5 x 3.5mm Chassis Sockets (Switched)	25p
S9	5 x 2.5mm. Chassis Sockets (Switched)	25p
S10	4 x Metal Std. Chassis Switched Jack Sockets	50p
S11	2 x Stereo Jack Sockets with instruction leaflet for Headphone connection	50p
S12	5 x 5-pin 180 Din Chassis Sockets	40p
S13	8 x 2-pin Din Chassis Sockets	50p
S14	6 x Single Phono Sockets	40p

AUDIO LEADS

Order No	Description	Price
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123	20ft of coiled guitar lead	£1.15
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125	Audio Lead 5-pin Plug to 5-pin Din Plug	50p
126	Audio Lead 5-pin Din plug to tinned open ends	50p
127	Audio Lead 5-pin Din plug to 4 phono plugs	90p
129	Audio Lead 5-pin Plug to 5-pin Din Plug — mirror image	70p
130	5 Meter Lead 2-pin Din plug to 2-pin Din inline socket	45p
132	10 Meter Lead 2-pin Din plug	65p

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With aluminium lid and fixing screws
 Size: 6 1/4" x 3 3/4" x 2"
 Order No S16 Only 75p

74 SERIES TTL ICs

TYPE	QUANTITY		TYPE	QUANTITY		TYPE	QUANTITY	
	1	100		1	100		1	100
7400	0.09	0.08	7448	0.70	0.68	74122	0.45	0.42
7401	0.11	0.10	7450	0.12	0.10	74123	0.65	0.62
7402	0.11	0.10	7451	0.12	0.10	74141	0.68	0.65
7403	0.11	0.10	7453	0.12	0.10	74145	0.75	0.72
7404	0.11	0.10	7454	0.12	0.10	74150	1.10	1.05
7405	0.11	0.10	7460	0.12	0.10	74151	0.85	0.80
7406	0.28	0.26	7470	0.24	0.23	74153	0.70	0.68
7407	0.28	0.25	7472	0.20	0.19	74154	1.20	1.10
7408	0.12	0.11	7473	0.26	0.22	74155	0.70	0.68
7409	0.12	0.11	7474	0.24	0.23	74156	0.70	0.68
7410	0.09	0.08	7475	0.44	0.40	74160	0.95	0.85
7411	0.22	0.20	7476	0.26	0.25	74161	0.95	0.85
7412	0.22	0.20	7480	0.45	0.42	74161	0.95	0.85
7413	0.26	0.25	7481	0.90	0.88	74162	0.95	0.85
7416	0.28	0.25	7482	0.75	0.73	74163	0.95	0.85
7417	0.28	0.25	7483	0.88	0.82	74164	1.20	1.10
7420	0.11	0.10	7484	0.85	0.80	74165	1.20	1.10
7422	0.19	0.18	7485	1.10	1.00	74166	1.20	1.10
7423	0.21	0.20	7486	0.28	0.26	74174	1.10	1.00
7425	0.25	0.23	7489	2.70	2.50	74175	0.85	0.82
7426	0.25	0.23	7490	0.38	0.32	74176	1.10	1.00
7427	0.25	0.23	7491	0.65	0.62	74177	1.10	1.00
7428	0.36	0.34	7492	0.43	0.35	74180	1.10	1.00
7430	0.11	0.10	7493	0.38	0.35	74181	1.90	1.80
7432	0.20	0.19	7494	0.70	0.68	74182	0.80	0.78
7433	0.38	0.36	7495	0.60	0.58	74184	1.50	1.40
7437	0.26	0.25	7496	0.70	0.68	74190	1.40	1.30
7438	0.28	0.25	74100	0.95	0.90	74191	1.40	1.30
7440	0.12	0.10	74105	0.40	0.35	74192	1.10	1.00
7441	0.60	0.57	74106	0.30	0.25	74193	1.05	1.00
7442	0.80	0.70	74107	0.30	0.25	74194	1.05	1.00
7443	0.95	0.90	74110	0.48	0.45	74195	0.80	0.78
7444	0.95	0.90	74111	0.75	0.72	74196	0.80	0.85
7445	0.80	0.75	74118	0.85	0.82	74197	0.90	0.85
7446	0.80	0.75	74119	1.30	1.20	74198	1.90	1.80
7447	0.70	0.68	74121	0.28	0.26	74199	1.80	1.70

Devices may be mixed to qualify for quantity price. Data is available for the above series of ICs in booklet form price 35p

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price
C04000	£0.14	C04018	£0.85	C04035	£1.40	C04056	£1.15
C04001	£0.16	C04019	£0.45	C04037	£0.78	C04069	£0.32
C04002	£0.16	C04020	£0.95	C04040	£0.78	C04070	£0.32
C04006	£0.80	C04021	£0.80	C04041	£0.68	C04071	£0.20
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C04010	£0.50	C04025	£0.18	C04045	£1.15	C04510	£1.10
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BI-PAK

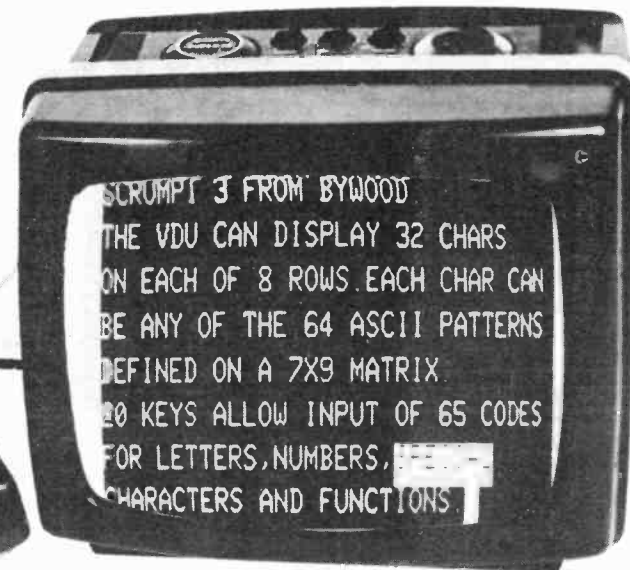
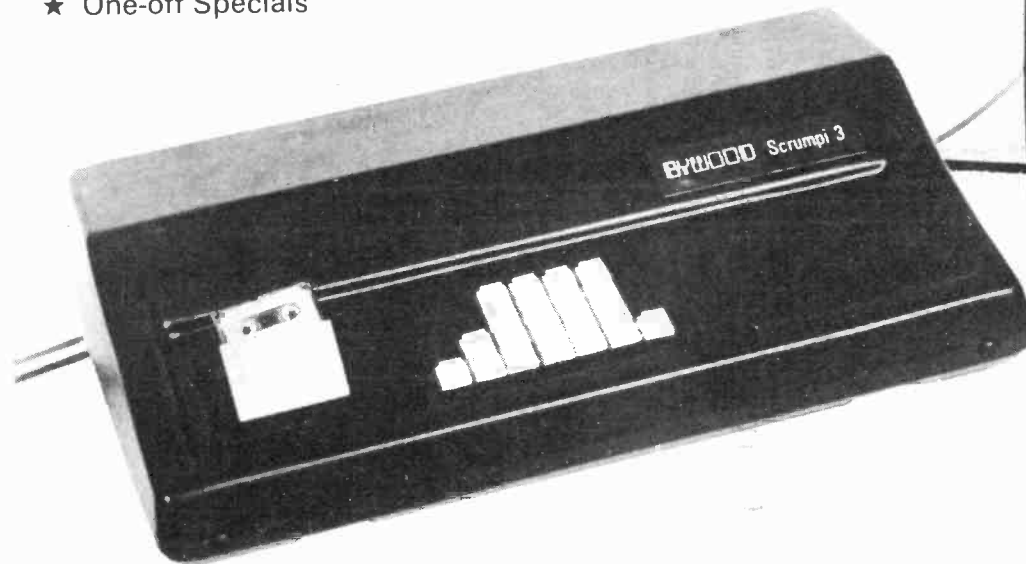
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news digest.

RED TAPE GAGS THE QUEEN!

In the wee small hours of January 19th 1903, Marconi established the first two-way communication across the Atlantic. Messages were exchanged between the American president Theodore Roosevelt and the British King Edward VII. To mark the 75th anniversary of this event, the Cornish Radio Amateur Club have organised a team of sixty local amateurs to run GB3 MSA (Marconi's Seventy-fifth Anniversary). The station was run 24 hours a day, from the

14th to the 22nd January, from the lounge of the Poldhu Hotel in sunny Cornwall – only metres away from the spot Marconi used.

Transmitting on 80m, 20m and 2m the team had already made 1 100 contacts in 51 countries when ETI contacted them on the 16th! All the equipment was owned by the club and its members and set up for the week specially. On the American side was another station, KM1 CC, based in Cape Cod. KM1 CC was run by

the local Barnstaple, Mass. radio club with the help of the Radio Club of America.

Now for the red tape . . . President Carter sent a message via KM1 CC and the Queen wanted to send a reply via GB3 MSA, just like Edward VII did back in 1903. The Home Office said that if she did, it would break a condition in all British amateurs licences – namely the one about not passing on messages from 3rd parties! So after 2 years preparation the Cornish Amateurs and the Queen were denied permission to reply to President Carter.

Bureaucracy reigns?!

now you see it

Following the tremendous success of the 'Light Fantastic' Exhibition in 1977, the Royal Academy of Arts is staging 'Light Fantastic 2' – this time sponsored by Guinness.

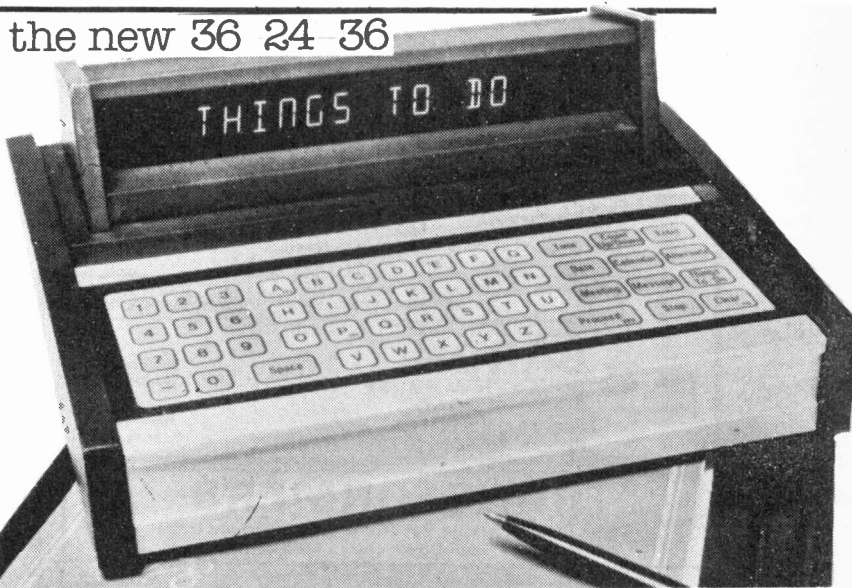
Since the first exhibition there have been several innovations in Holographic technique, at long last the public can see 3-dimensional semi-nude dancing ladies – frozen

in mid-air. Other new techniques include experimental 'Head Up Displays' for supersonic aircraft, and multiple exposure Holograms.

Running from 12th January for three months Light Fantastic 2 gives you another chance to see Holograms in real life.

Royal Academy of Arts, Piccadilly, London. W1V ODS.

the new 36 24 36



the little cb that santa forgot

Citizen Band radio manufacturers around the world are crying into their transceivers after Xmas. They expected a boost to sales to revive their drooping business, and it didn't materialise. Seems no-one wanted to contact anyone else – not even the reindeer.

chrysler lit up

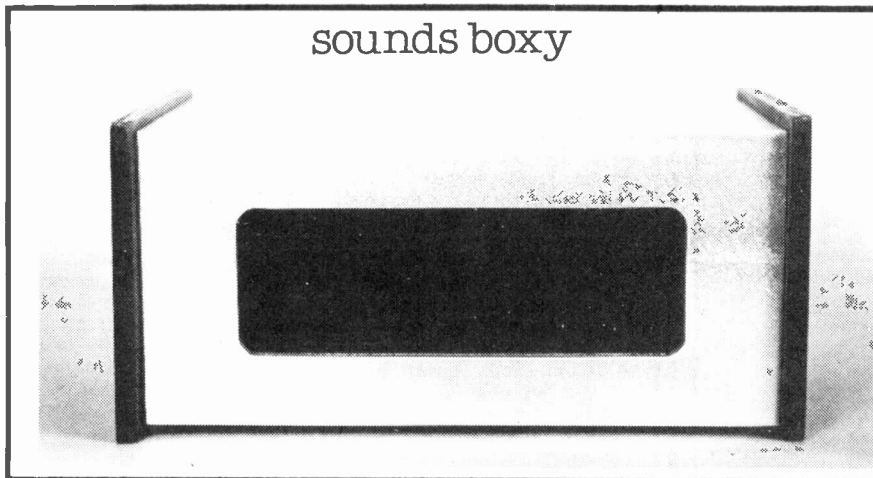
HP have signed a \$400,000 contract to supply Chrysler with LED lamps and displays for this year's car ranges. They are to go into digital radios (?) fitted to some prestige models. Twinkle Twinkle little car . . . ?

This gentleman is the replacement for all those nubile 'Miss Jones's' cavorting in slinky fashion around the offices in Britain. A right gang of spoilsports called Optimisation intend to replace all of that with all of this. Called the Mind Reader (it's a good job Miss Jones's weren't mind readers) the box is basically a memory system combined with stop watch, calendar and clock. Information and 'things to do' can be filed away under each day with the machine dutifully displaying the required information on the required day.

The keyboard is touch operated it is 10½ by 7½ by 4½ – not a patch on 36-24-36 – it weighs nine pounds and sells for around £300.

Optimisation, 45 South Street, Bishops Stortford, Hertfordshire. P.S. I bet it makes lousy tea and looks *terrible* in a bikini

sounds boxy



The biggest problem with building things is *still* finding something to build things in. Whenever we hear of a new box (and there aren't all that many are there?) we endeavour to let you know.

This offering caught our attention whilst meandering around Metac in Edgware Road. Constructed in one piece of 3mm thick aluminium, with wooden (REAL!) end-pieces the box has a 75mm by 25mm cut out in the front panel for displays etc, and three pre-punched holes in the box for switches and one for a mains lead. Overall measurements are approx. 120mm x 50mm x 80mm (or four and three quarters by two by three and a quarter if you haven't yet let go of the Empire!) Price is £2.80 all inc. from Metac, 327 Edgware Road, London W2.

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MICROPROCESSOR: Z80 CPU **£22.68**
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9-0.9	100	13	1.85	.40
9.0-9	330 330	235	1.95	.40
0.8-9.0-8.9	500 500	207	2.35	.55
0.8-9.0-8.9	1A 1A	208	3.50	.55
0.15-0.15	200 200	236	1.95	.40
0.20-0.20	300 300	214	2.35	.70
20-12.0-12-20	700(DC)	221	3.10	.70
0.15-20.0-15-20	1A 1A	206	4.20	.85
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4 2	18	3.75 .70
6 3	70	5.35 .85
8 4	108	6.25 1.00
10 5	72	6.95 1.00
12 6	116	7.85 1.00
16 8	17	9.25 1.10
20 10	115	12.75 1.30
30 15	187	16.60 1.30
60 30	226	22.90 1.60

30 VOLT (Pri. 220-240V)
Sec 0-12-15-20-24-30V

Amps	Ref. No.	Price	P&P
0.5	112	2.45	.70
1	79	3.05	.70
2	3	4.80	.85
3	20	5.80	1.00
4	21	6.85	1.00
5	51	7.75	1.00
6	117	9.50	1.00
8.00	88	11.35	1.30
10.0	89	12.00	1.30

50 VOLT (Pri. 220-240V)
Sec 0-19-25-33-40-50V

Amps	Ref. No.	Price	P&P
0.5	102	3.20	.70
1.0	103	4.20	.85
2.0	104	6.10	1.00
3.0	105	7.85	1.00
4.0	106	9.80	1.10
6.0	107	14.95	1.30
10.0	118	15.75	1.50
10.0	119	20.50	2.00

60 VOLT (Pri. 220-240V)
Sec 0-24-30-40-48-60V

Amps	Ref. No.	Price	P&P
0.5	124	3.40	.70
1.0	126	4.65	.85
2.0	127	6.50	1.00
3.0	125	9.15	1.10
4.0	123	11.25	1.30
5.0	40	11.80	1.30
6.0	120	14.75	1.40

AUTO TRANSFORMERS
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VA (Watts)	Ref. No.	Price	P&P
20	113	2.25	.70
75	64	3.50	.70
150	4	5.35	.85

Input/Output Tapped
0-115-210-220-240V

300	66	7.15	1.00
500	67	10.75	1.30
1000	84	17.00	1.40

Also 1500/2000/3000VA

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Pri. 120/240 Sec 120/240V

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100	150	6.40	1.00
200	151	10.00	1.10
250	152	11.95	1.30
350	153	14.45	1.40
1000	156	35.00	3.00

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Herne Bay 64586

news

on the road

Not so very long ago Edgeware Road was the place to go for components. The pavements were lined with resistors - any value, any range - and most anything thing the constructor desired was there somewhere.

Even less long ago the road died. Shops closed up, and retailers, with a few notable exceptions, became surly and distinctly unhelpful. Edgeware Road was not the place to go to buy anything, except maybe a dead duck or two.

However things seem to have changed yet again. Recently three new component stores have opened, Metac, Audio Electronics and Marshalls. Even a couple of hi-fi emporiums have re-materialised from the ether and things are looking up. Certainly going into Edgeware was a shift of more than just the kitchen sink for Metac. Their shops are best known for their range of watches, clocks and TV games. Now however the Edgeware Road branch is to major in components, although it will still carry an excellent array of time keeping machinery.

In addition to this the shop acts as an inlet for Metac's TV game service facilities, and will carry a range of MPU equipment when set up.

Anyone who has followed the beaten path to Edgeware Road in search of the trappings of our art will have felt the edge of indifference wearing them a little thin at times. We can but hope that Metac and the rest of the reinforcements bring with them their present high standard of service.

colourfull sounds PAL

The Videograph is a new product that provides a means of displaying colourful "music inspired" patterns on any domestic colour TV set. The basic Videograph circuitry generates a green background upon which blue and orange stripes are superimposed. Each of these stripes can be modulated, rather like the display on a 'scope', by audio signals fed to the Videograph's two audio inputs. The two audio signals will usually be derived from the Left and Right outputs of a stereo amplifier thus turning the TV into a sophisticated sound to light unit.

The circuitry is mounted on two boards, the larger taking care of sync generation, audio signal handling and 'stripe generation' while the other provides the colour modulator.

This latter board is interesting in itself as unlike some colour modulators it does not require complex drive signals, i.e U and V inputs, but operates on three separate R, G and B signals. This modulator, with the addition of a small interface circuit, can provide a colour facility for games based on the ubiquitous AY-3-8500 which means most tele football games.

The Videograph comes in kit form and, if the instructions provided are followed carefully, can be built up in a few hours. If there are any problems with the unit however, the manufacturers will put things right for you at a small fee.

The Videograph is available from:- W. P. Stuart-Bruges at 137, Billericay Road, Herongate, Brentwood, Essex. CM13 3SD.

The complete Videograph costs £15.95 but the modulator is available separately at £5.50.

horseplay

From Rapid Recalls Stable have come three ICs designed as motor drive devices. The three models have 1 A (8510), 2 A (8520), and 2.7 A (8530) output current capability and a standard 741 input characteristic.

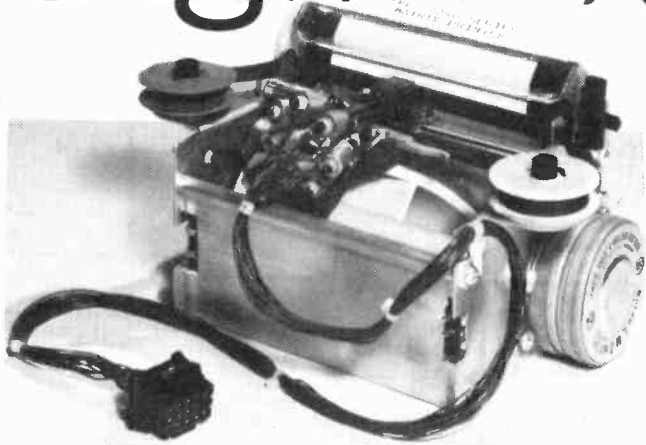
They are of hybrid construction, and consist of a 741, driver chip and complementary output pair with frequency compensation. Short circuit protection is provided

on chip, with the current into such a load set by external resistors.

One suggested application not to do with controlling actuators, is for a programmable PSU consisting of a D to A converter, 8520 etc, and thumbwheel switches to control the D to A. Output can then be set to ± 0.1V.

Rapid Recall, 9, Betterton Street, Drury Lane, London WC2H 9BS.

digest



quite a ChArAcTeRXXxxX...

Looking a first glance like a cross between Heath Robinson and IBM, this endearing little machine is actually a compact dot matrix printer introduced by Impectron Ltd.

Print speed is one 3.3 in line per second (40 characters) with a character height of 0.123 in. Multiple copies can be arranged, and power supply requirements are 40 V DC at 3.6A peak. (0.8A average). With its small size (8 in x 4 in x 5 in approx.) and low cost the 7040 will probably find many at home. Accessories to extend usage are available. Details from: Impectron Ltd., Impectron House, 23-31 King Street, London. W3 9LH.

ETIPRINTS

In case you have missed out on ETIPRINTS thus far, they are a complete PCB pattern already to rub down in seconds. The patterns are produced from our original artwork so that the results they produce are nice and sharp.

We think that ETIPRINTS are such a good idea that we have patented the system (Patent numbers 1445171 and 1445172).

ETIPRINTS 005 is now available, and joins 001-004 as part of the regular system.

Details of ordering the ETIPRINTS are shown below.



Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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Please indicate clearly the ETI PRINTS you require. Those available at present are:

- 001 With patterns for skeet, clock board A, and the compander from Nov 77 plus the spirit level, three-channel tone control, and the digital thermometer from Oct 77.
- 002 With patterns for the burglar alarm from Jan 78 plus clock board B and the rev monitor from Dec 77.
- 003 With patterns for hammer throw and race track from Jan 78 plus the freezer alarm from Dec 77.
- 004 With patterns for the ultrasonic transmitter-receiver, metronome, 1B metal locator and porch light from Feb. '78 plus 5 / w stereo amplifier Mk. 2 from Jan. '77.
- 005 March 77 issue projects, including howlround suppressor, RMS voltmeter, LCD panel meter

Readers please note that in earlier ads the contents of 002 and 003 were reversed. Would you please indicate when ordering from which issue the patterns you require were taken.

amplifying news

A very worthwhile kit of the ETI 100 W amp has come to our attention, using a more compact PCB and output transistors to bring down cost. The board is well made, and top quality components are used throughout. The firm perpetrating the act are Kingsley Services of Newcastle. Prices are extremely reason-

able at £16.25 + £2.10 VAT etc. for a built amp module. PSU costs £7.10 + £1.57. Recommended for aspiring 100 W merchants without the confidence to undergo the ritual of the hot iron. Kingsley TV Service, 40/42 Shields Road, Newcastle Upon Tyne, NE6 1DR.

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WINNER OF THE ETI DESIGN COMPETITION

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Gaps?

electronics today international

VCT etl comp report on this new technology

NEW SERIES CIRCUIT CIRCUITS

ELECTRONICS IN NORTH SEA OIL-REACTION YESTER

38 555 CIRCUITS

5W STEREO AMP

Gaps?

It can be a nuisance can't it, going from newsagent to newsagent? "Sorry squire, don't have it - next one should be out soon."

Although ETI is monthly, it's very rare to find it available after the first week. If it is available, the newsagent's going to be sure to cut his order for the next issue - but we're glad to say it doesn't happen very often.

Do yourself, your newagent and us a favour. Place a regular order for ETI; your newsagent will almost certainly be delighted. If not, you can take out a postal subscription so there's nothing for you to remember - we'll do it for you.

For a subscription, send us £6.00 (£7.00 overseas) and tell us which issue you want to start with. Please make your payment (in sterling please for overseas readers) to ETI Subscriptions and keep it separate from any other services you want at the same time.

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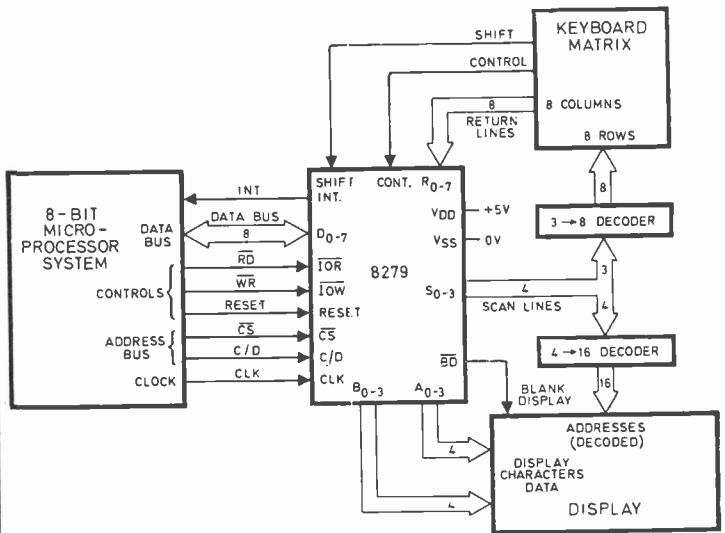
ALSO: IMPROVED LCOs EXPLAINED

WHAT IS WAVE SOUND?

KENNEDY SPACE CENTRE

... news

key development



Since Data input and display form an important part of micro-processor systems, a new Intel device, a new programmable single-chip keyboard/display interface device. Known as the 8279 will be of interest to many. The device is suitable for use with 8-bit microprocessors, (such as the 8080A) it relieves the CPU in a system from the task of monitoring and servicing the keyboard, and from updating the output display.

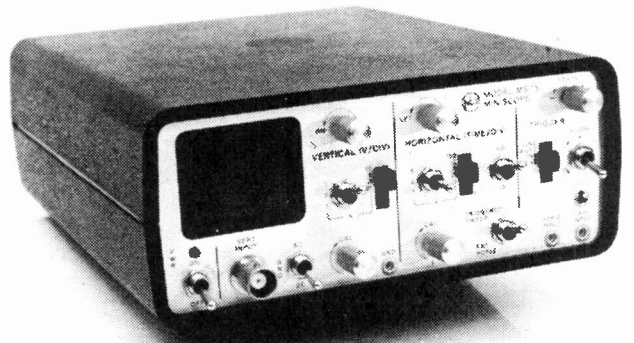
Key depressions can be either 2-key or n-key rollover. All keyboard entries are 'de-bounced' within the chip and are stored in a first-in, first-out memory (FIFO) where they are queued for input to the microprocessor when it has time to read them. If more than eight characters are loaded into the FIFO, the 8279's overrun status flag is set.

The CPU has full access to the display memory and the display memory address can be incremented automatically on memory read or write. Intel Corporation (UK) Ltd., 4 Between Towns Road, Cowley, Oxford, OX4 3NB.

game set

The FTC in America has come out with a report on tests they conducted which show that normal use of a TV game will not result in damage to a set. And about time, too.

not much scope



The MS15 is a completely new battery oscilloscope manufactured by Non Linear Systems. Sockets are provided for external triggering and X deflection and a one volt internal calibrator is provided. Lawtronics Limited, 139 High Street, Edenbridge, Kent. TN8 5AX.

digest...

bit on the out-side

The BBC has recently been using an experimental 2-channel digital transmission system to assess the feasibility of conveying high-quality stereo sound programme signals from OB sites to London in digital form.

When signals originating at Outside Broadcast (OB) sites are to be propagated throughout the UK, they have to be sent first to London where they are mixed into one or other network programme. Analogue contribution circuits are normally used for this purpose, but their quality is generally inferior to that of the digital distribution circuits that take the signals out from London to the network

of VHF transmitters

The first two broadcasts handled in this way were of a 'Music to Remember' concert at Cardiff on 4th December 1977 and a concert at Lancaster University on 15th December. In both cases the digital signals were transmitted on a radio link from the OB site to a convenient BBC centre, using 4-phase DPSK (differential phase shift keying) modulation. They were then conveyed to London in suitably transcoded form on a television circuit, and mixed into the Radio 4 programme.

This meant that the transmitted signal quality was virtually identical to that at the OB site itself.

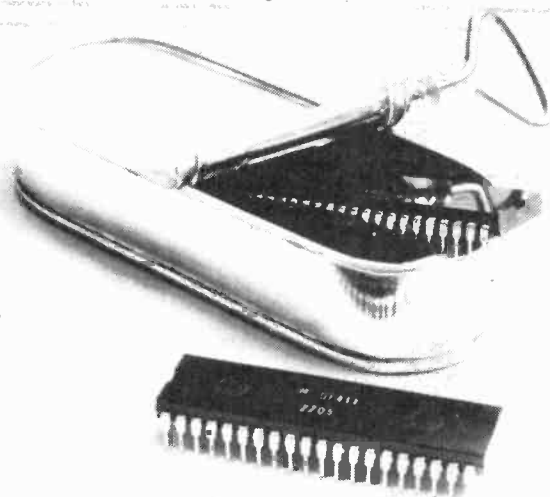
its a wide word

Intel, Zilog and Motorola are taking their places in the front rank on the grid for this year's expected race to 16 bit MPU sales. All three have completed development, and will probably show the nature of

their teeth at next month's US Solid State Circuits Conference. The pause between this and letting loose of the hounds as it were will almost certainly mean late autumn production.

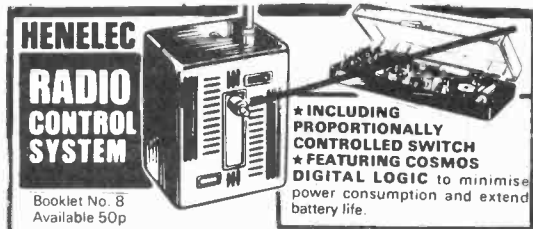
On yer marks

driven to LCD?



This new DF411 Siliconix chip carries on board all the clever bits necessary to decode and display up to four multiplexed digits of BCD information in liquid crystal fashion. They can be persuaded to gang up if more than 4 digits are required. Supply requirements are 3-8 V.
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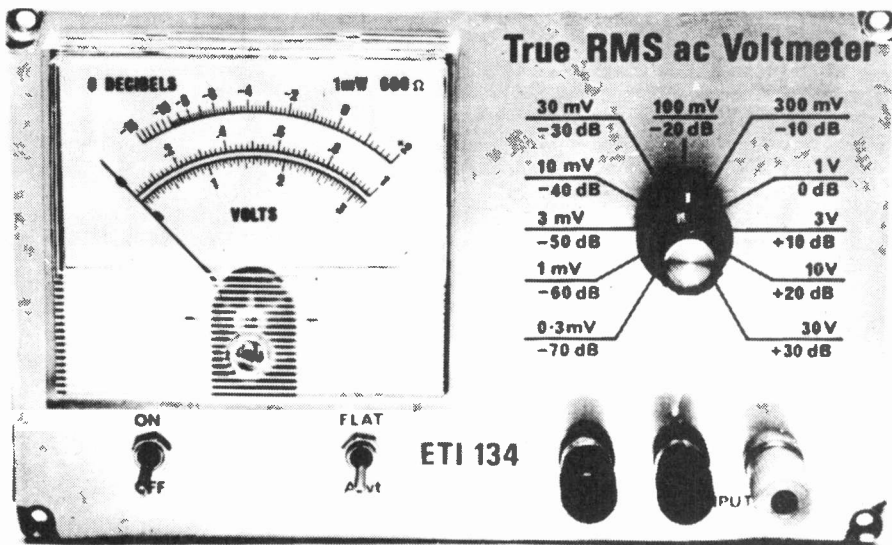
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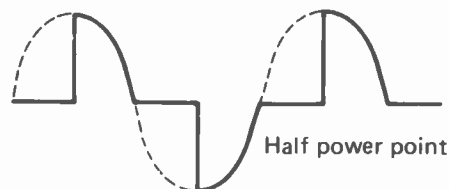
RMS VOLTMETER

MOST METERS which can measure AC signals do so by rectifying the signal and then measuring the average voltage. With a sine wave the average voltage is 0.637 of the peak voltage while the RMS value is 0.707 of the peak. Therefore a correction factor of 1.11 is built into the meter to give the RMS value of the signal.

Provided you stick with sine wave signals these meters are adequate. With any other waveform, however, they are not accurate. With a square wave the error is 11% and with pulse wave forms the error increases.

Before continuing we should explain what RMS means and its significance. Without getting mathematical, the RMS value of any wave form is the same as a DC value which would produce the same heating effect in a resistor. For example:

Power in a load can be varied by using phase control (i.e., light dimmer) where the time the load is connected to the mains is variable. The RMS value is difficult to calculate except at the point where it is half on—half off. The power then is obviously half power.



If the input voltage is 240 V and the load is 240 ohms the power (maximum) is given by

$$P = \frac{E^2}{R} \text{ or } \frac{240 \times 240}{240} = 240 \text{ W}$$

Half power therefore is 120 W. The voltage corresponding to this is given by

$$E = \sqrt{P \times R} \text{ or } 170 \text{ V (RMS).}$$

On a "normal" meter this will read 120 V or an error of 30%.

This design uses an RMS detector IC, which is basically a small, special-purpose analogue computer to mathematically calculate the true RMS value for any waveform.

Design Features

The design of the voltmeter is basically simple, starting with an attenuator in the front end, then an amplifier with a high input impedance and switchable gain which, with the attenuator, gives the range selection. A filter is then added to give the "A" weighting and the RMS detector IC (LH 0091) does the rest

The output of the input amplifier is 60 mV, independent of range selected, for an input corresponding to the full scale reading. This gives a maximum gain of 46 dB on the 0.3 mV range. There is a loss of about 2.3 dB in the filter (at 1 kHz) and the spare amplifier in IC2 is used to provide a gain of 20 dB giving 500 mV (for full scale reading) before the RMS detection is done. The RMS detector has unity gain with 500 mV RMS in giving 500 mV DC out.

However things are never that simple. With a total of 60-odd dB gain, along with the requirement for a 1 M input impedance, we have an excellent formula for an oscillator. With the third try (yes, we have failures too) with ade-

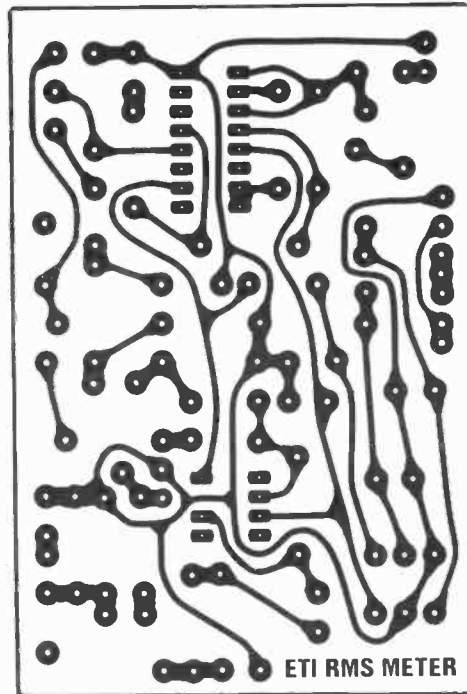
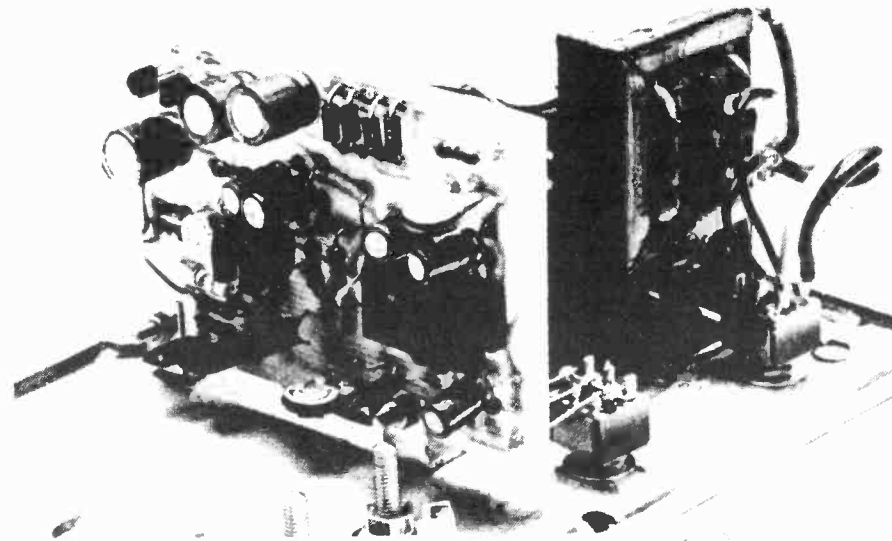


Fig 4. Printed circuit layout.
Full size 90 x 60mm.



Internal view of the RMS voltmeter, showing how the PCB is mounted within the box relative to the mains transformer.

PARTS LIST

RESISTORS

All 1/4 W 5%, except where marked.

R1	1M	1%
R2,6	100k	1%
R3,7	10k	1%
R4,16	12k	1%
R5	150k	
R8	56R	1%
R9	1k	
R10	120R	1%
R11	3k9	
R12	390R	1%
R13,19	47k	
R14	1k5	1%
R15,17	39k	
R18,20,21,24*	27k	
R22,23	270k	
R25	330R	

POTENTIOMETERS

RV1	100k
RV2	200R

CAPACITORS

C1,9,10	100n	polyester
C2*	15p	ceramic
C3*	150p	ceramic
C4*	1n5	polyester
C5,6*	27n	polyester
C7	15p	ceramic
C8	100u	25 V
C11	10n	polyester
C12	820n	ceramic
C13	4n7	polyester
C14-C18	10u	25 V
C19,20	100u	25 V

* These capacitors should be as accurate as possible as they affect accuracy above 10kHz.

SEMICONDUCTORS

IC1	CA3140
IC2	LH0091
IC3	78L15
IC4	79L15

D1-D4	1N4001 or similar
-------	-------------------

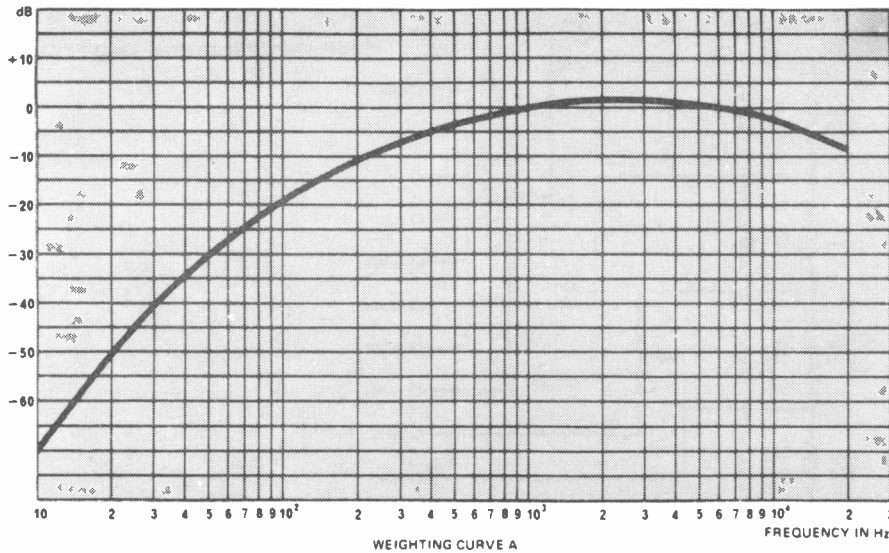
SWITCHES

SW1	2 pole 11 position
SW2	SPDT miniature toggle switch
SW3	DPDT miniature toggle switch

MISCELLANEOUS

T1	28 V secondary
M1	Meter 1mA scaled as shown

3 terminals (red, black, green), Box to suit, Metal brackets and shields, 3 core flex and plug, 16 pin socket for IC2, Knob.



The response in the "A" weight position.

quate shielding and layout, stability was obtained and this final design is presented here.

The spare IC in the LH0091 is normally used to buffer, filter or amplify the output of the converter, but used before so as to buffer the filter network and save an additional op amp (the input impedance of the RMS converter is only 5k). The output voltage from the converter is only 500 mV but this is adequate to drive a meter. We could have provided more gain in the buffer stage so giving a higher output but this would lead to greater errors with high crest factor waveforms.

We have limited this instrument to AC signals as this eliminates the need for balance controls to correct for drift when measuring low level signals. This normally is of no consequence as most signals, i.e., output of a tape recorder, sound level meter, etc, have no DC component. If DC capability is needed capacitors C1, 8, 9, 14, 15 and 16 have

to be shorted out, a zero adjustment potentiometer added to IC1 along with the potentiometers needed to offset adjust IC2 (see data sheet).

Construction

The wires associated with the rotary switch should be no longer than necessary to minimise any pickup. The box should be earthed to the mains earth and the front panel earth terminal (left hand one) should also be connected to earth.

Use

When measuring low level signals there may be 50 Hz pickup unless the common side of the input signal is connected to ground. This may be done either in the unit under test or on the meter (hence the earth terminal). Also with the meter terminals open circuited the meter will give some reading. However, as the output impedance of low level signals (0.3 mV and less) is normally relatively low this is normally no problem. **ETI**

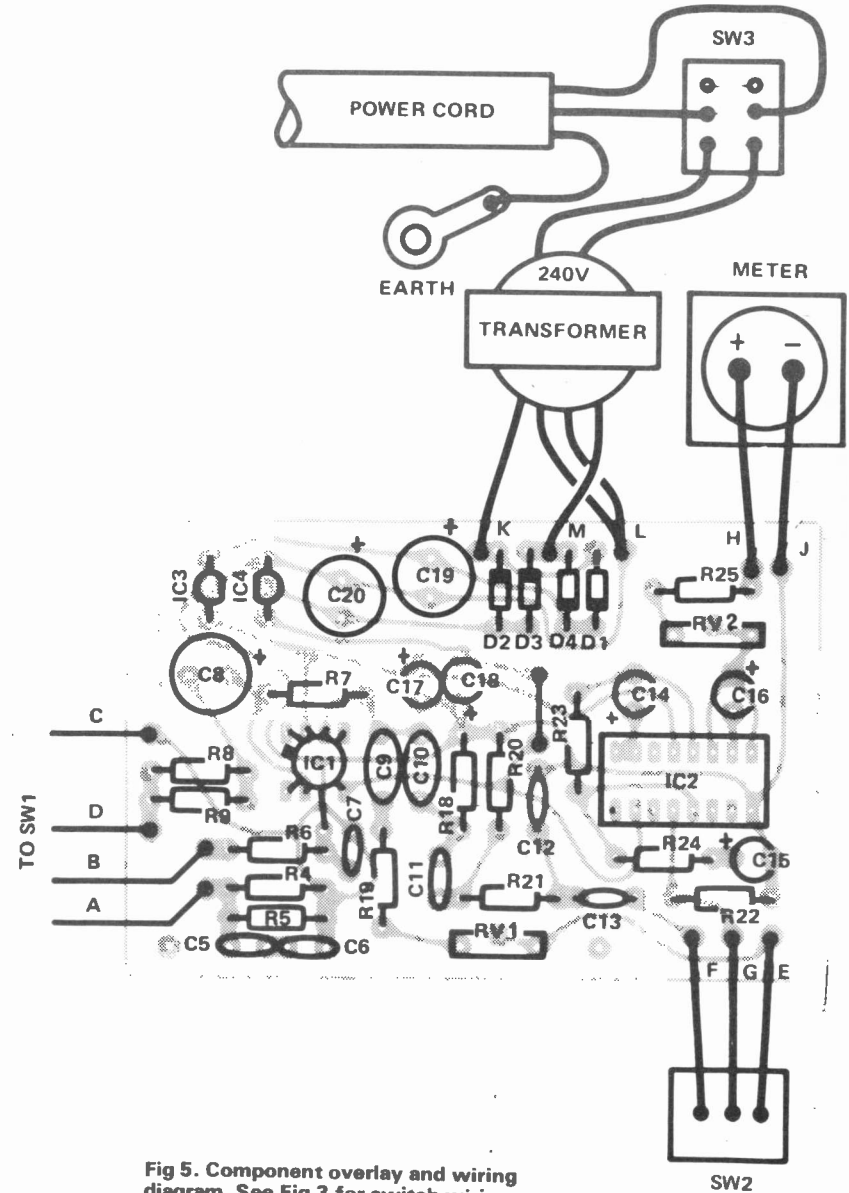


Fig 5. Component overlay and wiring diagram. See Fig 3 for switch wiring.

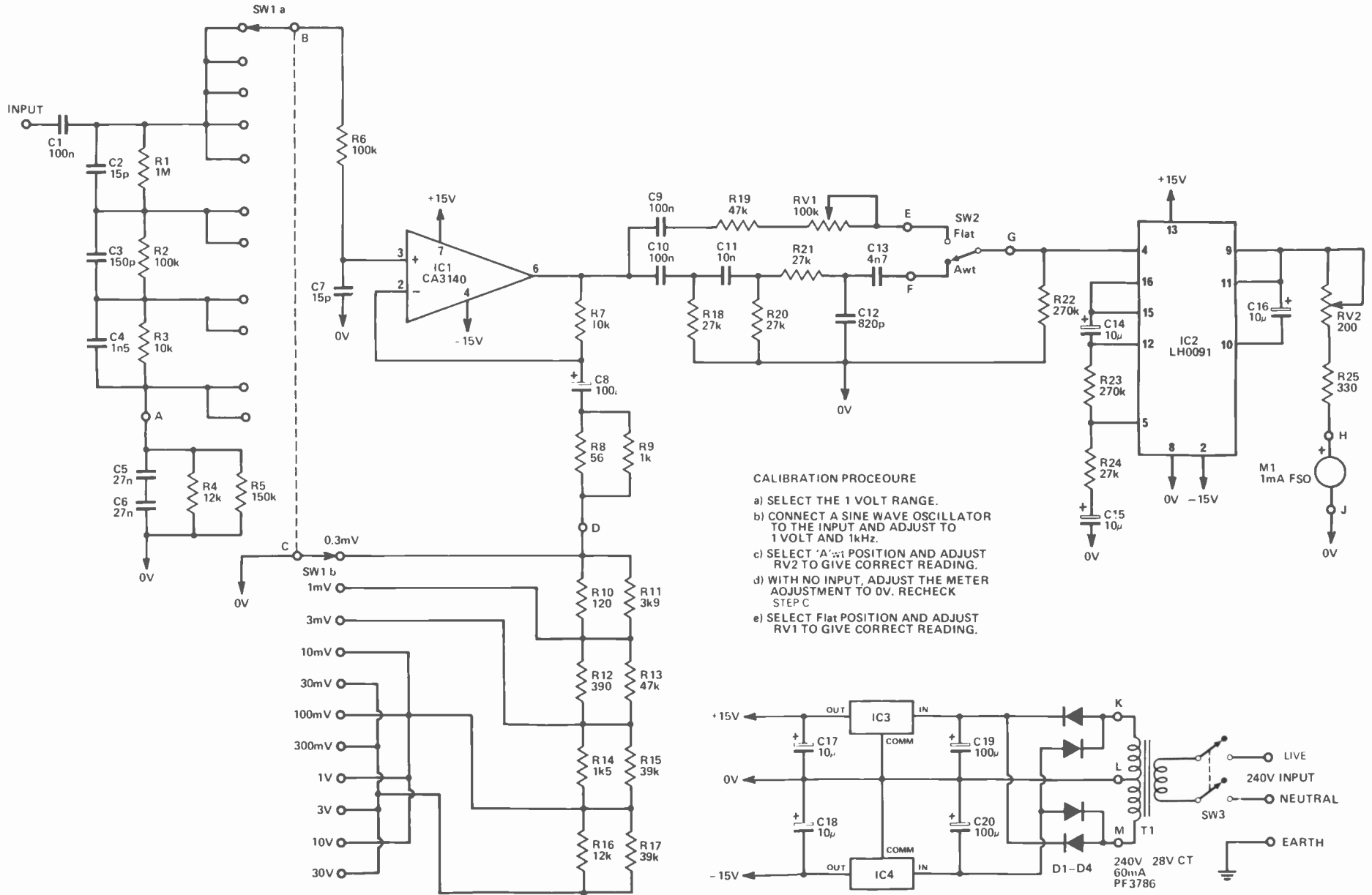
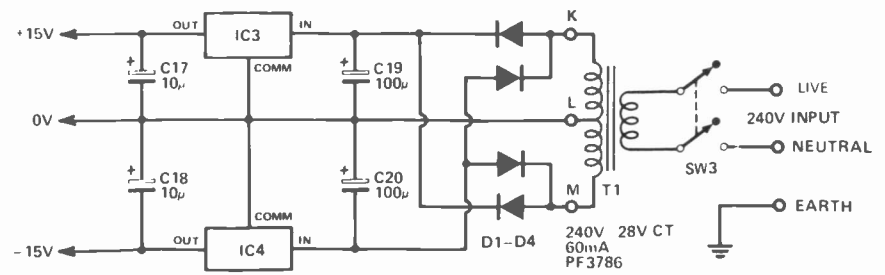


Fig 1. Circuit diagram of the voltmeter.



HOW IT WORKS

The input signal is attenuated by the network R1–R5 and C2–C6; the appropriate attenuation is selected by SW1a. This gives 0 dB, 20 dB, 40 dB and 60 dB. The output of SW1a is buffered by IC1 which is a FET input op-amp. This amplifier has a gain which is switchable giving 5.56 dB, 15.56 dB, 25.56 dB, 35.56 dB and 45.56 dB. By selecting a combination of these two variables the eleven ranges from 0.3 mV to 30 V are obtained. The output of IC1 for full scale reading is 60 mV.

The output of IC1 goes to the 'A' wt filter network and also directly (via R19) and RV1) to SW2. This selects either 'A' weighting or flat response. As the filter has 2.3 dB loss at 1 kHz the "flat" position is also attenuated (hence R19, RV1) to maintain calibration.

The RMS detector IC provides a gain of 20 dB before the detector; the output of the detector is about 500 mV for full scale reading.

The power supply is simply a full wave rectified supply giving both plus and minus voltages of about 20 V, which are then regulated to ± 15 V by IC3 and IC4.

BUYLINES

The only 'hard-to-get' component in this design is the LH0091 true RMS detector. Marshalls have arranged to stock it for ETI readers and can supply most of the other components as well. The PCB will be available from normal suppliers Crofton, Ramar, Tamtronik who advertise at the back of the magazine.

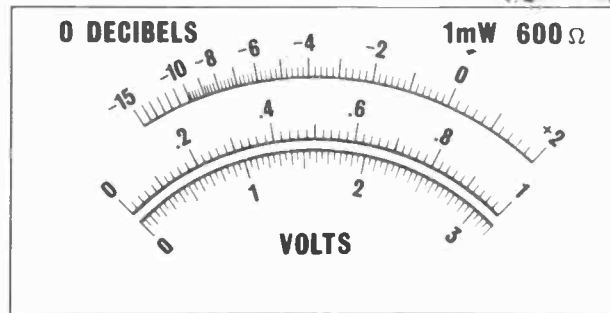
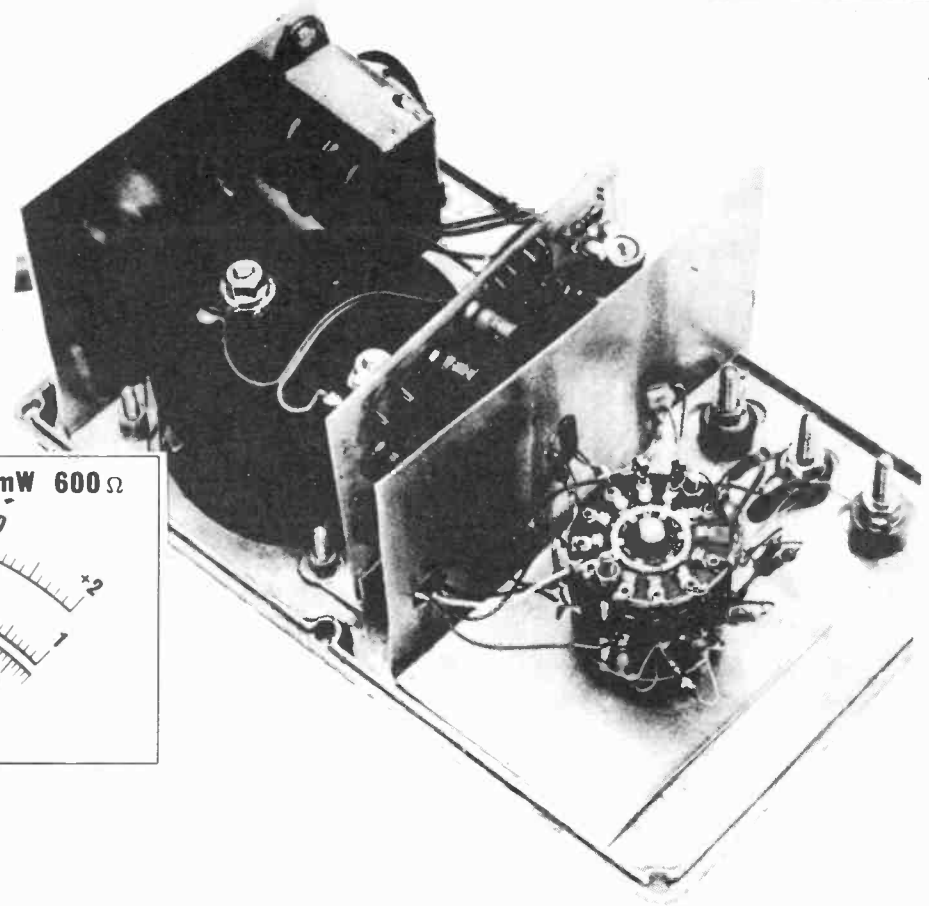


Fig 2. Meter scale shown full size.



SPECIFICATION

Meter Type	RMS reading AC only
Ranges	0.3, 1, 3, 10, 30, 100, 300 mV 1, 3, 10, 30 V
Accuracy	+3% nominal (crest factors up to 3) -8% at crest factory of 10
Input Impedance	1M in parallel with 25p
Weighting Networks	Flat or 'A' weight
Frequency Response	10 Hz – 20 kHz

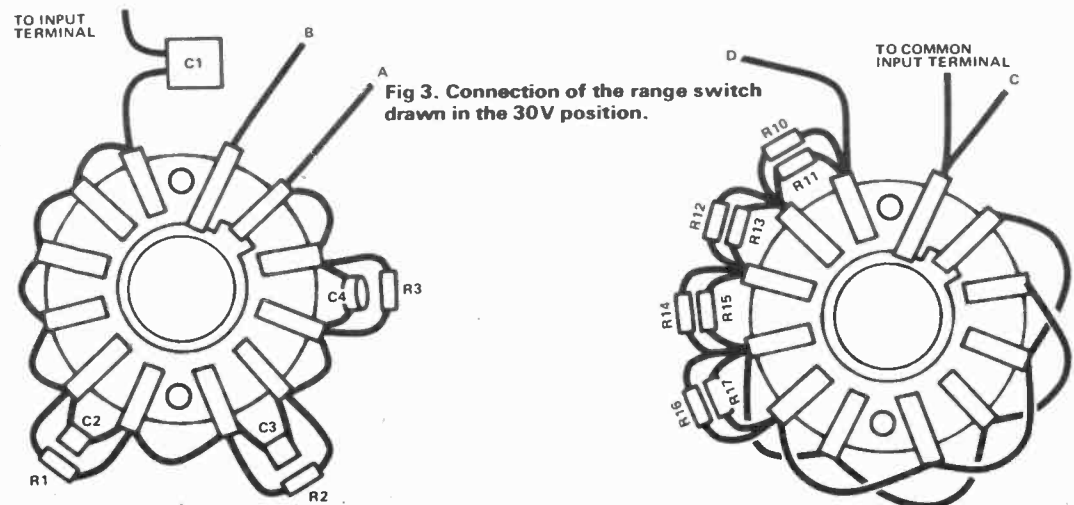


Fig 3. Connection of the range switch drawn in the 30V position.

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2N696	0.35	2N3703	0.15	2N6126	0.45	8C159	0.16	8D116	1.20	8YK85	0.35	TA521	1.00
2N697	0.30	2N3704	0.15	8C160	0.50	8C160	0.35	8D131	0.51	8YK87	0.30	TA522	1.00
2N698	0.62	2N3705	0.15	40362	1.55	8C161	0.35	8D132	0.54	8YK88	0.30	TA550	0.60
2N699	0.55	2N3706	0.16	40363	1.30	8C162	0.12	8D133	0.37	8YK89	1.25	TA550	1.75
2N700	0.28	2N3707	0.18	40406	0.60	8C168	0.12	8D136	0.37	8YK90	0.25	TA551	2.30
2N706A	0.28	2N3708	0.13	40407	0.52	8C169	0.12	8D137	0.38	8YK91	0.25	TA551	2.30
2N707	0.28	2N3709	0.15	40408	0.75	8C170	0.18	8D138	0.38	8YK92	0.30	TA552	2.15
2N709	0.50	2N3710	0.16	40409	0.75	8C171	0.16	8D139	0.40	8YK93	0.34	TA552	2.15
2N718	0.27	2N3711	0.16	40410	0.75	8C172	0.14	8D140	0.40	8YK94	1.20	TA552	2.15
2N718A	0.50	2N3712	1.20	40411	2.85	8C177	0.20	8D239	0.40	8YK99	0.50	TA553	1.50
2N720A	0.80	2N3713	2.30	40594	0.80	8C178	0.20	8D240	0.45	8YK99	0.33	TA553	1.50
2N914	0.35	2N3714	2.45	40595	0.90	8C179	0.23	8D241	0.45	8YK99	0.32	TA553	1.50
2N916	0.30	2N3715	2.55	40673	0.75	8C182	0.11	8D242	0.50	8YK99	1.40	TA553	1.50
2N925	0.25	2N3716	3.00	40125	0.45	8C182L	0.14	8D243	0.60	8YK99	2.20	TA553	1.50
2N929	0.25	2N3717	1.95	40127	0.45	8C183	0.11	8D244	0.65	8YK99	0.20	TA553	1.50
2N930	0.26	2N3722	2.00	40128	0.45	8C183L	0.14	8D245	0.65	8YK99	0.15	TA553	1.50
2N1131	0.30	2N3723	2.90	40151V	0.40	8C184	0.12	8D246	0.66	8YK99	0.20	TA553	1.50
2N1132	0.37	2N3724	3.80	40152	0.50	8C184L	0.16	8D247	0.66	8YK99	0.15	TA553	1.50
2N1613	0.30	2N3729	3.10	40153	0.55	8C207	0.16	8D300	0.50	8YK99	0.10	TA553	1.50
2N1711	0.30	2N3731	3.10	40153K	0.55	8C208	0.16	8D320	1.00	8YK99	1.55	TA553	1.50
2N1893	0.38	2N3732	3.50	40156	0.50	8C212	0.14	8D321	1.00	8YK99	1.55	TA553	1.50
2N2102	0.98	2N3734	4.20	40176K	0.65	8C212L	0.17	8D322	1.00	8YK99	1.85	TA553	1.50
2N2118	0.33	2N3819	0.36	40178K	0.60	8C213	0.14	8D323	1.00	8YK99	1.85	TA553	1.50
2N2122	0.37	2N3820	0.38	40178K	0.50	8C213L	0.16	8D324	1.00	8YK99	1.85	TA553	1.50
2N2129	0.35	2N3823	0.80	40181	1.00	8C214	0.16	8D325	1.00	8YK99	1.85	TA553	1.50
2N2219A	0.36	2N3904	2.10	40162	1.00	8C214L	0.17	8D326	1.00	8YK99	1.85	TA553	1.50
2N2220	0.35	2N3906	0.22	4F106	0.55	8C237	0.14	8D327	1.00	8YK99	1.85	TA553	1.50
2N2221	0.25	2N4036	0.67	4F109	0.75	8C238	0.12	8D328	1.00	8YK99	1.85	TA553	1.50
2N2222	0.26	2N4037	0.55	4F124	0.55	8C239	0.15	8D329	1.00	8YK99	1.85	TA553	1.50
2N2222A	0.25	2N4038	0.20	4F125	0.65	8C251	0.16	8D330	1.00	8YK99	1.85	TA553	1.50
2N2222B	0.25	2N4039	0.15	4F126	0.55	8C253	0.22	8D331	1.00	8YK99	1.85	TA553	1.50
2N2368	0.25	2N4060	0.20	4F139	0.69	8C257A	0.17	8D332	1.00	8YK99	1.85	TA553	1.50
2N2369	0.25	2N4061	0.17	4F186	0.50	8C258A	0.17	8D333	1.00	8YK99	1.85	TA553	1.50
2N2369A	0.25	2N4062	0.18	4F200	1.20	8C259B	0.18	8D334	1.00	8YK99	1.85	TA553	1.50
2N2464	0.75	2N4126	0.17	4F239	0.65	8C261A	0.24	8D335	1.00	8YK99	1.85	TA553	1.50
2N2547	1.40	2N4289	0.20	4F240	1.14	8C262B	0.24	8D336	1.00	8YK99	1.85	TA553	1.50
2N2904A	0.36	2N4919	0.65	4F279	0.80	8C262C	0.30	8D337	1.00	8YK99	1.85	TA553	1.50
2N2904A	0.37	2N4920	0.75	4F280	0.85	8C300	0.40	8D338	1.00	8YK99	1.85	TA553	1.50
2N2905A	0.37	2N4921	0.50	8C107	0.15	8C301	0.40	8D339	1.00	8YK99	1.85	TA553	1.50
2N2905A	0.38	2N4922	0.55	8C108	0.15	8C303	0.50	8D340	1.00	8YK99	1.85	TA553	1.50
2N2906	0.28	2N4923	0.70	8C109	0.15	8C307	0.15	8D341	1.00	8YK99	1.85	TA553	1.50
2N2906A	0.35	2N4924	0.60	8C113	0.20	8C308	0.15	8D342	1.00	8YK99	1.85	TA553	1.50
2N2907	0.25	2N4925	0.70	8C115	0.20	8C309C	0.15	8D343	1.00	8YK99	1.85	TA553	1.50
2N2907A	0.25	2N4926	0.75	8C116	0.19	8C317	0.14	8D344	1.00	8YK99	1.85	TA553	1.50
2N2924	0.15	2N5195	0.90	8C118A	0.20	8C318	0.13	8D345	1.00	8YK99	1.85	TA553	1.50
2N2925	0.17	2N5245	0.34	8C117	0.22	8C327	0.20	8D346	1.00	8YK99	1.85	TA553	1.50
2N3019	0.55	2N5294	0.40	8C118	0.20	8C328	0.19	8D347	1.00	8YK99	1.85	TA553	1.50
2N3053	0.26	2N5295	0.40	8C119	0.20	8C337	0.19	8D348	1.00	8YK99	1.85	TA553	1.50
2N3054	0.60	2N5296	0.40	8C121	0.45	8C344	0.35	8D349	1.00	8YK99	1.85	TA553	1.50
2N3055	0.70	2N5298	0.40	8C132	0.30	8C547	0.12	8D350	1.00	8YK99	1.85	TA553	1.50
2N3390	0.20	2N5447	0.15	8C134	0.20	8C548	0.12	8D351	1.00	8YK99	1.85	TA553	1.50
2N3391	0.20	2N5448	0.15	8C135	0.20	8C549	0.13	8D352	1.00	8YK99	1.85	TA553	1.50
2N3391A	0.20	2N5449	0.19	8C136	0.19	8C549	0.13	8D353	1.00	8YK99	1.85	TA553	1.50
2N3392	0.16	2N5457	0.20	8C137	0.20	8C550	0.13	8D354	1.00	8YK99	1.85	TA553	1.50
2N3393	0.15	2N5458	0.20	8C140	0.35	8C551	0.13	8D355	1.00	8YK99	1.85	TA553	1.50
2N3393A	0.15	2N5459	0.29	8C141	0.40	8C552	0.13	8D356	1.00	8YK99	1.85	TA553	1.50
2N3394	0.18	2N5484	0.38	8C142	0.30	8C553	0.13	8D357	1.00	8YK99	1.85	TA553	1.50
2N3440	0.64	2N5486	0.38	8C143	0.30	8C554	0.13	8D358	1.00	8YK99	1.85	TA553	1.50
2N3441	0.81	2N6027	0.60	8C147	0.12	8C742	0.60	8D359	1.00	8YK99	1.85	TA553	1.50
2N3442	1.35	2N6101	0.45	8C148	0.12	8C743	0.60	8D360	1.00	8YK99	1.85	TA553	1.50
2N3638	0.16	2N6107	0.42	8C149	0.12	8C744	0.60	8D361	1.00	8YK99	1.85	TA553	1.50
2N3638A	0.16	2N6109	0.50	8C153	0.27	8C745	0.75	8D362	1.00	8YK99	1.85	TA553	1.50
2N3639	0.30	2N6121	0.38	8C154	0.27	8C771	0.26	8D363	1.00	8YK99	1.85	TA553	1.50
2N3641	0.20	2N6122	0.41	8C157	0.14	8C772	0.24	8D364	1.00	8YK99	1.85	TA553	1.50
2N3702	0.13	2N6123	0.43	8C158	0.14	8D115	0.80	8YK84	0.35				

INTEGRATED CIRCUITS

CA3020	2.00	LM748-8	0.55	TA521	1.00
CA3020A	2.29	LM748N	0.55	TA522	1.00
CA3028B	1.29	LM1800	1.76	TA550	0.60
CA3028A	1.01	LM1808	1.92	TA550	1.75
CA3030	1.35	LM1828	1.75	TA551	2.30
CA3030A	2.00	LM3301N	0.85	TA551	2.30
CA3045	1.40	LM3302N	1.40	TA552	2.15
CA3046	0.89	LM3401	0.70	TA552	2.15
CA3048	2.23	LM3900	0.75	TA552	2.15
CA3049	1.80	LM3905	1.60	TA553	1.50
CA3050	2.42	LM3909	0.68	TA553	1.50
CA3053	1.62	MC1035	1.75	TA550	2.21
CA3080	0.75	MC1035	1.03	TA550	2.20
CA3080A	1.88	MC1034	1.40	TA551	2.20
CA3086	0.60	MC1305	1.40	TA510	2.31
CA3088	1.70	MC1310	1.91	TA520	2.21
CA3089	2.52	MC1327	1.54	TA520	2.20
CA3090	4.00	MC1330	1.00	TA530	1.98
CA3091	0.98	MC1350	0.90	TA530	2.07
LM3011A	0.67	MC1351	1.20	TA540	2.21
LM3012	0.40	MC1352	1.10	TA540	2.30
LM3014	2.45	MC1458	0.91	TA550	3.13
LM3017	0.65	NE555	0.40	TA550	3.22
LM3080C	1.82	NE556	1.10	TA560	3.22
LM3080N	0.85	NE566	1.30	TA570	1.29
LM3090K	1.85	NE566	1.85	TA570	1.38
LM317K	3.00	NE567	1.80	TA570	1.29
LM318L	2.26	SAS550	2.50	TA651	2.20
LM323K	6.46	SAS570	2.50	TA700	1.52
LM333N	1.40	S042P	1.25	TA700	1.61
LM334N	0.85	TA501N	1.30	TA700	2.30
LM350N	2.75	TA6003N	2.20	TA750	1.98
LM370N	2.50	TA6008K	1.50	TA750	2.07
LM371N	1.70	TA6013N	1.50	TA800	1.25

INSIDE VCT

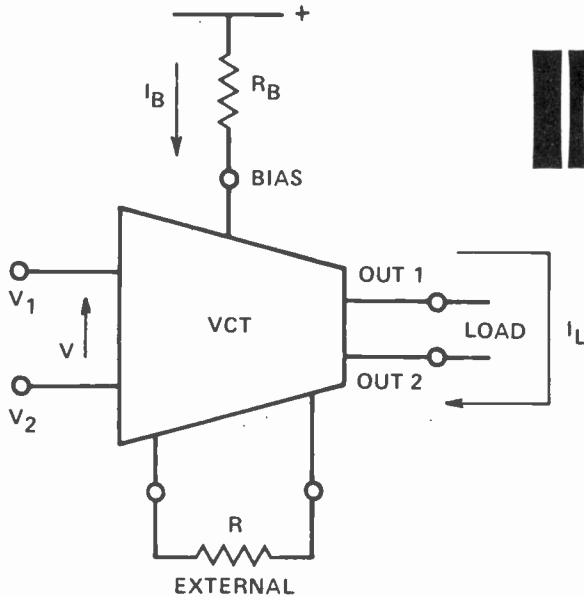


Fig 1. VCT symbol and external connections.

In the January 1977 issue of ETI Ron Harris reviewed the recent development of the Voltage-Current Transactor (VCT), perhaps the most important device innovation of recent years for not only is the VCT expected to perform all the functions we now expect of the op-amp but to perform them either better or with fewer additional components.

The earlier article briefly covered the VCTs development and its terminal properties, together with basic circuit applications. This article describes the VCTs internal functioning. It has been written for ETI by Dr. J. E. Morris of the Department of Physics, Victoria University of Wellington, New Zealand.

THE CIRCUIT SYMBOL for the VCT is shown in Fig. 1 along with the necessary bias supply and an external resistor R which determines terminal gain. The name "voltage-current transactor" is derived from the translation of differential input voltage into a proportional output current.

As with the conventional op-amp, the input impedance is made as high as possible to minimise loading of any practical source of input voltage, but the main difference between the VCT and an op-amp lies in the output port. As a current source rather than one of voltage, the port impedance is high rather than low. Furthermore, whereas the op-amp output signal is usually single-ended and referenced to ground, the VCT output is completely floating. The VCT is thus a true four terminal device and either terminal of either port may be used as a common point. It will also be apparent from Fig. 1 that there is no external feedback element involved in a simple amplification application.

The internal circuit is shown in Fig. 3 and as explained in this article there is no overall feedback concealed within

the unit. With no feedback, there can be no feedback stability problems and thus a major headache of op-amp design vanishes.

VCT Circuit

Modern ICs are generally very complex and involve many functional blocks. At first glance a circuit diagram often appears to have more relevance as a design for a maze than as a sensible means of serving these required electronic functions. The trick is to identify the functional blocks. Once their patterns are recognized, circuit operation may be deduced. For example it is obvious that the VCT is essentially symmetrical about the centre, so only one side need be considered in detail. And the input transistors (Q_1 Q_2 on side 1) clearly form a Darlington pair and may be regarded as a single composite transistor (Q_D say) in any simplified analysis.

Most of the functional blocks in the circuit are derived constant current sources and these will be briefly reviewed before seeing how they fit together to form the VCT.

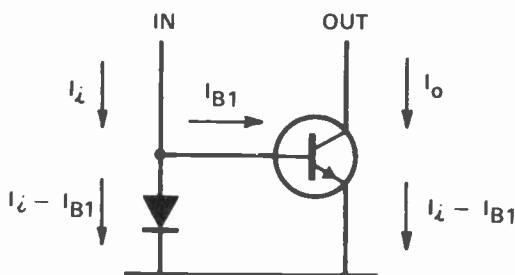


Fig 2. Basic constant current source. I_o is fixed by injected I_i .

The obvious solution to the impedance matching problem might appear to be the use of a common-base transistor stage which has low input impedance into the emitter and the same high output impedance from the collector as above. In an equivalent situation to Fig. 3 however, a PNP transistor is required and the sign of I_o is reversed. A minimum of three supply voltages would then be required instead of the two implied by Fig. 3.

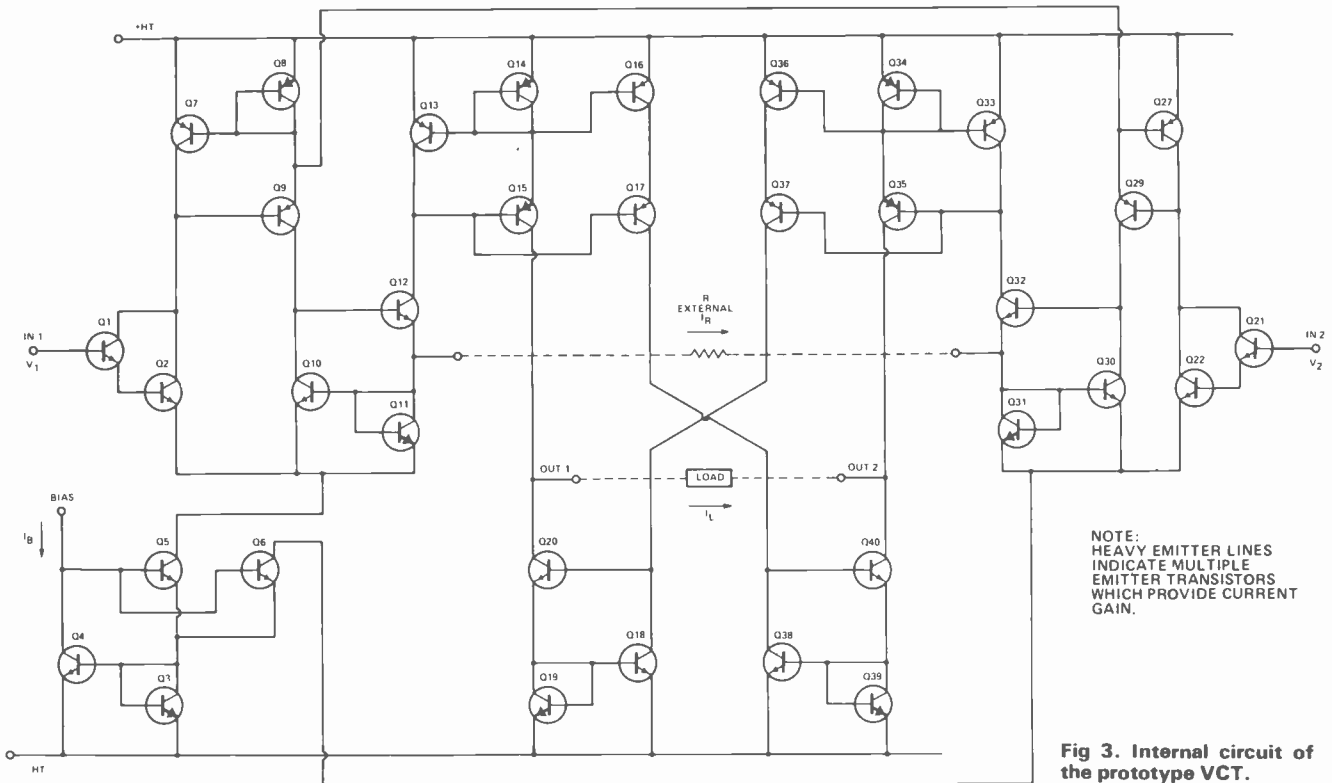


Fig 3. Internal circuit of the prototype VCT.

IC Current Sources

A) Mark I

The derived current source performs a similar impedance matching function with respect to current to that which an emitter follower provides in voltage circuits. A circuit commonly employed in ICs is shown in Fig. 2 where the essential requirement for operation is that the diode is matched to the B-E junction of the transistor. For a given diode voltage equal to the B-E voltage, identical currents must flow through the diode and emitter junction. By inspection $I_o = I_i - 2I_{B1}$ in this case and $I_o \approx I_i$ provided transistor gain β is high. The input impedance is low and the output impedance is high to provide the current in/current out impedance matching required. In addition the input DC level (V_{BE}) is low and the output DC voltage (V_{CB}) will depend upon the nature of the load.

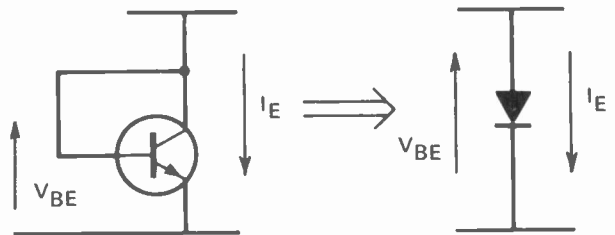


Fig 4. IC diode format.

B) Diodes

The crux of the design in Fig. 2 is the matching of the diode to the B-E junction. One major feature of the modern IC is the close matching which may be achieved between adjacent transistors on a chip. Whereas the absolute values may vary quite considerably, and such variation occurs almost identically in nearby transistors. Tight thermal coupling also ensures that the characteristics remain matched independent of external temperature fluctuations and local Joule heating. The diode employed in the VCT is actually a normal transistor with the base shorted to the collector (see Fig. 4). If this transistor is adjacent to the current source transistor and physically identical to it, then the fact that V_{BE} is common to both ensures an identical emitter current in each (Fig. 2). To a first approximation only, the particular configuration also provides

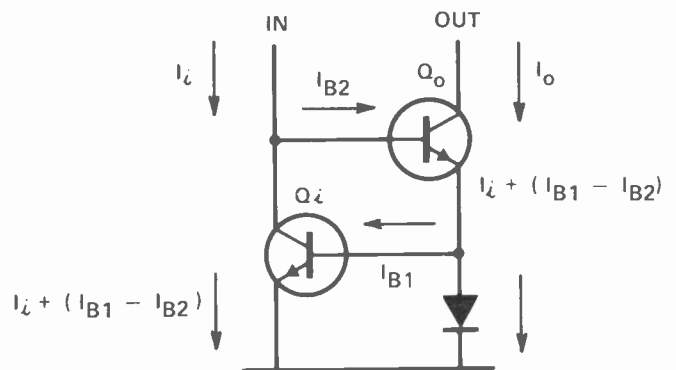


Fig 5. Constant current source employed in the VCT.

for a similar distribution of I_E between I_B and I_C . Truly identical transistors will not, however, possess identical current gains in the circuit due to the differences in V_{CB} (zero for the diode transistor).

C) Mark II

The problem with the single circuit of Fig. 3 is the requirement of high transistor gain. A partial solution is provided by the circuit of Fig. 5 which is the basis of all the functional blocks of the VCT. Here $I_o = I_i + 2(I_{B1} - I_{B2})$ and is made to closely approximate I_i by ensuring that $I_{B1} \approx I_{B2}$ rather than relying only on a large β . Note that the improvement is at the cost of an increased input impedance and DC input level ($V_{BE1} + V_{BE0}$). If $I_{B1} = I_{B2}$ exactly, β must be slightly greater for Q_o than for Q_i (which is reasonable since V_{CB0} will be greater than $V_{CBi} = V_{BE0}$).

Each of the functional blocks involves further modification of this circuit. These will each be described in turn.

D) Multiple Emitters

The multiple emitter structure has been mentioned before. All it means is that the transistor emitter current is increased for a given V_{BE} by increasing the emitter area. In this way the multiple emitter, when used in the output side of a derived current source, can provide current gain. A current gain of two for each of the multiple emitter stages in the VCT leads to the prototype device specifications quoted by Harris and is assumed below.

Bias Circuit

The bias circuit has been redrawn in Fig. 6 where the multiple emitter transistor Q_3 has been split and is shown as two separate diodes. Current amplification leads to the defined bias current $I_B = (V_S - 2V_{BE})/R_B$ being drawn equally from each of the two sides of the VCT.

Note that while the total symmetry shown in the diagram implies that the introduction of a multiple emitter structure requires β_5, β_6 to be twice β_4 , this conclusion is misleading. In fact one would be more likely to vary the multiple emitter area slightly off two, such that (i) all β 's were approximately equal as before (ii) diode currents become $I_B + \frac{1}{2}I'$, and (iii) the base current of Q_4 reverts to $(\frac{1}{2}I') + (\frac{1}{2}I')$.

Differential Input

It should be clear by now that the VCT relies upon defined current sourcing and multiple emitter current amplification to function. The input signal however is defined as a differential voltage ($V_1 - V_2$) and must be converted to a proportional current. This is the purpose of the external resistor R as shown by the simplified view of Fig. 7 where I_R is clearly $(V_1 - V_2)/R$ provided symmetry is maintained. (Q_D is the Darlington combination Q_1 and Q_2 ; Q_{11} functions as a diode).

It will be seen shortly that the existence of a finite I_R upsets the symmetry — in fact this is how the circuit functions. So once again, our ideal is not quite possible since the diodes carry different currents at slightly different voltages. In fact $I_R \approx (V_1 - V_2)/R$.

The next step is to see how I_R is converted to an output current.

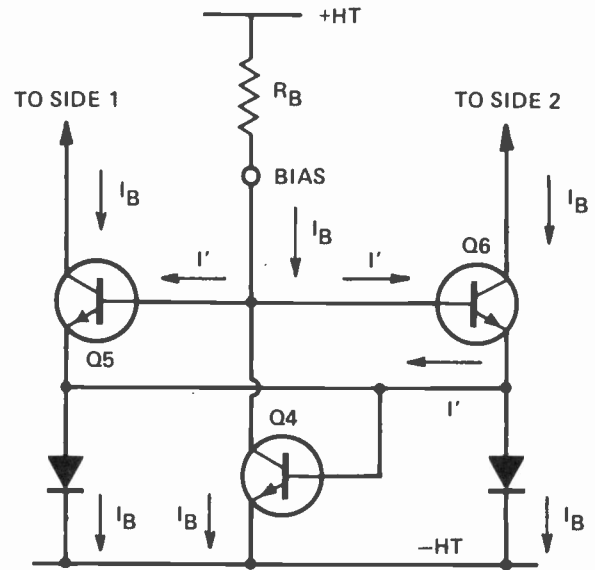


Fig. 6. Bias circuit as an example of the multiple-emitter diode.

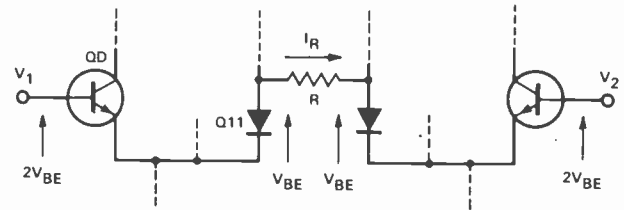


Fig. 7. Simplified view of the differential input circuit.

Input Circuit

The input section of one side of the VCT is redrawn in Fig. 8. Q_8 services both sides of the circuit and has been split in the diagram. Assume for the moment that some current I_x flows down through Q_7 and then the Darlington Q_D . The Q_7, Q_8, Q_9 current sourcing circuit requires I_x to also flow through Q_9 and Q_{10} . Similarly Q_{11} should draw $2I_x$ due to the double emitter. The total $4I_x$ must equal the bias current I_B and hence the currents are as shown with Q_{12} also carrying I_B . The principle of this input circuit is summarised for reinforcement in Fig. 9 which should be compared with Figs. 7 and 8.

It has already been stated that V_{CB} of the source output transistors will vary under operating conditions and cause deviations from ideal behaviour due to resultant β . In Q_{12} the base current I_{B12} (assuming constant β to first order) can no longer equal I_{B10} . Current source operation must therefore deteriorate under operational conditions.

Output Circuit

The next step is to determine how the input signal current I_R is translated into a proportional floating output. Fig. 10 shows the remainder of side 1 of the VCT, designated as the output circuit. Clearly transistors Q_{18} to Q_{20} form a derived current source with gain equal to two. But it may be more difficult to see that Q_{13} forms part of two similar sources: with Q_{14}/Q_{15} to give a gain of two, and with Q_{16}/Q_{17} for unity gain.

So the current drawn by Q_{12} (Fig. 8) is converted into two proportional currents. The first $(I_B + 2I_R)$ flows into the node "OUT 1" while the second $(I_R + I_B/2)$ is delivered to side 2. A corresponding current from side 2 $(-I_R + I_B/2)$ flows into Q_{18} and the amplified signal $(I_B - 2I_R)$ is drawn from the "OUT 1" terminal. The net current delivered to the load (I_L) is therefore $4I_R$.

In the paragraph before last, the detailed operation of Q_{14} to Q_{17} was hurriedly glossed over in order to first cover the principle of the output circuit. The diode function of Q_{14} should be familiar by now, but the reason Q_{15} has also been made with a double emitter is to keep V_{BE15} with $(I_B + 2I_R)$ equal to V_{BE17} with half that current. In this way, the collector and base terminals of Q_{16} are linked by a virtual short circuit and Q_{16} is constrained to also function as a diode.

Overall Principle

When side 1 and side 2 are considered together, as in the simplified equivalent of Fig. 11, one can appreciate the overall concept of the VCT. The input signal $(V_1 - V_2)$ causes a current imbalance $(V_1 - V_2)/R$ to be superimposed on the null input bias levels (Fig. 9). With current gain mixed into the process, the bias currents are then balanced out leaving a net differential load current $4(V_1 - V_2)/R$ in the load (Fig. 11).

Device Properties

Each multiple emitter in the prototype VCT has been assumed to give a gain of two. Clearly, it would be simple to vary this; indeed it would appear feasible to provide gain in other parts of the circuit as well as or instead of those shown. Nevertheless, for the prototype as shown, $I_L = 4(V_1 - V_2)/R$. For voltage gain, one might merely insert a load resistor R_L for a totally floating output gain $4R_L/R$. Other elementary circuit configurations have been described by Harris.

The absolute linear range of the VCT is restricted in both current and voltage. Transistor cutoff when $2I_R = I_B$ (See Fig. 10) limits output current $I_L = 4I_R$ to a maximum of $\pm 2I_B$; I_B being set by the circuit designer. Either output current or load is also limited by load voltage and the onset of saturation in the output transistors, i.e. the load voltage $I_L R_L$ may not exceed the total power supply range minus $4V_{BE}$. For +15 V supplies and 10 mA bias current the load impedance limit is 1k4 if the full output current range is to be available. Note also that wide signal excursions from the symmetrical design bias point lead to loss of linearity, since V_{CBS} of the current source output transistors are moved off bias values causing β to shift. The need to maintain V_{CB} and β close to design values also limits the acceptable power supply variation — about 10 to 15% according to Harris. These figures would suggest that linearity may be seriously degraded by voltage swing well before the saturation limit is reached.

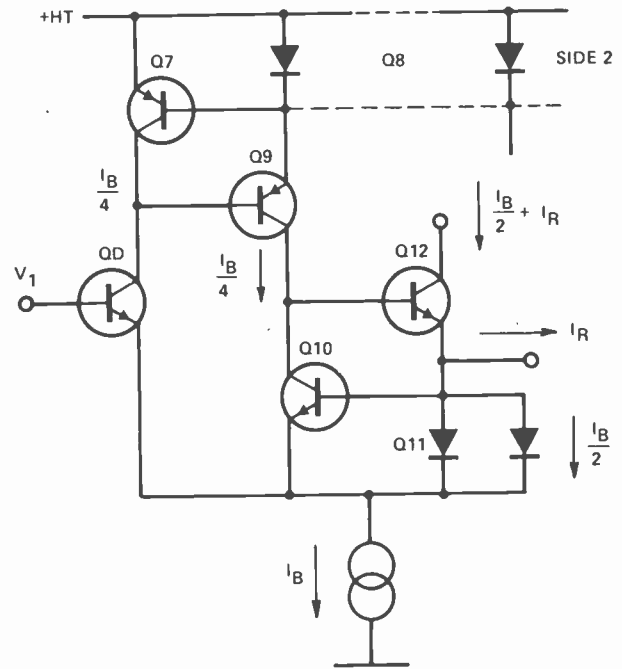


Fig 8. Input circuit — side 1.

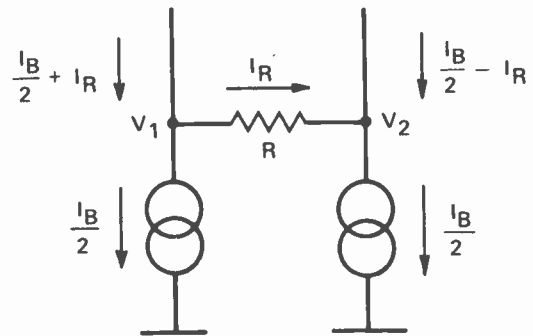


Fig 9. Equivalent input circuit.

High input impedance R_{in} is a fundamental requirement of the VCT concept and is the reason for the use of Darlington inputs. To the grossest of approximations, small signal $R_{in} (= \beta_1 \beta_2 R / \beta_{10})$ is critically dependent upon the input stage current gain and maximising it leads to a whole series of tradeoffs, (e.g. R should be low for high transconductance, β_{10} high for current source operation).

Common mode rejection ratio and required offset will both depend upon the degree of symmetry attainable in mass production but there is no reason to be pessimistic about them. High slew rates have been reported and are undoubtedly due to the fact that currents vary in only half of the circuit transistors and that the signal only proceeds sequentially through about half of these.

FEATURE: Inside VCT

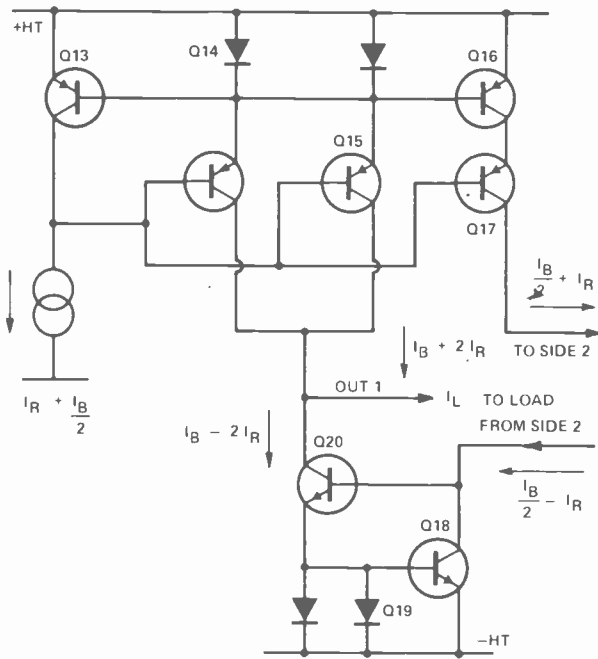


Fig 10. Output circuit — side 1.

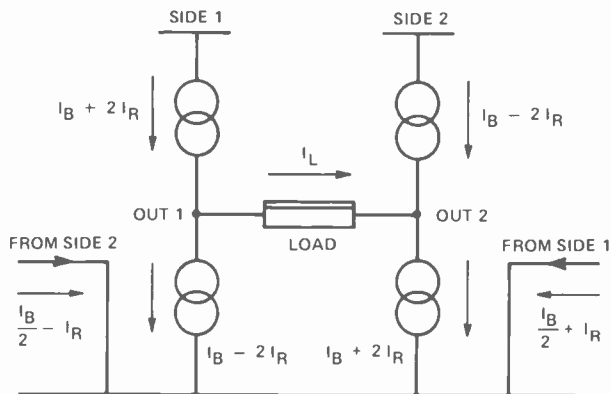


Fig 11. Equivalent circuit of the differential current output.

Conclusion

The main objective of this article has been the explanation of the principles of circuit operation. A secondary aim was to point out some unwanted second order effects and practical limitations. Such limitations occur in all devices and must not be ignored by either the designer or the user.

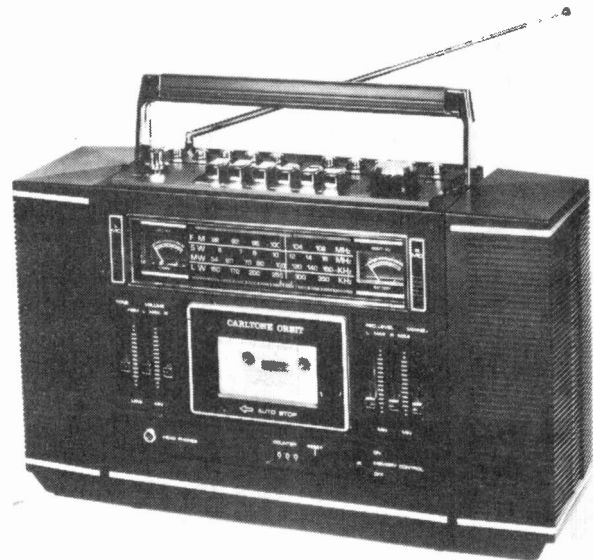
The immediate question is whether the VCT will survive through to production or remain just another bright idea. Simplicity is a major advantage to any technological innovation and despite the plethora of transistors, the VCT is very simple in principle. Furthermore its implementation will rely totally on existing technology — its future looks bright.

I should like to thank my students whose curiosity and questions led directly to this article.

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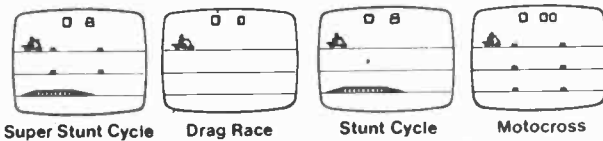
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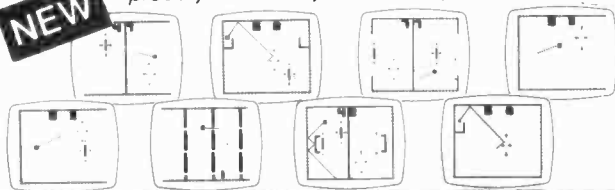


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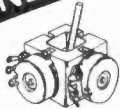


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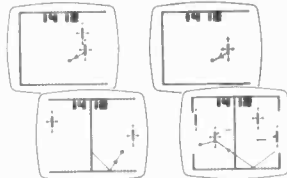
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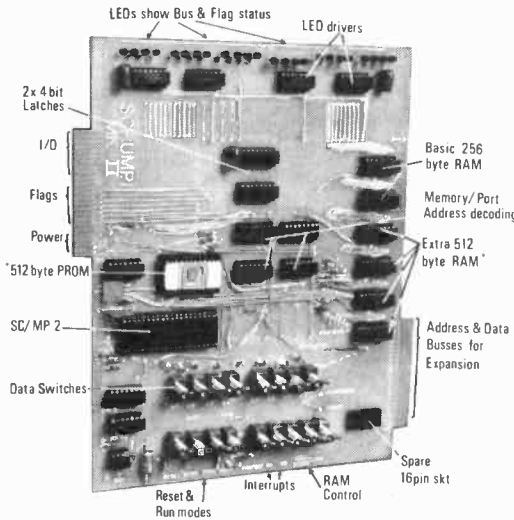
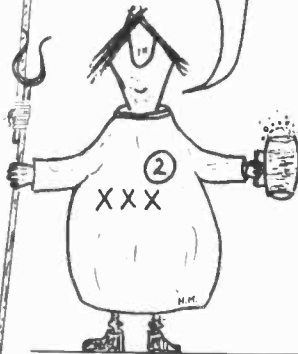
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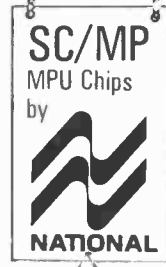
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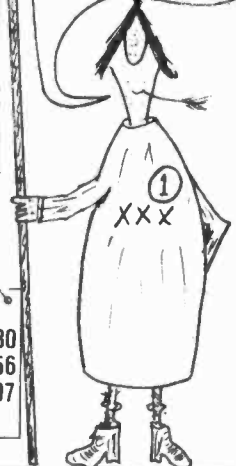
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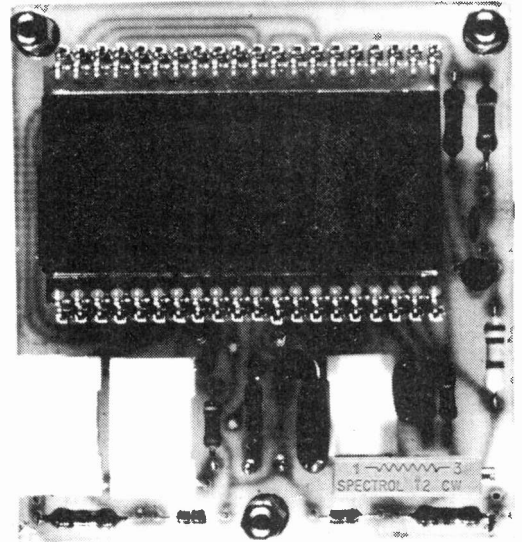
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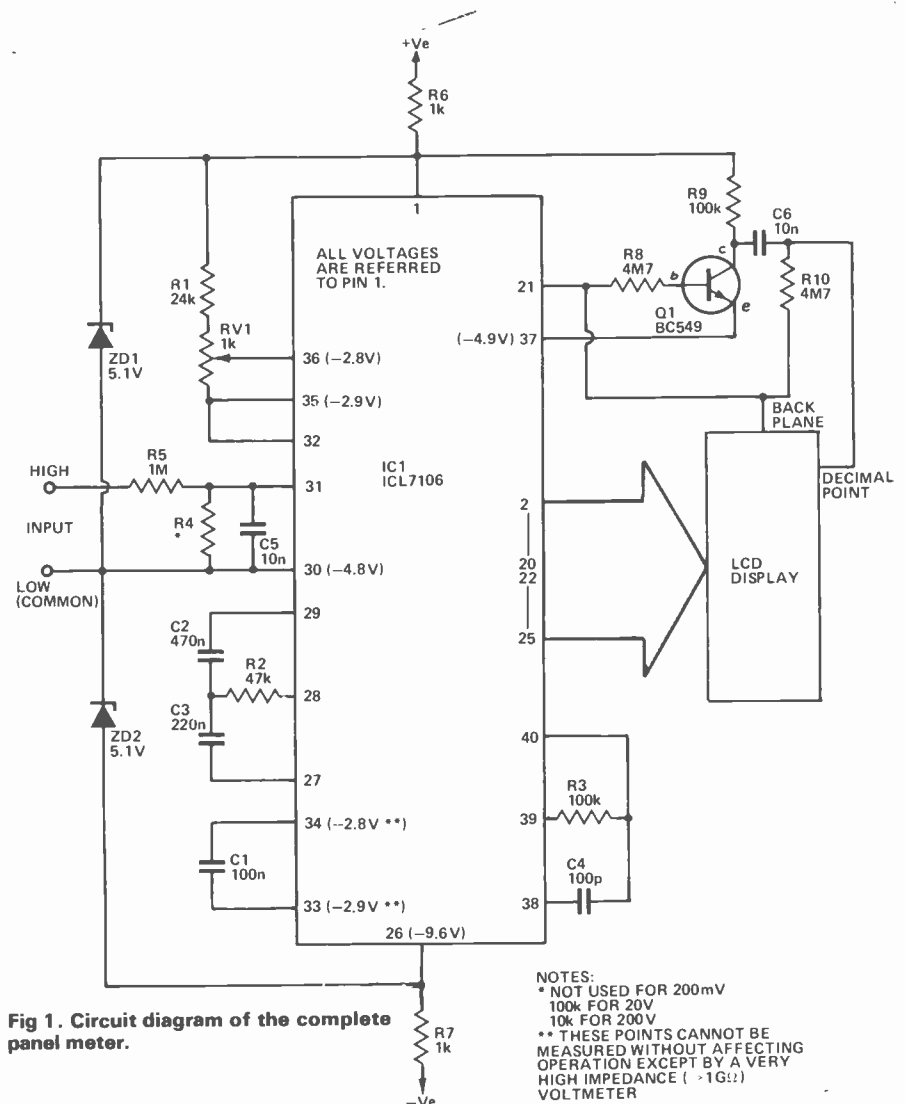


WE INITIALLY purchased a number of Intersil evaluation kits for our own use but soon realised that while they were very good electronically, the physical layout wasn't too hot. We therefore redesigned the PCB, reducing the size dramatically, adding the decimal point drive circuitry and some dropping resistors and zener diodes to allow the board to run from a dual power supply of $\pm 5V$ or more (e.g. with op-amps). This resulted in a very useful device which we decided to run as a project. While it is basically a panel meter suitable for DC voltages and current (with a shunt) it will be the display module for several future projects.

Construction

To save on real estate, the main IC is mounted under the display. We used the Soldercon pins supplied with the evaluation kit for the display and soldered the IC directly into the board. If you want to mount the IC in a socket a low profile type should be used, with a high one for the display. As a socket is not available for the display a standard 40 pin one can be cut up to fit.

However before fitting either the display sockets or the IC, fit all the other components first. The overlay in Fig. 2 shows the positioning of the components. Most of the components come with the evaluation kit. The large capacitors are laid on their side to minimise height.



SPECIFICATION

Full scale reading	200mV
Resolution	100 μ V
Accuracy	< 1 digit
Display	3½ digit LCD
Input impedance	> 10 ¹² ohms
Input bias current	≈ 2 pA
Polarity	automatic
Conversion method	dual slope
Reference	internal
Power supply	±5V to ±15V DC 1mA @ ±5V

BUYLINES

The Intersil Evaluation kit is available from Rapid Recall, 9 Betterton Street, Drury Lane, London WC2H 9B5 at a cost of £23.29 all inc. If you want to just build the ETI version, Doram and Marshalls stock the chips and display. Watford stock everything as a kit. The PCB is available from all the 'usual' suppliers e.g. Rammar, Tamtronik etc.

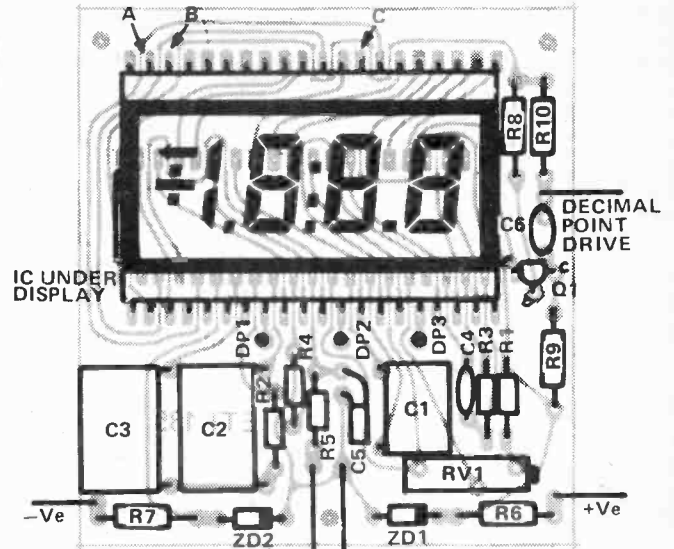
HOW IT WORKS

Not much can be said on how this project works as everything is done by one IC and if anything goes wrong it is usually the IC. We have included some waveform diagrams and voltages for reference purposes. The conversion works on the dual-slope integration technique, which is the most reliable of the simple methods available. A capacitor is charged up at a rate proportional to the input voltage for a predetermined time (in this case 1000 clock pulses), then it is discharged at a constant rate until it reaches the starting point again. The time taken to do this (i.e. the number of clock pulses) is proportional to the input voltage.

It is a true dual polarity system where the integration direction depends on the polarity of the input voltage. Provided AC ripple on the input averages to zero over 1000 clock pulses it will be rejected, hence where 50Hz mains is to be rejected a 50 kHz clock should be used, giving 80 ms sample time (4 cycles of 50 Hz). The clock can be adjusted by varying R3 if desired.

For further details of the IC see the data sheet in this issue.

Fig 2. Component overlay with the display in place. Points marked A, B and C are the unused display segments — the vertical part of the + sign, the arrow and the semicolon respectively.



PARTS LIST

RESISTORS all ½ W 5%

R1*	24k
R2*	47k
R3*, 9*	100k
R4	See circuit diagram
R5*	1M
R6,7	1k
R8,10	4M7

POTENTIOMETER

RV1*	1k 10 turn type
------	-----------------

CAPACITORS

C1*	100n	Polycarbonate
C2*	470n	Polycarbonate
C3*	220n	Polycarbonate
C4*	100p	Ceramic
C5*, 6	10n	Ceramic

SEMICONDUCTORS

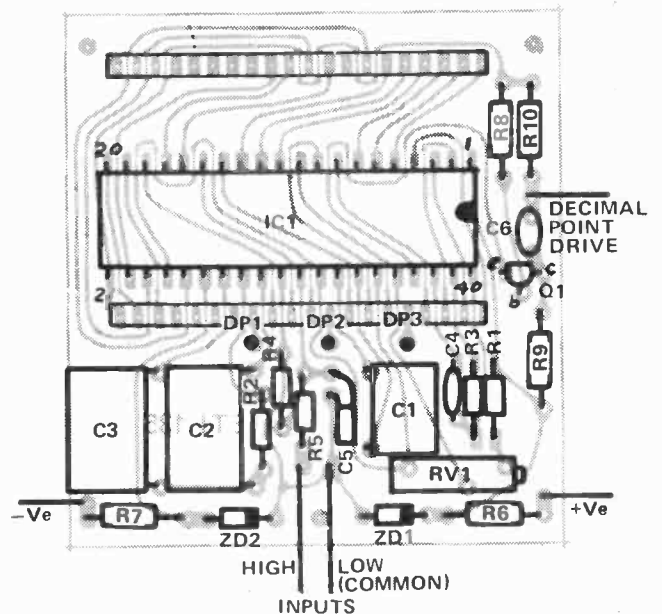
IC1*	ICL7106
Q1	BC549 or similar
ZD1,2	5V1 400 mW

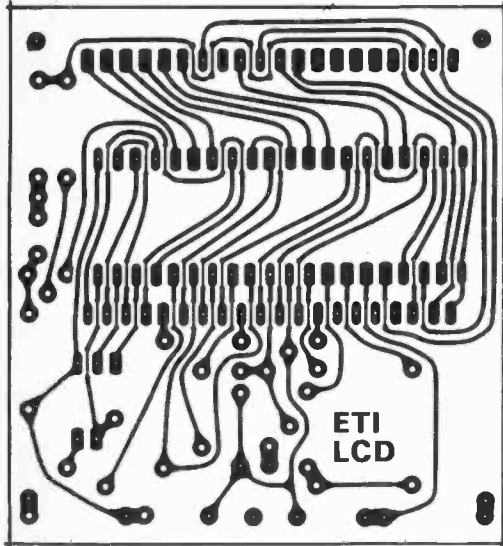
MISCELLANEOUS

PCB, LCD 3½ digit display*, soldercon pins*.

* These components are supplied with the Intersil evaluation kit.

Fig 3. The component overlay without the display showing the positioning of the integrated circuit.





Foil pattern for LCD panel meter, shown full size. (65 x 70 mm).

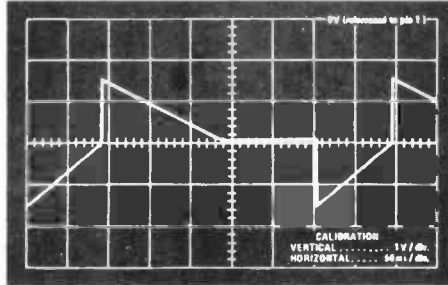


Fig 4. The waveform at pin 27 with a negative input of 170mV.

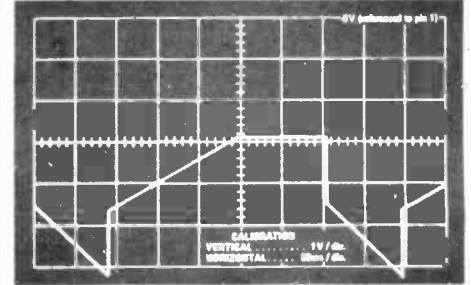


Fig 6. The output of the master oscillator on pin 38.

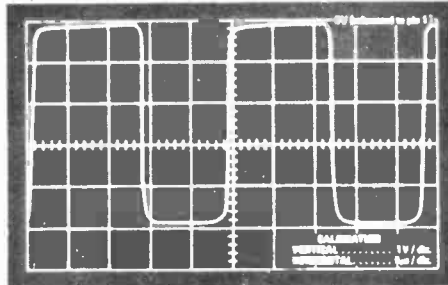


Fig 5. The waveform at pin 27 with a positive input of 170mV.

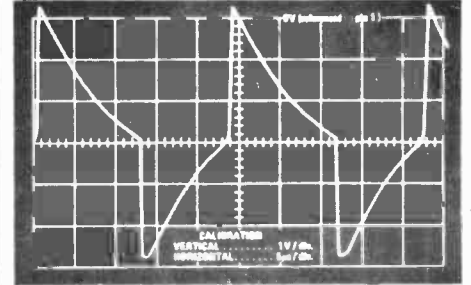


Fig 7. The input of the oscillator-pin 40.

When fitting the IC solder pins 1 and 26 first (the power supply pins) so that the protection diodes on the inputs can operate, thus preventing damage by static electricity. It is necessary that a small tipped iron and fine solder be used

to prevent bridging tracks. The IC sockets can now be fitted in two strips of 20 with the top connecting pieces being broken off using long nosed pliers after they are soldered in.

As there are no polarity marks on the

display it is necessary to hold it at an angle to the light and look for the outline of the digits. The full format of the display is shown in Fig. 3. In this unit the arrow, semicolon and the vertical part of the + sign are not used. **ETI**



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1N4148	75v	10mA	.05	18-pin	pcb	.25	ww	.75	2N3054	NPN		.35
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4001	.20	7401	.15	7474	.35	74180	.85	74H101	.75	74S140	.75
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4006	1.20	7404	.15	7480	.55	74190	1.75			74S157	.80
4007	.35	7405	.25	7481	.75	74191	1.35	74L00	.35	74S158	.35
4008	.95	7406	.35	7483	.95	74192	1.65	74L02	.35	74S194	1.05
4009	.30	7407	.55	7485	.95	74193	.85	74L03	.30	74S257 (8123)	.25
4010	.45	7408	.25	7486	.30	74194	1.25	74L04	.35		
4011	.20	7409	.15	7488	1.35	74195	.95	74L10	.35	74LS00	.35
4012	.20	7410	.10	7490	.55	74196	1.25	74L20	.35	74LS01	.35
4013	.40	7411	.25	7491	.95	74197	1.25	74L30	.45	74LS02	.35
4014	1.10	7412	.30	7492	.95	74198	2.35	74L47	1.95	74LS04	.35
4015	.95	7413	.45	7493	.40	74221	1.00	74L51	.45	74LS05	.45
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4017	1.10	7416	.25	7495	.60			74L72	.45	74LS09	.35
4018	1.10	7417	.40	7496	.80	75108A	.35	74L73	.40	74LS10	.35
4019	.60	7420	.15	74100	1.85	75110	.35	74L74	.45	74LS11	.35
4020	.85	7426	.30	74107	.35	75491	.50	74L75	.55	74LS20	.35
4021	1.35	7427	.45	74121	.35	75492	.50	74L93	.55	74LS21	.25
4022	.95	7430	.15	74122	.55			74L123	.55	74LS22	.25
4023	.25	7432	.30	74123	.55	74H00	.25			74LS32	.40
4024	.75	7437	.35	74125	.45	74H01	.25	74S00	.55	74LS37	.35
4025	.35	7438	.35	74126	.35	74H04	.25	74S02	.55	74LS40	.45
4026	1.95	7440	.25	74132	1.35	74H05	.25	74S03	.30	74LS42	1.10
4027	.50	7441	1.15	74141	1.00	74H08	.35	74S04	.35	74LS51	.50
4028	.95	7442	.45	74150	.85	74H10	.35	74S05	.35	74LS74	.65
4030	.35	7443	.85	74151	.75	74H11	.25	74S08	.35	74LS86	.65
4033	1.50	7444	.45	74153	.95	74H15	.30	74S10	.35	74LS90	.95
4034	2.45	7445	.65	74154	1.05	74H20	.30	74S11	.35	74LS93	.95
4035	1.25	7446	.95	74156	.95	74H21	.25	74S20	.35	74LS107	.85
4040	1.35	7447	.95	74157	.65	74H22	.40	74S40	.25	74LS123	1.00
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4044	.95	7453	.20	74165	1.50	74H51	.25	74S74	.40	74LS164	1.90
4046	1.75	7454	.25	74166	1.35	74H52	.15	74S112	.90	74LS367	.85
4049	.70	7460	.40	74175	.80	74H53J	.25	74S114	1.30	74LS368	.85
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Just how will the role of the driver be changed by the rapid advances and increasing implementation of electronics in the motor car? Dr Peter Sydenham examines the most recent equipment to give us a glimpse of the standard accessories of the future.

AUTO ELECTRONICS

IT WAS IN THE LAST DECADE of the nineteenth century that the motor car was born. Most designs of what we now call *veteran* cars used internal combustion engines, for which the main use of electrics was to ignite the fuel in the combustion chamber. Storage batteries were used in some designs of the 1890s to drive the high-tension ignition device and to power an electric warning bell.

Sparkplugs, magnetos, ignition distributors, starter motors, and headlights followed in the 1900 to 1910 era, then a DC generator was added to the engine to keep the battery charged.

Electrical direction signals were in common use by the 1930s, along with stop lights, reversing lights, and courtesy lights. At that time instrumentation of vehicle speed, engine revs, engine temperature and oil pressure almost always used non-electrical methods. Usually the only panel instrument using electrical indication was the ammeter for battery charge or discharge. Regulation of

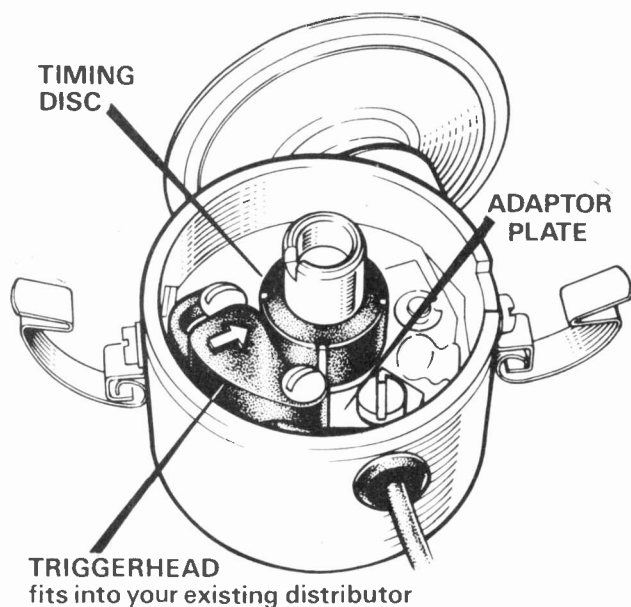


Fig 1. Contactless electronic ignition is available for just about any car. This changeover system is used in the Mobelec system.

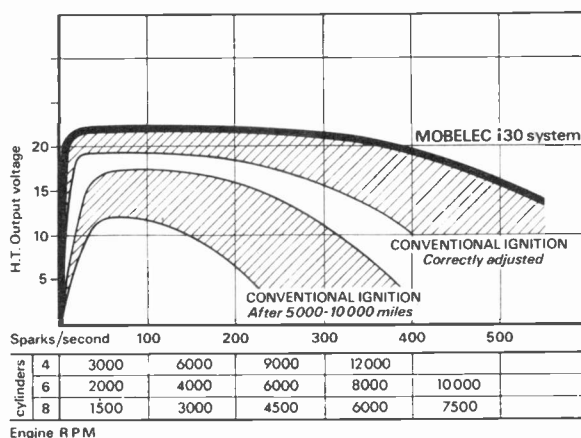


Fig 2. Comparative chart of electronic ignition with the conventional rapidly-dating contact-points method.

battery charge was controlled by moving the "third" brush of the generator and a summer-winter switch position was available to adjust the system for seasonal temperature change.

Cars of the '40s and '50s were little improved. In the 1960s, however, things rapidly began to change. The DC generator was replaced with a much smaller and more efficient AC alternator, which required solid-state diodes for rectification. The day had come when the average do-it-yourself owner could no longer confidently tackle the auto-electrics of the car. Regulators changed from electro-mechanical relays to solid-state circuitry; some cars introduced electronically-controlled fuel-injection, others introduced electronic ignition.

What we saw in the progressive designs of the '60s and early '70s are fast becoming standard equipment today. This study of the 1977 new models and accessory market reveals that there is still a long way yet to go.

Engine And Mechanics

Electronic ignition is becoming standard in an increasing number of cars — Ferrari, Renault, Chrysler and Mercedes use it, while US cars have had it since 1975.

A do-it-yourself kit is available which enables the standard distributor to be used with a change-over "points" component that replaces the contacting points with a non-contact sensor (Fig. 1).

Advantages provided by electronic ignition are lower fuel consumption, easier starting, better idling, improved timing accuracy, and constancy of timing with period of operation, plus no points to need replacing. One maker, Mobelec Ltd, issues a chart showing high-tension voltage output produced by conventional methods compared with their electronic system, shown in Fig. 2. It is seen that the electronic alternative gives the best high-tension performance and holds it over time, unlike the points method that wears.

The next stage of ignition improvement is to replace the rather cumbersome, and not really adequate, automatic vacuum and centrifugal ignition timing control. The latest US Cadillac Seville and Fleetwood Brougham cars have an "electronic spark selection system", which uses electronic logic circuits to monitor engine speed and inlet manifold vacuum, and signal the appropriate spark advance or retard. Thinking it through, it is not hard to see that once electronic ignition is used, with engine speed being measured electronically, it is relatively simple to add a vacuum measuring transducer and use a phase-shift spark time control circuit arrangement. Overall this should be cheaper than the conventional vacuum advance mechanics — and much more reliable and predictable.

Pollution And Economy

Economy is now a strong sales point, so manufacturers are seeking ways to reduce fuel consumption, and the level of pollutants produced by an engine. Fuel injection has been used by a few makers for many years now, and some have reached sophisticated levels of electronic "computer-brain" injector control.

Electronic analysers are used to tune the carburettor for minimum CO emission, but Volvo cars of 1977 now go one step further in the interest of economy and emission control. Their Lambda-Sond electronic air/fuel ratio sensor system uses a "ruggedised" zirconium dioxide oxygen gas content probe in the exhaust manifold. The level of O₂ in the exhaust is measured as an electric signal equivalent that is fed back automatically to control the fuel-injector equipment made by Bosch. This has, it is claimed, enabled the Volvo engines to meet stringent low-emission requirements at less cost than other methods. A snag is that the sensor at present needs replacement at 30 000km periods. They next hope to apply this principle to conventional carburettor control.

A Datsun answer to economy is to provide the driver with a simple "go"-"no-go" indicator of the lead-footedness of the driver. "Drive it on the green" is their slogan for the new 1977 Laurel Six saloon. Above the steering column block are two lights — the left green, the right orange. Economy is very much a matter of keeping the inlet manifold vacuum within limits and this

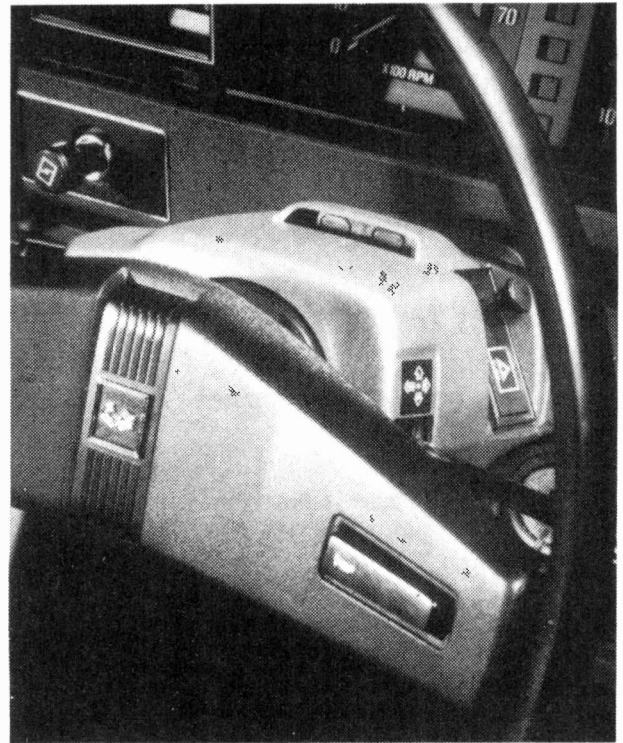


Fig 3. "Drive-it-on-the-green" is the Datsun Laurel slogan. Two lights, seen here above the steering wheel centre, indicate when the driver is operating the engine within good economy limits.

Fig 4. Retrofit cruise control is possible with this kit. The right chain-coupled unit stores the throttle position required. It is operated by the left-hand push button unit. The brake pedal electric connection is used to cancel the position during deceleration.



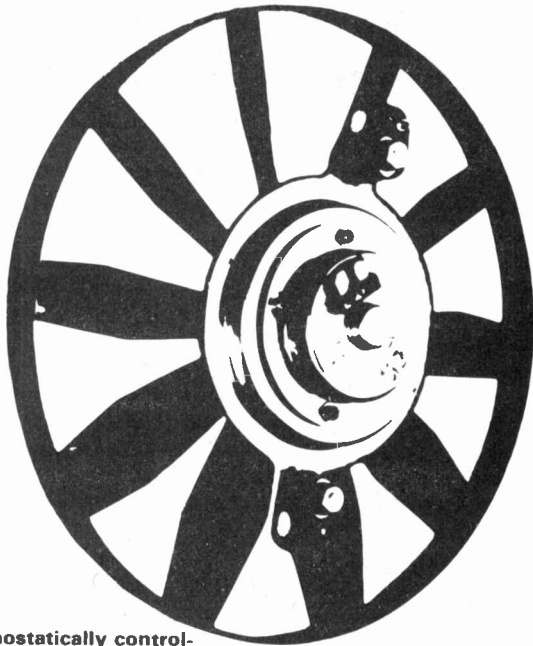


Fig 5. Thermostatically controlled engine cooling fan by Kenlowe.

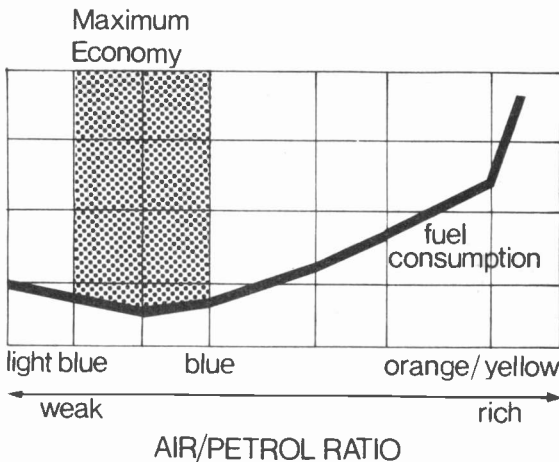
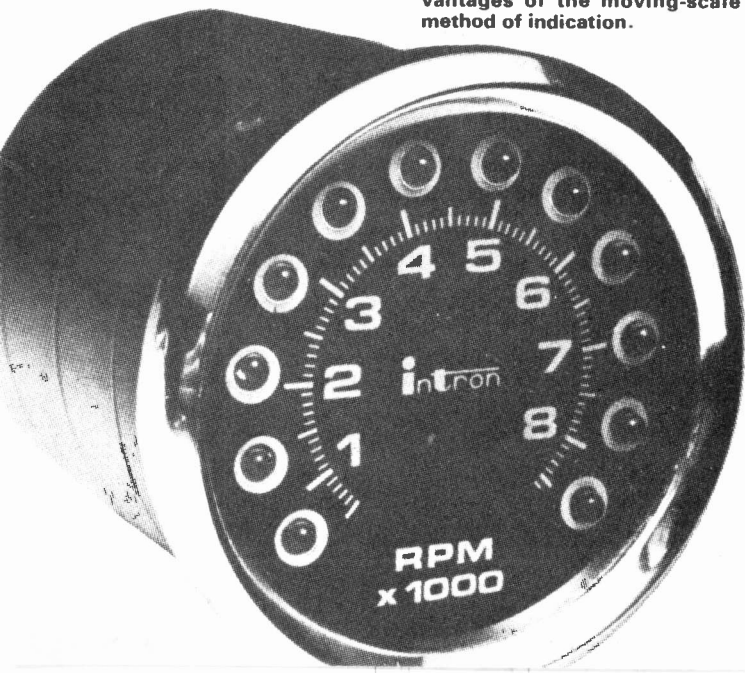


Fig 6. Different air/fuel ratios burn with different colours. Maximum economy is obtained when the colour is in the blue region.

Fig 7. Needle indicators will soon disappear from the dash panel. They will be replaced by solid-state light-emitting diode "scales" that preserve the advantages of the moving-scale method of indication.



is largely decided by the throttle setting for the speed existing.

The 1978 Cadillac Sevelles released in Britain will incorporate the "Tripmaster" facility. This is a central electronic data processing unit. Amongst many other things their display will give digital readout of instantaneous fuel consumption (they call it fuel economy now!) and average trip economy, a calculation which requires the addition of a petrol flow-rate sensor.

Steady driving greatly increases economy, and automatic electronic car speed maintenance — called "cruise control" — is now available on some models. The 1978 US Chevrolet Caprice and some US Ford models have it fitted as a standard addition. The latter have finger-tip touch pads mounted in the crossbar of the steering wheel — to hold the speed reached just touch the button. A retro-fit package produced by Holdspeed Productions Ltd is shown in Fig. 4. The small push-button unit is mounted on the fascia and an electro-magnetic throttle "memory" unit is connected in series with the throttle cable to clamp the cable upon electronic demand. Slight movement of the brake pedal releases the unit when the stop light is energised, but it returns to the preset throttle position after acceleration conditions.

The next logical step might be to maintain the car's speed by closed-loops control, using vehicle speed to vary the throttle setting to suit the load. This is, however, yet to be proven as a useful and safe function to provide.

Another way to reduce consumption a little is to replace the engine-driven fan with an electric thermostatically controlled unit. This is not a new idea, but it is at last being adopted to reduce loss and engine noise. The fan still consumes energy, of course, but comes on only when the engine really needs it. It can, it is claimed by Kenlowe Accessories, whose fan is shown in Fig.5, release up to 9% more engine power. It makes sense to cool the engine this way, and has the added advantage of faster warm-up, and quieter peak engine speed noise.

These systems are thermostatically controlled and, therefore, require a temperature sensor to be added to the water jacket. This can be fitted easily by the use of a special rubber fitting placed under the hose connection, and the temperature control point is set by a dial on the control unit.

Gunson's "Colortune 500" engine tuning system has been on sale for several years now. It is not a complex electronic device but simply a special spark-plug through which the observer can see the colour of the ignition process happening inside the combustion chamber. It is remarkably simple to use, and AA certified tests on five cars made in 1974 showed conclusively that this method could be used to set the carburettor for a better economy. They commented that whilst the drivers could detect no performance difference after tuning, the petrol consumption tests showed fuel consumption was reduced in each case by amounts of 4.45% to 17.39%. Fig. 6 illustrates the colours seen for various mixtures. This device demonstrates the possibility of a closed-loop method that monitors combustion colour using a sensor of this type to control the mixture.

Electronic tuning meters are now marketed in many shapes and forms. Depending on make and model, these enable the setting of breaker points to obtain correct ignition timing, measurement of points contact re-



Fig 8. Stereo speaker equipped headrests can provide better listening. These will also be used for road information services that go only to the driver (or co-pilot!)

istance, and general electrical fault chasing. These are best used in the driver's cabin so that measurements can be checked during actual driving conditions. Once the correct timing is available as an electronic signal, the next stage will be to check this automatically and continuously as one function of a microprocessor diagnostic centre.

Instrumentation

It is clear that the engine will be one significant area of future motor cars in which electronic measurement and control will become a vital part of improving economy, reducing emission, and sensing the need for maintenance.

Electronics will also blossom in the instrumentation of the car. Electric indication of battery charging state, oil pressure, and temperature is now commonplace, the direct hydraulic lines and vapour expansion tubes having been replaced with electrical "senders" many years back. Now also standard are indicators of oil level, seat belts not fastened, brakes not functional, and parking brake on.

Recent additions to the range have been the disc-brake pad-wear warning lights (found in the Renault 20TL), battery condition indication, and a warning light

to tell the driver if all doors are not properly shut.

The Cadillac Seville "Tripmaster" also offers digital readout of estimated arrival time, miles still to go to destination, air temperature, fuel remaining and, of course, speed, the function being chosen via a keyboard mounted on the dash. Many of these functions are provided in the futuristic six-wheel Panther 6 vehicle, which also features a miniature television for the passengers' pleasure, and a panel light-bulb check routine incorporated in the panel.

The days of the electromagnetic instrument movement are numbered. Solid-state analogue-style displays, in which position on a graduated dial is indicated by a lengthening line formed by successively energised light-emitting diodes, are now available. An Austrian tachometer by Intron is shown in Fig. 7.

Utility Without

The motorist's involvement with electrics and electronics does not stop inside the car's compartment. Electronic rear-end levelling is standard in Cadillacs. Height is sensed by an electronic sensor, using photo-electric methods, and this operates an electrically-driven air compressor that alters the height actuators.



Fig 9. This small hand-set is the control for radio-controlled garage doors.

When you arrive at the petrol station the fuel is now monitored with advanced metering electronic systems that compute cost and quantity, and which can provide fixed-sum or cash batching. Many countries — Sweden and USA are examples — have banknote recognising, self-service outlets. Credit-card recognisers will ultimately displace these.

When you arrive home there is no need to get out to open the garage door. When you are within 10 m just press the button on your radio transmitter, shown in Fig. 9, and the door will open by remote control. (A licence is required to operate such transmitters.)

Electronics will even help you sell or buy your car. Private car owners in the London area can now market their cars by a computer service. Computacar's sales service, by Unilever Ltd, begins with the owner registering the car for sale. The data are filed in a computer data bank that updates daily until the vehicle is cleared. Buyers have access to a sorted list of the desired car characteristics, thus saving all that hunting through the massive lists of cars offered in published weeklies.

Future Drive

Without a doubt the car of the very near future will be bristling with more and more electronic devices, but, to date, no one car has all the features mentioned in this review.

As many additions are marketed independently of the car maker, it is likely that the overall reliability may fall along with the standard of low-priced expert servicing. Somewhere there will be a trade-off point between complexity of operation, servicing, cost and the benefits gained. Just where this will be will only be found as a result of practical use.

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7402 18p	74110 80p	4002 21p	CA3160	120p	733	150p	2112-2	RAM	300p	2N2926RB 8p	OA85 15p	1A 400V 31p	
74002 25p	74111 75p	4006 127p	LM301A	40p	741	25p	2708	RAM	E27	2N2926G 8p	OA90 9p	2A 50V 40p	
7403 18p	74112 96p	4007 21p	LM318N	175p	747	75p	8080A	C.P.U.	E11	2N3053 22p	OA91 9p	2A 100V 45p	
7404 24p	74116 218p	4008 180p	LM324N	130p	748	40p	AY5 1013	UART	600p	2N3055 65p	OA95 9p	2A 200V 55p	
7405 25p	74118 160p	4009 67p	LM348N	130p	776	216p	AY5 2376	KBic	51p	2N3442 151p	OA200 9p	3A 200V 70p	
7406 43p	74119 225p	4010 67p	MC1458P	75p	3900	70p	RO3 2513	ROM	700p	2N3643 54p	OA202 10p	3A 600V 80p	
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7409 22p	74122 52p	4013 55p	AY 3 8500	775p	NE556	450p	16pin	14p	28pin	2N3704 514p	IN4001 26p	6A 50V 96p	
7410 18p	74123 75p	4014 90p	CA3028A	112p	NE561B	450p	18pin	30p	40pin	2N3706 714p	IN4003-4 7p	6A 100V	
7411 26p	74125 70p	4015 90p	CA3046	85p	NE562B	450p	AC125 620p	BF170	25p	R2008B 225p	IN4005 78p	108p	
7412 25p	74126 85p	4016 54p	CA3048	250p	NE565	200p	AC127 820p	BF173	27p	R2010B 225p	IN4007 31p	6A 400V	
7413 40p	74128 82p	4017 100p	CA3053	75p	NE566	200p	AC176 20p	BF178	30p	TIP29A 50p	IN4008 48p	270p	
7414 85p	74132 81p	4018 110p	CA3065	200p	NE567	180p	AC176 20p	BF178 30p	30p	TIP30A 80p	IN5401 74p	10A 400V	
7416 40p	74136 81p	4019 57p	CA3080E	97p	RC4151DN	432p	AC187 820p	BF179 35p	35p	TIP30C 72p	IN5404 720p	120p	
7417 40p	74142 85p	4020 140p	CA3080E	250p	SN72710N	84p	AD161 45p	BF184 524p	524p	TIP31A 56p	IN5407 20p	432p	
7420 18p	74142 300p	4021 120p	CA3090AQ	425p	SN76003N	275p	AD162 48p	BF194 13p	13p	TIP31C 68p	25A 400V		
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7422 26p	74147 205p	4023 23p	ICL8038	400p	SN76013N	175p	AF116 730p	BF196 17p	17p	TIP32A 63p	160p		
7423 36p	74148 160p	4024 82p	LM339N	175p	SN76013ND	160p	AF127 40p	BF197 19p	19p	TIP32C 85p	200p		
7425 33p	74150 130p	4025 23p	LM339N	175p	SN76018	280p	AF139 60p	BF200 135p	135p	TIP33A 97p	225p		
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7433 43p	74157 100p	4031 67p	MC1310P	190p	TBA120	97p	BC147 9p	BF259 48p	48p	TIP35C 280p	130p		
7437 37p	74159 250p	4042 97p	MC1351P	110p	TBA841B	300p	BC148 8p	BF240 134p	134p	TIP36A 207p	130p		
7438 37p	74160 130p	4043 100p	MC1495L	490p	TBA851	225p	BC157 11p	BF240 134p	134p	TIP36C 360p	130p		
7440 18p	74161 130p	4046 150p	MC1495L	112p	TBA800	112p	BC158 9p	BF240 134p	134p	TIP41A 70p	130p		
7441 85p	74162 130p	4047 150p	MC3340P	180p	TBA810	125p	BC159 13p	BF240 134p	134p	TIP41C 84p	130p		
7442 75p	74163 130p	4049 64p	MC3360P	160p	TBA820	100p	BC169 5p	BF240 134p	134p	TIP42A 76p	130p		
7443 120p	74164 120p	4050 58p	NE540L	225p	TDA2020	405p	BC172 11p	BF240 134p	134p	TIP42C 86p	130p		
7444 120p	74165 150p	4054 120p	NE543K	225p	ZN414	140p	BC178 17p	BF240 134p	134p	TIP42C 86p	130p		
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7448 85p	74172 750p	4068 30p	1 Amp +ve			15V	BC178 17p	BF240 134p	134p	TIP42C 86p	130p		
7450 18p	74173 190p	4069 30p	5V			7805	BC178 17p	BF240 134p	134p	TIP42C 86p	130p		
7451 18p	74174 130p	4071 30p	8V			7808	BC178 17p	BF240 134p	134p	TIP42C 86p	130p		
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7480 54p	74191 160p	4528 110p	TBA625B TO5			120p	BC178 17p	BF240 134p	134p	TIP42C 86p	130p		
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7493 36p	75244 400p	9314 175p	MC1468 DIL			300p	BC178 17p	BF240 134p	134p	TIP42C 86p	130p		
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





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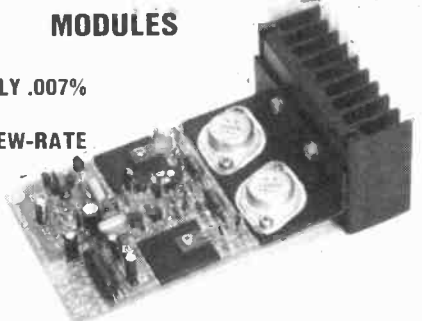
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HIGH DEFINITION — 'MUSICAL' — POWER AMP MODULES

- ★ T.H.D. TYPICALLY .007%
- @ 10W, 500Hz
- ★ ZERO T.I.D. (SLEW-RATE LIMIT 16 V/µS)

Module size:
 120 x 80 x 25 mm. using glass fibre pcb with ident and solder resist.
 Illustrated light duty heatsink.



CRIMSON ELEKTRIK power amplifier modules are fast gaining a reputation as the best sounding, most musical modules available. Perhaps the most important features of this design are exceptional freedom from crossover distortion (due to the use of output triodes) and zero T.I.D. The amplifier is protected against open and short circuit loads and yet will drive a highly reactive lower impedance load, which is more representative of a real loudspeaker. Square waves maintain their rise times up to full power whilst simulated electrostatic loads are easily handled, with negligible overshoot and a settling time of 12µS. Other specs: S/N > 110dB; Rise time 10µS; Sensitivity 775mV; DC coupled; 5Hz-35kHz (-3dB); THD < 0.15% 100mW clipping, 500Hz.

CRIMSON ELEKTRIK power supplies are in kit form for maximum flexibility and feature a low field, slimline toroidal transformer with a 120-240V primary and screen, two large capacitors, bridge rectifier and all fixings.

Heatsinks are attractive black anodised extrusions, 80mm wide.

POWER AMP MODULES	HOME	EUROPE
CE 608 60Wrms/8 ohms + 35v dc	£16.30	£16.30
CE 1004 100Wrms/4 ohms + 35v dc	£19.22	£19.00
CE 1008 100Wrms/8 ohms + 45v dc	£23.22	£22.70
POWER SUPPLIES		
CPS 1 For 2xCE608 or 1xCE1004	£12.85	£14.20
CPS 2 For 2xCE1004 or 2 or 4xCE608	£14.55	£17.90
CPS 3 For 2xCE1008	£15.85	£19.20
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High power *100mm 1.6° C/W	£1.60	£2.40
Disco/group *150mm 1.1° C/W	£2.30	£3.65

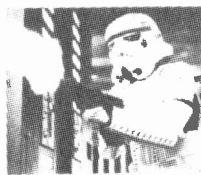
NOTE OUR NEW ADDRESS
CRIMSON ELEKTRIK
 (ET1)
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 TEL. (0533) 386211

Home prices include VAT and carriage. Payment by cheque/PO. COD 60p (£50 limit). Export no problem. European prices include carriage, insurance and handling, payment in Sterling by bank draft, PO, International Giro or Money Order. Outside Europe, please write for specific quote by return. Send SAE or two International Reply Coupons for full literature. Favourable trade quantity price list on request. Suitable pre-amp circuit 20p.

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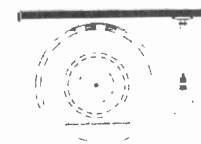
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MATERIAL. CONTENTS
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STAR WARS: Already the most successful film ever made and a MUST for all sci-fi fans. ETI gets behind the scenes to find out how the effects were effected!



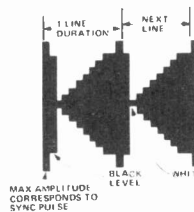
CMOS PREAMP: Many hi-fi manufacturers are coming to realise the degrading effects of rectifying metal contacts in the signal path at low levels. Our design overcomes this in a novel manner.



HIFI 2008: Ron Harris had help here — someone somewhere up in the future sent us a history book. So we know this one is true!



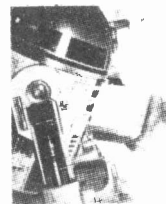
VIDEO TOMORROW: Angus Robertson peers into his crystal CRT and discovers the future is plain today if you know where to look. (Like in his article.)



VIDEO MODS: How to convert your own little tele to act as a terminal for anything producing a decent signal. (More important — how NOT to convert it!)



SINCLAIR STORY: Clive Sinclair talks to ETI in an amazingly frank and open manner about the ups and downs in his company's never boring rise to power! (Don't miss this!)



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HOME COMPUTERS: Our own micro-man Gary Evans casts his runes to see what MPU men will be up to in the future, and makes some startling admissions in the process!



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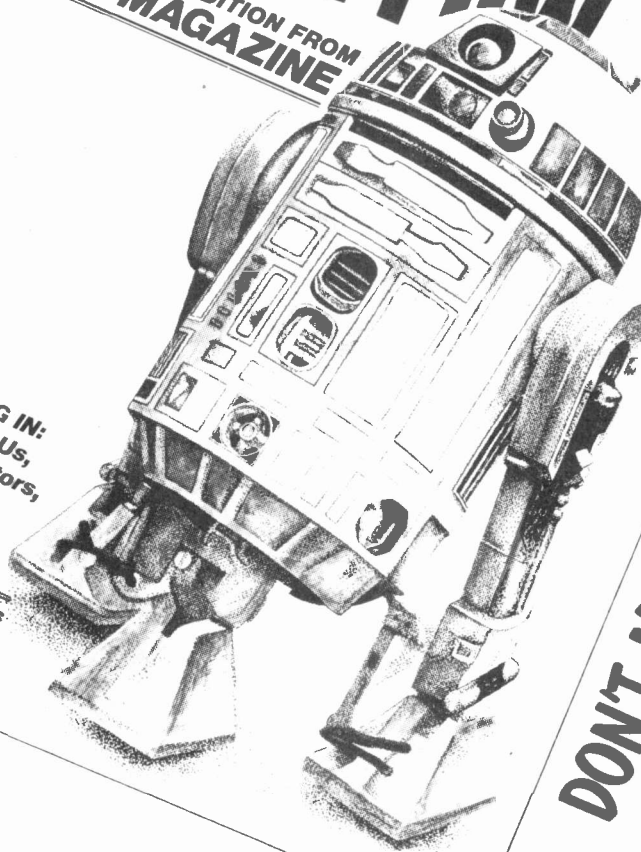
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75p

WHAT'S HAPPENING IN:
Projects, MPUs,
Hi-Fi, Calculators,
Video, Audio...

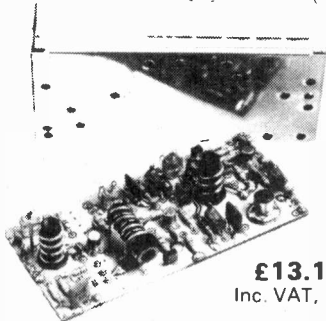
**Behind the scenes
of STAR WARS**



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**THE MOST
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EVER DISPLAYED**

HF 7948 FRONT END



£13.12
Inc. VAT, P&P

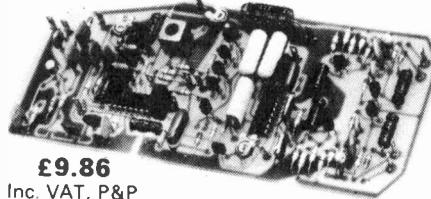
TECHNICAL CHARACTERISTICS:

Output terminal for digital frequency meter; Antenna impedance - 75 to 300 Ohms; Frequency ranges 87.5 to 104 MHz or to 108 MHz; Sensitivity - 0.9 uV 26dB signal to noise ratio \pm 75 kHz deviation; Intermodulation 80dB Image rejection - 60dB; Tuning voltage - 1V to 11V; Total gain - 33dB; Intermediate frequency - 10.7 MHz; Power supply voltage +15V; Power consumption 15mA; Dimensions 104 x 50 mm.

TECHNOLOGY:

Double sided epoxy printed circuit board with plated through holes; Dual gate effect transistors; Silvered coils.

**FI 2846
IF AMP AND DECODER**



£9.86
Inc. VAT, P&P

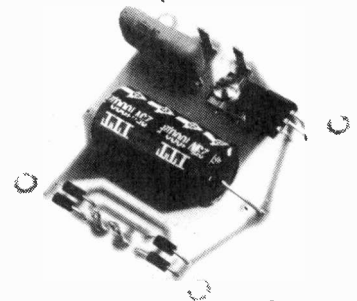
TECHNICAL CHARACTERISTICS:

Intermediate frequency - 10.7MHz; IF Bandwidth - 280kHz; Signal to noise ratio - 70dB with 1mV input; Distortion - mono 0.1%, stereo 0.3%; Sensitivity - 30uV up to the 3dB limit; Channel separation - 40dB at 1kHz; Pass band - 20 to 15,000Hz; Rejection at 38 kHz greater than 55dB; Am rejection - 45dB; De-emphasis - 50 to 75 μ s. Pilot capture at 19kHz +4%; Channel matching within less than 0.3dB; Output impedance - 100 Ohms; Output voltage - 500mV; Phase locked loop stereo decoder; Output for LED VU-meter; Null indicator; Outputs for AGC AFC and inter-station muting; Consumption - 55mA LEDs extinguished, 100mA LEDs illuminated; Power supply - 15V; Dimensions 195 x 76mm.

CIRCUIT TECHNOLOGY:

Epoxy printed circuit board; Monolithic integrated circuits, ceramic filter.

**ALS 1500
STABILISED POWER SUPPLY**



£2.53
Inc. VAT, P&P

TECHNICAL CHARACTERISTICS:

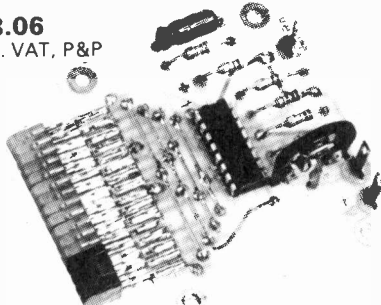
Output voltage - 15V; Max. output current - 500mA; Thermal coefficient less than 1mV/°C; 15V power supply for modules HF 7948 and FI 2846; Supply protected against short circuit (power and current protection); Dimensions - 65 x 55mm.

TECHNOLOGY:

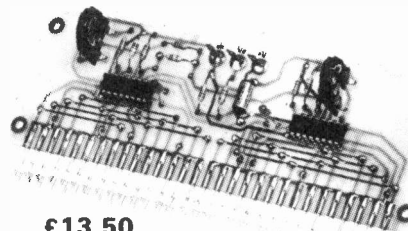
Double sided epoxy circuit board; Monolithic integrated circuit.

OPTOELECTRONIC OPTIONS

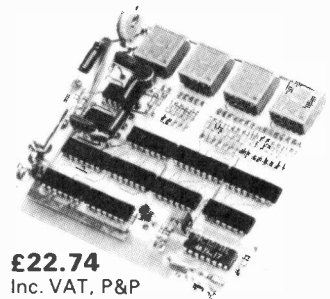
£8.06
Inc. VAT, P&P



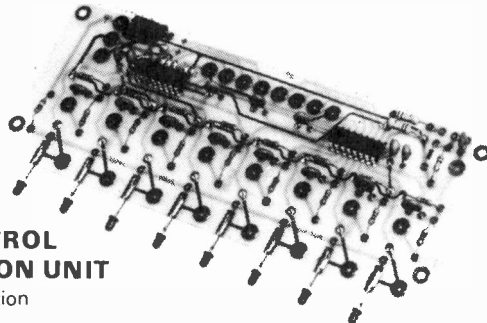
LED VU-METER
Station strength indicator



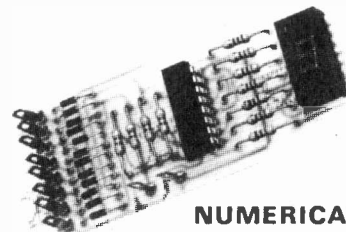
£13.50
Inc. VAT, P&P
ILLUMINATED POINTER
Station finder



£22.74
Inc. VAT, P&P
FREQUENCY METER
Digital display of received station frequency



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**TOUCH CONTROL
PRE-SELECTION UNIT**
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What to look for in the April issue: On sale March 3rd

200 W AMP

Most magazines (including ETI) have produced designs for 100W amplifiers, but it seems that our readers are a power hungry lot and want more! So by popular request we proudly present our 200W per channel International Powerslave. Specially designed for ETI by Powertran the monster is a superb piece of audio design. Distortion is well below 0.1% at all output levels and CCIR weighted noise a negligible -101dB. Perfect for PA systems and high power discotheques, with reliability a main consideration, the International Powerslave should satisfy most readers' cravings for power!



GAS MONITOR

Designed originally for use in small boats, the ETI Gas Monitor senses any build-up of petrol vapour or propane, and prevents electrical equipment being switched on (bang!) when danger exists. ETI readers will no doubt find many other situations where this device will be useful.



FREE! 108 PAGE TANDY CATALOGUE

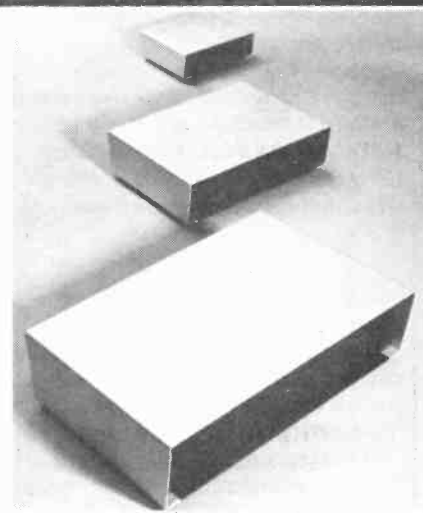
Discount voucher worth 50p also included! The catalogue will be inside all UK newsstand and subscription copies, but we regret will not be in overseas copies.

PET REVIEW

Available soon in Britain, Commodore's self-contained personal computer (PET) has been given the once (and twice) over by our Canadian office. With exclusive internal photographs, read all about it in next month's ETI.

CASING SURVEY

The days of the biscuit tin amplifier are over. The modern constructor has a huge — often bewildering — choice of cases and racking systems to wrap around their project. The choice of a suitable case can make the project look a lot more professional when completed, so read all about the various brands next month in ETI.



Articles mentioned here are in an advanced state of preparation but circumstances may affect the final contents.

Special Offer: Commodore 5R39 £14.95!

FREQUENCY SHIFTER



A useful device for squeezing a few extra dB out of most PA systems. Designed by our shifty project team.

ANYONE WHO HAS USED a microphone in public address work has come across problems with feedback. These are caused by the level of sound reaching the microphone from the speaker approaching or exceeding that from the person originating the sound. As the reflected sound approaches the level of the original signal, the sound becomes distorted or 'coloured', then audible ringing occurs and finally complete oscillation or howl-round occurs as the reflected sound exceeds the level of the original signal.

The most effective method of eliminating this problem in most cases is to use the correct location for the speakers and the correct choice of microphone.

However in certain environments the most effective use and selection of microphone/speakers does not help the problem of feedback. These are the halls and rooms which have little sound-absorbing material on the walls and are very 'live'. If a frequency response curve is drawn for such a room it will be found that there are many peaks and troughs, normally only 4 or 5 Hz apart, along with perhaps major resonances.

Solutions

There are various electronic devices which have been developed to deal with this problem, the main ones being the graphic equalizer, the variable notch filter and the frequency shifter. The first two (especially the notch filter) are ideal for eliminating major resonances. These however also alter the frequency response of the original sound. They can

also help if the offending 'echo' is actually a direct path and not dependent on the room (i.e. if the speakers are behind the microphone). The other method, frequency shifting, is described here.

With a frequency shifter the echo signal is of slightly different frequency on each path round the loop and cannot directly reinforce itself so that while on the first echo it may strike a room resonance the second time it will probably be in a null. This tends to even out the frequency response of the room and allows 5 to 8 dB higher levels to be used in the average room. Also the onset of howl-round is not as dramatic as with

the conventional system and the distortion which normally occurs below the howl-round level is not as noticeable. The system does not however do a great deal for howl-round not associated with room resonances.

Only a small shift is normally required and it does not matter if it is an increase or a decrease. We chose to increase the frequency by about 5 Hz as it is easier to tell if a vocalist is flat rather than sharp. As the frequency response of the unit is good it is suitable for vocal work as well as general public address use. The frequency shift and the slight amplitude modulation cannot be detected by most people.

SPECIFICATION

Frequency shift	5Hz upwards
Maximum input voltage	3V
Frequency response +½ dB, -3dB	30Hz - 20kHz
Signal to noise ration re 3V output	70 dB
Distortion @ 1kHz, 2V out	0.25%
Amplitude modulation	100Hz - 10kHz < 1dB
Phase shift network 50Hz - 20kHz	90° ± 5°

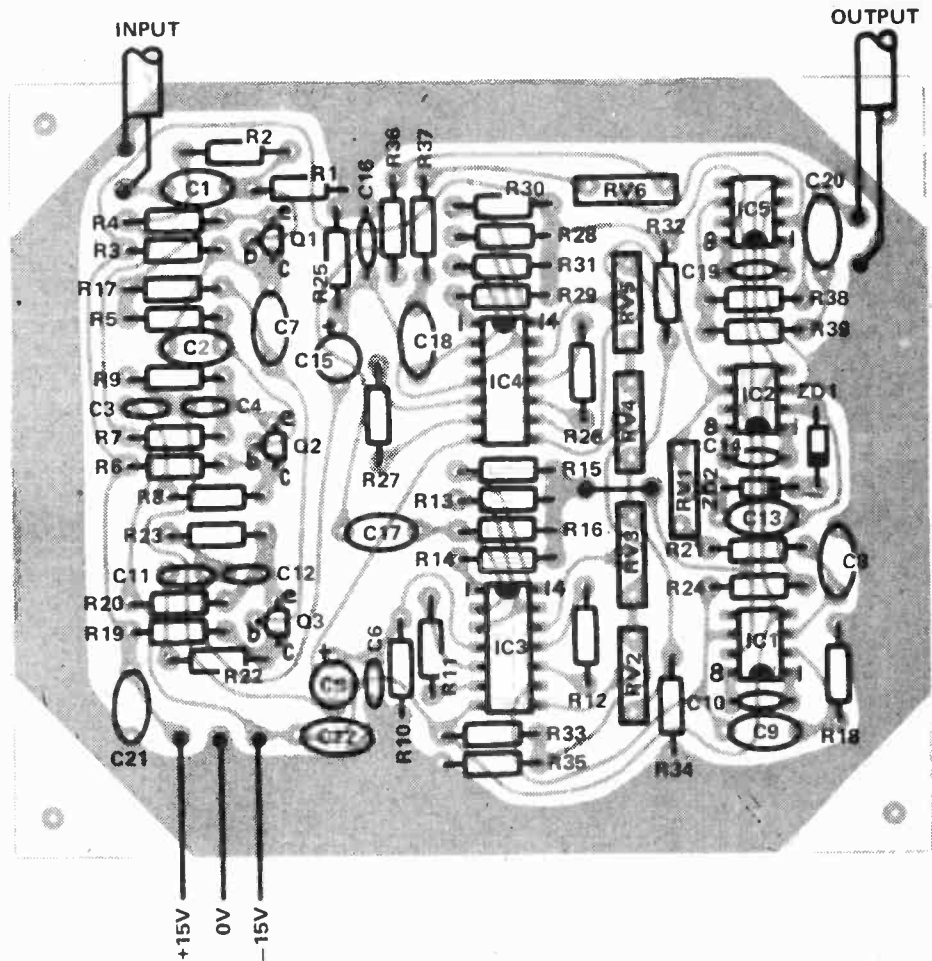


Figure 1, component positioning for the frequency shifter board.

Alignment

Equipment needed — a sensitive AC voltmeter (100 mV or less) or preferably an oscilloscope and an audio oscillator.

1. Check the output of the 5 Hz oscillator and adjust RV1 until it stops. If it cannot be completely stopped, try a link across C9.
2. Apply a signal of about 1 — 2 V amplitude at about 1 kHz to the input and measure the output of IC3 at pin 2. (If your meter does not reject DC, measure at the junction of C17 and R36). Adjust RV3 to give the minimum output.
3. Measure the output of IC4, pin 2 (or the junction of C18 and R37) and adjust RV5 for minimum output.
4. Measure the output of the 5 Hz oscillator on pin 6 of IC1 and adjust RV1 until it starts, then adjust to give about 1.25 V RMS.
5. With no input signal, measure the output of IC3 (or the junction...) and adjust RV2 for minimum output.
6. Measure the output of IC4 (or...) and adjust RV4 for minimum output.
7. If an oscilloscope is available, monitor the output with a 1 — 2 V input signal and adjust RV6 to give the minimum amplitude modulation. Alternatively, by using an amplifier and speaker, RV5 can be adjusted by ear. The unit is now set up. **ETI**

PARTS LIST

Resistors

Resistor	Value	Notes
R1	150k	all 1/2 W 5%
R2	100k	
R3,4	2k7	
*R5	22k	
*R6,7	2k7	
*R8	3k6	
*R9	24k	
*R10	15k	
R11	4k7	
R12	2k2	
R13	15k	
R14—R16	3k3	
*R17	56k	
R18	330k	
R19,20	2k7	
*R21	330k	
*R22	3k9	
*R23	27k	
R24	330k	
*R25	15k	
R26	2k2	
R27	4k7	
R28	15k	
R29—R31	3k3	
R32,33	10k	
R34,35	1k	
R36,37	100k	
R38	1M	
R39	100R	

Potentiometers

RV1	250k trim
RV2—RV5	25k trim
RV6	100k trim

Capacitors

C1	100n polyester
*C2	56n polyester
*C3	6n8 polyester
*C4	1n0 polyester
C5	10µ 25V electro
*C6	1n5 polyester
*C7	100n polyester
C8,9	100n polyester
C10	33p ceramic
*C11	22n polyester
*C12	4n7 polyester
C13	100n polyester
C14	33p ceramic
C15	10µ 25V electro
*C16	5n6 polyester
C17,18	100n polyester
C19	33p ceramic
C20—C22	100n polyester

Semiconductors

IC1,2	LM301A
IC3,4	MC1495
IC5	LM301A
Q1—Q3	BC549
ZD1,2	5.1V 300mW

Miscellaneous

PC board
Power supply $\pm 15V$ 40mA

* For best results the components should be as accurate as possible, preferably 1% tolerance or selected to be within 1%.

PROJECT: Freq. Shifter

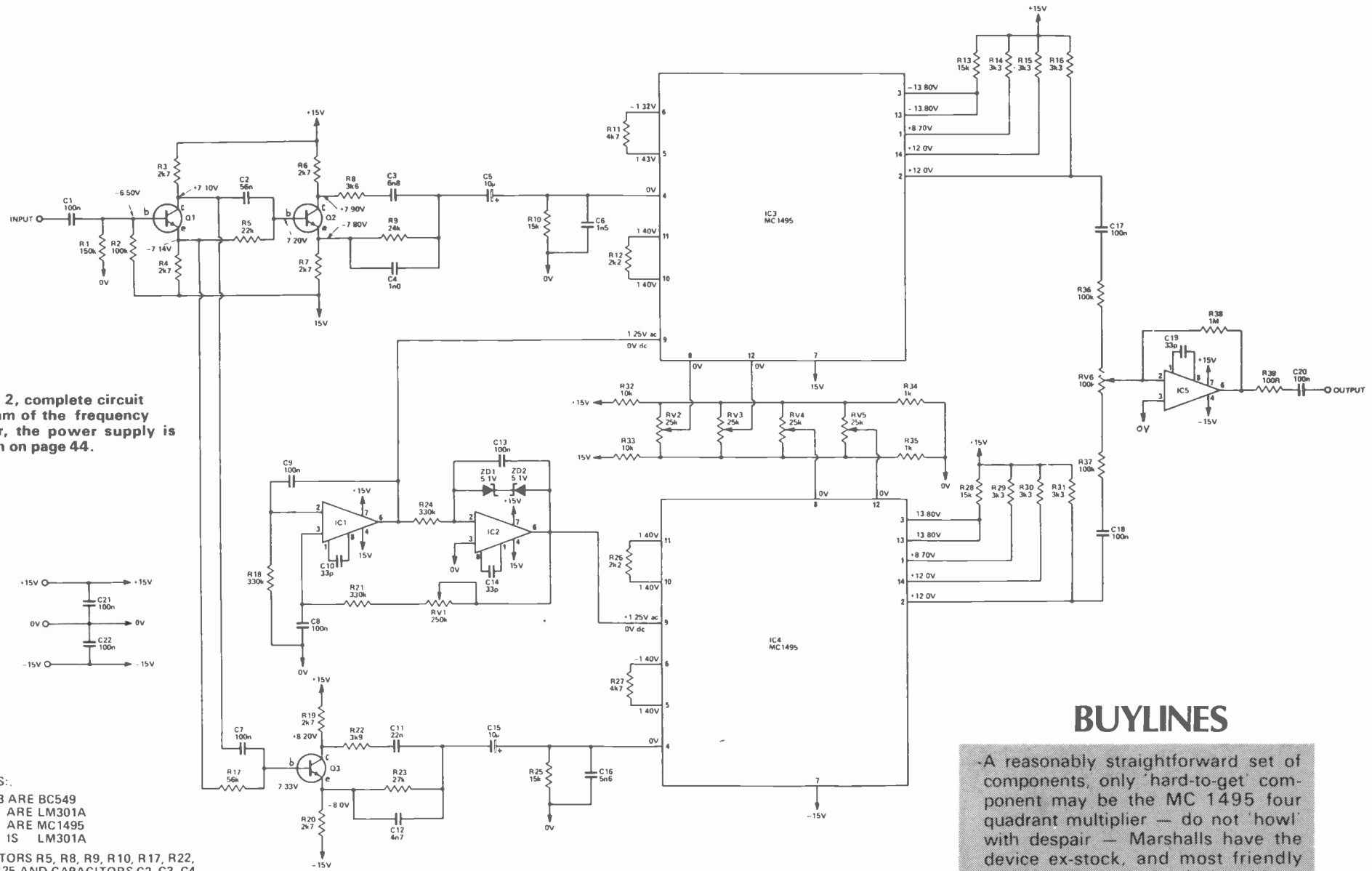


Figure 2, complete circuit diagram of the frequency shifter, the power supply is shown on page 44.

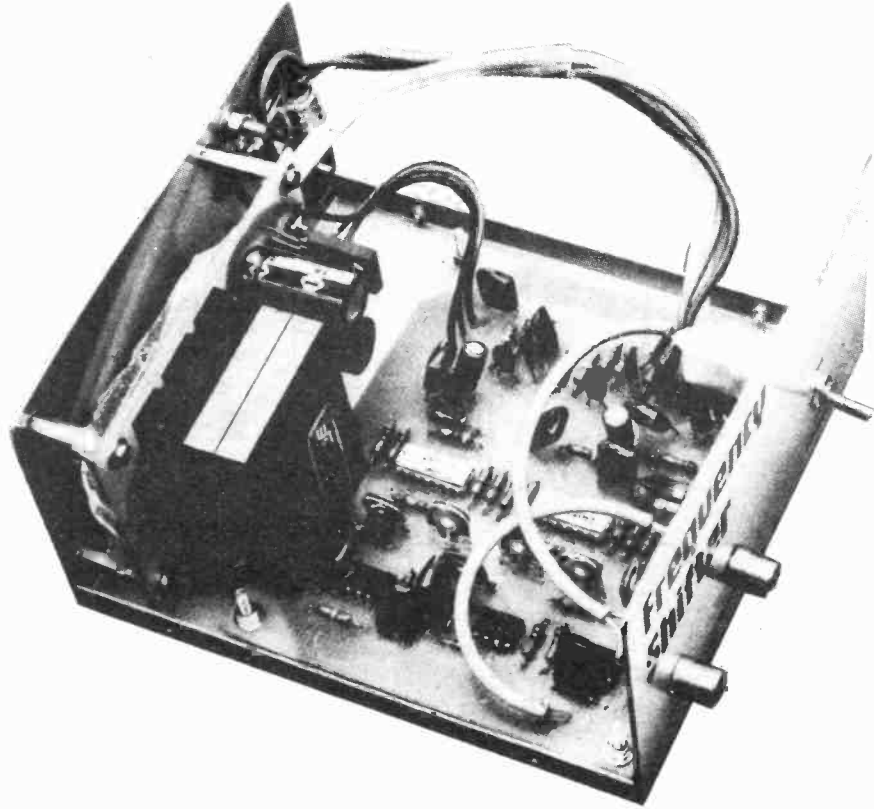
NOTES:

Q1-Q3 ARE BC549
 IC1,2 ARE LM301A
 IC3,4 ARE MC1495
 IC5 IS LM301A

RESISTORS R5, R8, R9, R10, R17, R22, R23, R25 AND CAPACITORS C2, C3, C4, C6, C7, C11, C12 AND C16 SHOULD BE 1% TOLERANCE OR SELECTED TO BE WITHIN 1% FOR BEST RESULTS. VOLTAGES GIVEN ARE OF THE PROTOTYPE AND SHOULD BE TYPICAL.

BUYLINES

A reasonably straightforward set of components, only 'hard-to-get' component may be the MC 1495 four quadrant multiplier — do not 'howl' with despair — Marshalls have the device ex-stock, and most friendly component stores should be able to supply it to order. PCBs from the usual suppliers.



HOW IT WORKS

The audio input is split into two circuits which provide a frequency-related phase shift as shown in Fig. 4. The amplitude however remains constant. Due to the different component values in the two networks the phase shifts are not the same but differ by 90° at all frequencies (50 Hz — 20 kHz $\pm 5^\circ$).

IC1 and IC2 form a quadrature sine wave oscillator with the frequency set by R18, R21, R24, C8, C9 and C13. Amplitude stability is provided by ZD1 and ZD2 along with RV1 (see adjustment section). The outputs from these two op amps are the same amplitude but 90° phase shifted.

We now multiply (the MC1495 is a four-quadrant multiplier) one of the audio signals by one of the 5 Hz outputs and the second audio input by the second 5 Hz signal. When we multiply two waveforms together the output consists of the sum of the two frequencies and their difference.

This means that if the audio signal is 100 Hz the output will contain a 95 Hz signal and a 105 Hz signal. These will beat with each other to produce a 10 Hz beat note as shown in Fig. 2. Due to the phase shift between the inputs of the multipliers the 105 Hz components of the outputs are in phase, while the 95 Hz components are 180° out of phase. Therefore by adding the outputs of the two multipliers in IC5 the 95 Hz components cancel out, leaving only the 105 Hz signal. Provided the multiplier inputs have the 90° phase relationship there will always be a 5 Hz shift, independent of frequency.

Due to the inability to maintain exactly the 90° phase relationship, the 95 Hz, or lower sideband, will not completely cancel and the result is a slight beat giving rise to an amplitude modulation effect (we had about 1 dB). This is not normally noticeable on speech or music.

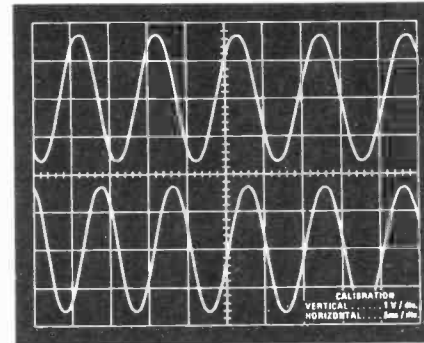


Fig. 3. Oscillogram showing relationship between input (upper) and output (lower) signals — note change in frequency.

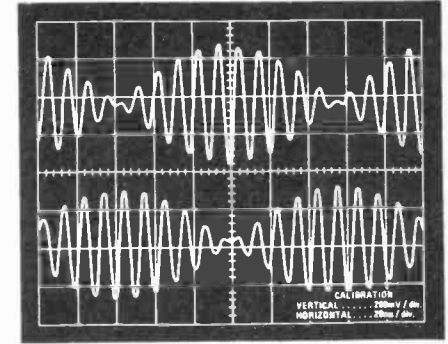
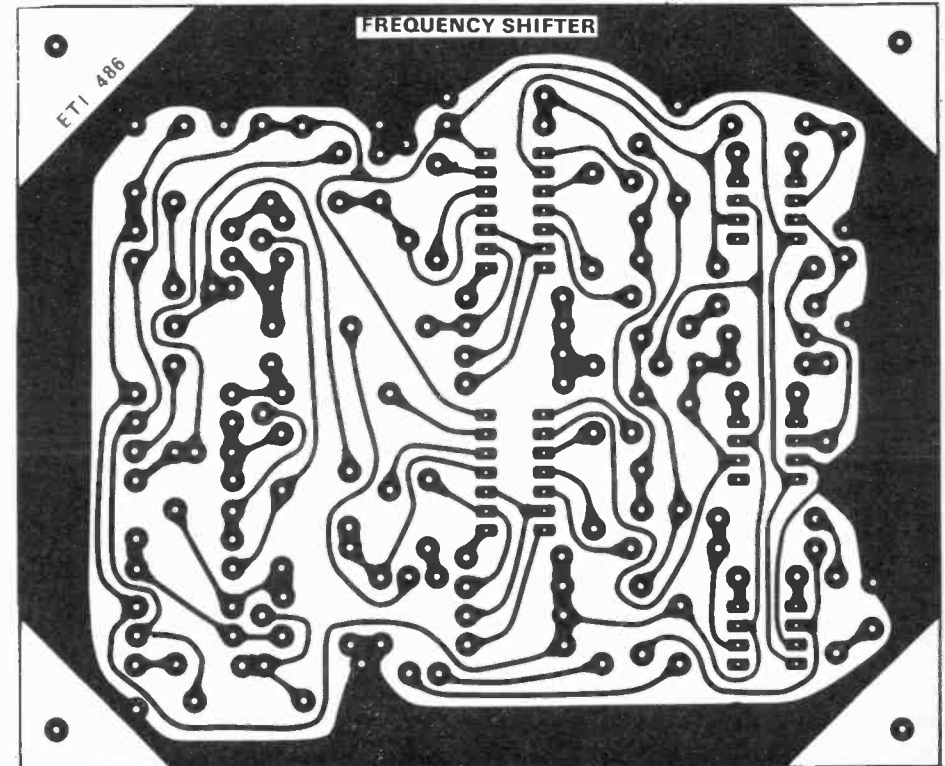
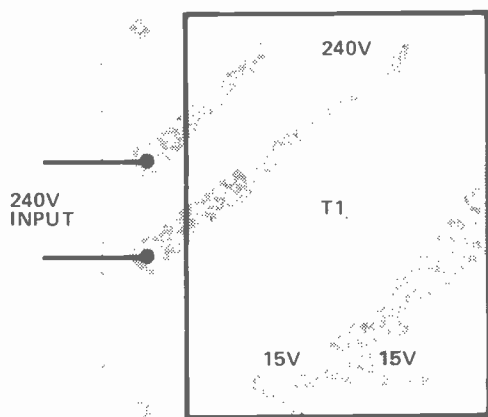
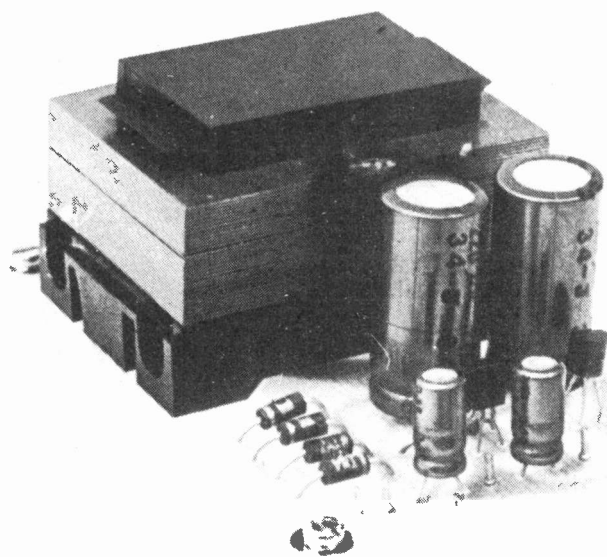
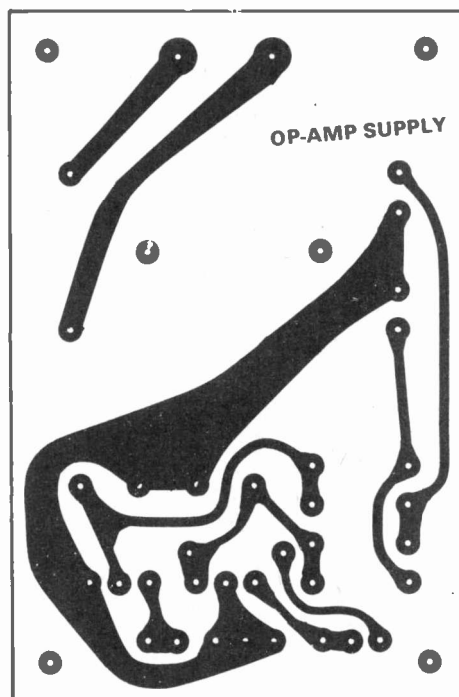


Fig. 4. Oscillogram showing output of IC3 (upper) and IC4 (lower); signal is 100 Hz, note phase difference. Below, full size foil pattern for the shifter (120 x 100 mm).

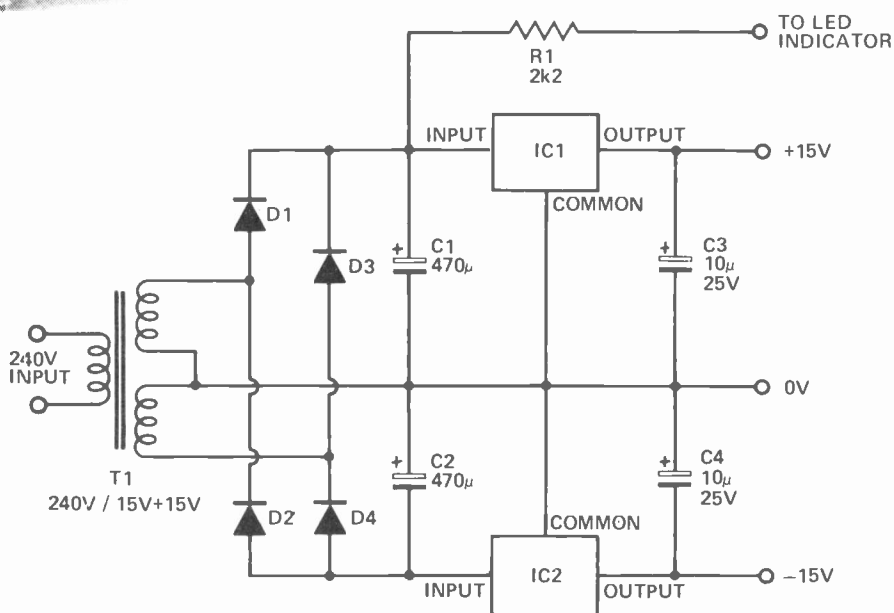




Component positioning and foil pattern for a suitable power supply (60 x 90 mm).



Circuit diagram for suitable power supply, in the prototype the option of LED1 was not used. Note that this power supply can be used by itself and in fact is a useful project in its own right.



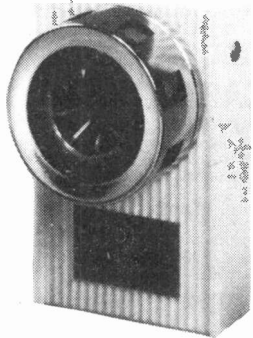
PARTS LIST

R1	Resistor	2k2 ½W 5%
C1,2	Capacitor	470µ 35V
C3,4	"	10µ 25 V
D1-D4	Diodes	1N4001
LED1	Indicator	
IC1	Regulator	7815
IC2	"	7915
T1	240V: 15V 0-15V	

GREENWELD

WHOLESALE/RETAIL SUPPLY OF ELECTRONIC COMPONENTS
443 Millbrook Road Southampton SO1 0HX Tel: (0703) 772501

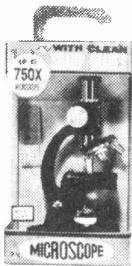
SIREN



A small extremely simple device that creates a lot of noise!! Everyday there are fresh reports of mugging, burglaries etc — with this siren you can feel safer. Fit it to a door or window, or take it with you when you go out. Its powerful noise will arouse a lot of attention!! Operates from 4 x HP7 batteries (36p extra) and is entirely portable so can be placed where it will cause most surprise.
Size overall
110 x 75 x 60mm

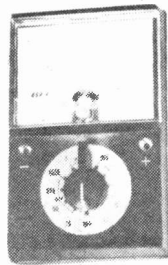
£1.75

MICROSCOPE



An extremely modestly priced yet very efficient microscope capable of magnification up to 750 times with clear sharp images. This model is self illuminating and incorporates an easily rotatable four position turret magnifying lens with rack and pinion focusing. The crackle black metal body houses the batteries for adjustable light illumination. Instructions for use are included and there is also a sample slide provided.

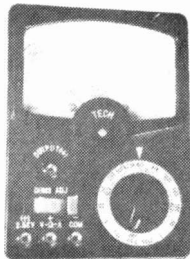
£10.95



Model LT101

A low cost useful meter ideal for carrying around in the pocket. 1000 ohms per volt sensitivity.
Ranges: DC Volts: 0-10-50-250-1000
AC Volts: 0-10-50-250-1000
DC Current: 0-1-100mA
Resistance: 0-150k (Mid Scale 2.5k)
Size 90 x 60 x 35mm

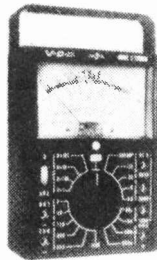
Price £6.00



Model IT1-2

A popular model with 20000 ohms per volt sensitivity. Compact easy to use model giving good value for money. Protected movement.
Ranges: DC Volts: 0-5-25-50-250-500-2500
AC Volts: 0-10-50-100-500-1000
DC Current: 0-50µA-2.5mA-250mA
Resistance: 0-50k-6M (Mid Scale 250-25k)
Capacitance & dB scales
Size 105 x 85 x 30mm

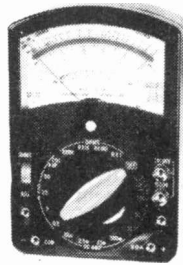
Price £11.30



Model C7200

Similar in appearance to the C7081 but at a much lower cost. This model has a mirror scale and is 20,000 ohms per volt.
Ranges: DC Volts: 0-6-30-120-600-1200
AC Volts: 0-6-30-120-600-1200
DC Current: 0-60µA-6-60-600mA
Resistance: 0-6k-60k-6M-30M-60M
dB s -20 to +63
Size 152 x 108 x 52mm

Price £14.64

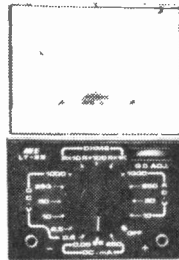


Model C7077 (Centre)

An exceptionally sensitive meter. 100,000 ohms per volt that will prove its worth in a very short time. It features 4 ohms ranges, measuring up to 100 megohms and has a mirror scale.
Ranges: DC Volts: 0-0.5-5-25-50-250-500-1000
AC Volts: 0-10-50-250-500-1000
DC Current: 0-10µA-2.5mA-25mA-500mA
Resistance: 0-10k-1M-10M-100M (Mid Scale 130-13k-130k 1.3M)

dB s -20 to +62
Size 152 x 102 x 44mm

Price £23.18



Model LT22

Probably one of the lowest priced meters featuring a mirror scale overload protection and 20,000 ohms per volt sensitivity. A modern styled meter with unusually clear scale markings.
Ranges: DC Volts: 0-0.5-2.5-10-50-250-1000
AC Volts: 0-10-50-250-1000
DC Current: 0-50µA-2.5mA-250mA
Resistance: 0-50k-500k-5M (Mid Scale 300-3k-30k)

dB s 4 ranges -20dB to +42dB
Size 130 x 90 x 42mm

Price £11.70



Model LB1

Transistor & Diode Checker
Tests I_C, Alpha and Beta. Measures parameters of transistors so that readings can be checked against manufacturers specification. Quick Test socket mounted on front panel. Full view meter for accuracy and easy reading.
178 x 108 x 83mm

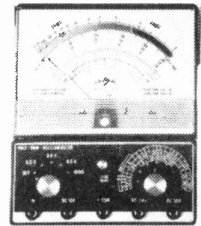
Price £18.95



Model C7081

A 45 range meter with exceptional performance: mirror scale, 50,000 ohms per volt, rigid carrying handle, diode protected, 15µA motor movement.
Ranges: DC Volts: 0-0.25-0.5-1.25-2.5-5-10-25-50-125-250-500-1000
AC Volts: 0-1.5-3-10-25-50-125-250-500-1000
DC Current: 0-25-50µA-2.5-5-25-50-250-500mA-5-10A
Resistance: 0-16-160k-1.6M-16M (Mid Scale 100-1k-10k-100k) dB s: from -20 to +62 in 10 ranges.
Size: 160x120x63mm

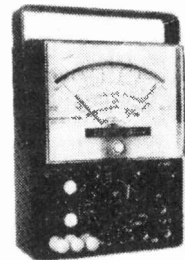
Price £22.90



Model C7080

An instrument for the professional; incorporates a 130mm long mirror scale, really well laid out easy to read scales. A top quality meter for anyone seriously interested in electronics.
Ranges: DC Volts: 0-0.25-1-2.5-10-50-250-1000-5000
AC Volts: 0-2.5-10-50-250-1000-5000
DC Current: 0-50µA-1-10-100-500mA-10A
Resistance: 0-2-200-20000k (Mid Scale 12-1.2k-120k) dB s: from -20 to +50
Size: 185x160x80mm

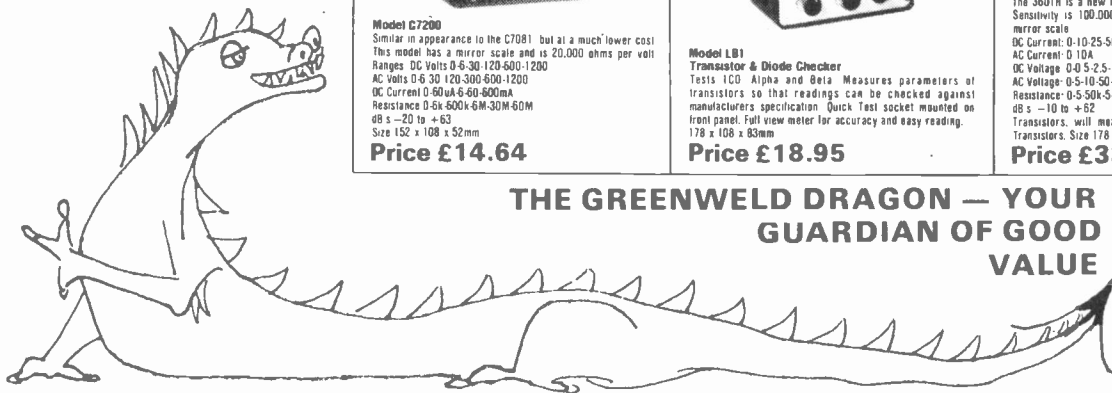
Price £29.90



The 360TR is a new model incorporating a transistor tester. Sensitivity is 100,000 ohms/volt and the instrument has a mirror scale.

DC Current: 0-10-25-500 A 5 10-500mA-10A
AC Voltage: 0-0.5-2.5-10-50-250-1000V
AC Voltage: 0-5-10-50-250-1000V
Resistance: 0-50k-5-5M
dB s -10 to +82
Transistors: will measure gain, leakage etc. of NPN/PNP
Transistors: Size 178 x 140 x 70mm

Price £33.27



THE GREENWELD DRAGON — YOUR
GUARDIAN OF GOOD
VALUE

PRICES INCLUDE VAT — JUST ADD 25p POST TO ALL UK/BFPO ORDERS

SEMICONDUCTORS

DIODES

Type No.	Case	Rating	V	A	Price
HM1084	Plastic	400	0.25		8p
IS109	Stud (S016)	1000	0.75		24p
HM4001	Plastic	50			5p
HM4002	"	100			5p
HM4003	"	200			5p
HM4004	"	400			7p
HM4005	"	600			7p
HM4006	"	800			8p
HM4007	"	1000			9p
BTX34	"	1250			10p
BT127	"	1250	1.5		12p
HM5171	"	50	2		8p
HM5172	"	100	2		9p
HM5173	"	300	2		10p
HM5174	"	400	2		10p
HM5175	"	500	2		11p
HM5176	"	600	2		12p
HM5177	"	800	2		14p
HM5178	"	1000	2		16p
HM5401	"	100	3		12p
HM5402	"	200	3		13p
HM5403	"	300	3		14p
HM5404	"	400	3		15p
HM5405	"	500	3		16p
HM5406	"	600	3		18p
HM5407	"	800	3		20p
IS410	Stud (S010)	100	3		24p
IS413	"	400	3		29p
IS415	"	800	3		35p
IS421	"	200	10		40p
IS423	"	400	10		48p
HM1183	..(D05)	50	35		90p

ZENERS

400mW 2.7V to 36V 5% 10p each
1.3W 3V3 to 200V 5% 20p each
10W 4V3 to 200V 93p each

BRIDGES

50V 1A	26p	200V 1A	32p
400V 1A	36p	100V 2A	48p
400V 2A	58p	100V 4A	65p
400V 4A	80p	100V 6A	74p
400V 6A	98p	400V 10A	124p

SCR's

0.8A	60V	T092	35p
1A	400V	T05	60p
4A	200V	T0220	52p
4A	400V	T0220	70p
6A	200V	T0220	56p
6A	400V	T0220	75p
6A	400V	T066	80p
10A	100V	T0220	82p
10A	200V	T0220	87p
10A	400V	T0220	120p
10A	600V	T0220	148p

TRIACS

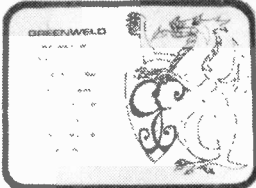
6A	400V	T0220	98p
8A	600V	T0220	135p
15A	200V	Stud	135p
15A	400V	Stud	220p

TRANSISTORS

AC127	18p	BC158	10p	BCY31	98p
AC128	18p	BC159	10p	BCY32	1.05
AC132	35p	BC161	40p	BCY33	80p
AC151	25p	BC168C	12p	BCY42	26p
AC176	18p	BC171	10p	BCY43	24p
AC187	20p	BC172	10p	BCY54	89p
AC188	20p	BC177	15p	BCY59	16p
AC189	20p	BC182	12p	BCY70	15p
ACY21	47p	BC183	12p	BCY71	15p
ACY22	58p	BC184	12p	BCY72	14p
AD149	70p	BC207	10p	BC112	1.70
AO161	40p	BC208	10p	BC131	38p
AD162	40p	BC209	10p	BC132	40p
AD726	4.32	BC212	14p	BC133	48p
AF114	20p	BC213	14p	BC135	35p
AF115	20p	BC214	14p	BC136	35p
AF116	20p	BC237	10p	BC137	40p
AF117	20p	BC252	18p	BC138	40p
AF127	26p	BC257	18p	BC139	42p
AF139	40p	BC297	24p	BC140	44p
AF239	40p	BC301	24p	BC163	73p
AF279	75p	BC302	24p	BC234	60p
ASV27	40p	BC303	26p	BC238	60p
ASZ23	1.50	BC304	28p	BC241A	45p
BC107	12p	BC307	12p	BC362	47p
BC108	10p	BC308	11p	BC437	72p
BC108C	12p	BC309	12p	BC510	54p
BC109	12p	BC320	15p	BC525	47p
BC109C	15p	BC327	16p	BC526	47p
BC114	12p	BC328	16p	BC527	47p
BC116A	15p	BC337	20p	BC532	2.00
BC118	10p	BC347	14p	BC532	2.00
BC119	22p	BC348	12p	BC590	2.25
BC126	20p	BC351	26p	BC590	2.25
BC136	13p	BC413	24p	BF115	20p
BC137	13p	BC441	32p	BF137	55p
BC139	24p	BC461	32p	BF152	18p
BC140	24p	BC547	10p	BF167	22p
BC143	24p	BC548	10p	BF173	20p
BC147	10p	BC549	11p	BF178	24p
BC148	10p	BC558	12p	BF179	24p
BC149	10p	BCX33	15p	BF180	30p
BC157	10p	BCY30	90p	BF181	30p

TRANSISTORS (cont'd)

BF182	30p	341	20p	2K373	3.10
BF183	24p	450	19p	2K372	3.72
BF184	20p	500	18p	2K381	28p
BF185	20p	503	20p	2K382	70p
BF194	10p	510	16p	2K382A	64p
BF195	10p	550	19p	2K383	43p
BF196	10p	2C444	5.71	2K390A	15p
BF197	12p	2G220	8.19	2K396	15p
BF200	28p	2G302	12p	2K397	32p
BF244B	30p	2G374	18p	2K398	24p
BF258	26p	2G385	27p	2K405	5.93
BF259	30p	2K336	42p	2K406	12p
BF311	20p	2N549	60p	2K4063	81p
BF337	30p	2N550	47p	2N4124	15p
BF338	33p	2N697	30p	2K4255	90p
BF362	47p	2N706	18p	2K4399	5.67
BF458	45p	2N706A	20p	2N4401	10p
BF499	24p	2N708	22p	2N4402	10p
BF499	24p	2N711	63p	2N4403	10p
BF499	24p	2N719A	57p	2N4410	40p
BF499	24p	2N865	42p	2N4416A	58p
BFX11	24p	2N918	35p	2N4418	10p
BFX29	22p	2N930	27p	2N4919	88p
BFX48	32p	2N956	28p	2N4931	56p
BFX84	22p	2N976	51p	2N5191	62p
BFX88	22p	2N985	51p	2N5192	62p
BFX93A	27p	2N995	28p	2N5193	68p
BFY18	40p	2N1043	86p	2N5194	68p
BFY19	21p	2N1091	48p	2N5195	73p
BFY39	17p	2N1131	38p	2N5245	43p
BFY50	18p	2N1142	37p	2N5294	52p
BFY51	18p	2N1170	42p	2N5345	1.23
BFY52	18p	2N1204A	83p	2N5401	35p
BFY56A	22p	2N1257	32p	2N5447	36p
BFY64	24p	2N1304	40p	2N5449	19p
BFY77	21p	2N1306	44p	2N5485	55p
BFY90	1.10	2N1307	44p	2N5831	42p
BFZ10	84p	2N1309	48p	2N6027	55p
BLV47A	2.15	2N1487	82p	2N6028	60p
BLV65	4.82	2N1502	91p	2N6106	71p
BRV39	40p	2N1535	1.20	2N6108	54p
BRV56	40p	2N1536	1.32	2N6109	54p
BSV64	70p	2N1539	1.14	2N6123	64p
BSX20	20p	2N1545	1.32	2N6133	69p
BSX24	17p	2N1613	24p	2S3536	11p
BSX28	21p	2N1700	1.10	2S3234	64p
BSX29	19p	2N1711	26p	40673	60p
BSX38	18p	2N1757	53p		
BSY95A	16p	2N1893	28p		
BU100	1.92	2N1905	93p		
BU108	2.62	2N1924	47p		
BU133	1.94	2N1974	52p		
BU205	2.16	2N1991	43p		
BU206	2.74	2N2015	4.60		
BU208	2.80	2N2040	4.60		
BUX54	92p	2N2077	2.39		
CI131	26p	2N2137	1.22		
MEU21	36p	2N2157	4.86		
ML423	5.20	2N2190	62p		
ML2955	1.20	2N2218	26p		
ML3540	80p	2N2219	26p		
MM1614	20p	2N2222A	22p		
MM1712	28p	2N2223	2.30		
MM3003	47p	2N2233	1.96		
MM4003	1.30	2N2243	35p		
MPS2669	15p	2N2289	25p		
		2N2484	24p		
		3640	18p		
		3642	21p		
		3646	28p		
		3646	31p		
		6515	20p		
		6521	23p		
		6534	22p		
		MPS466	38p		
		MPS452	46p		
		MPS455	60p		
		OC19	90p		
		OC24	60p		
		OC25	90p		
		OC29	90p		
		OC35	90p		
		OC36	90p		
		OC42	28p		
		OC44	22p		
		OC45	20p		
		OC70	18p		
		OC71	24p		
		OC72	28p		
		OC75	38p		
		OC77	80p		
		OC810	18p		
		OC139	74p		
		OC771	1.20		
		PBC108	12p		
		SE7055	46p		
		TIP30	40p		
		TIP34	65p		
		TIP41A	56p		
		TIP42A	66p		
		TIP2955	86p		
		TIP3055	42p		
		TIS43	35p		
		TIS44	12p		
		TIS55	12p		
		ZTR2	45p		
		ZT3439	86p		
		ZTX107	15p		



P.C. Etching Kit Mk III

This latest version of this popular kit now contains 200 sq ins copper clad board, 2 miniature drill bits, 1lb ferric chloride, Dalo etch-resist pen, abrasive cleaner, etching dish and full instructions
Price: £3.90

TRANSFORMERS

All have mains primary

Code	Secondary	Details	Size in mm	Price
X005	6-0-6V			
100mA		26x30x24	85p	
X021	9-0-9V 75mA	26x30x24	85p	
X032	12-0-12V			
50mA		26x30x24	85p	
X033	12-0-12V			
100mA		30x36x27	95p	
X009	6V 1A	42x50x42	£1.75	
X031	12V 500mA	42x50x36	£1.80	
X027	14V 1A	45x5x40	£2.10	
X035	12V 2A	53x62x60	£2.75	
X010	6.3V 1 1/2A	48x56x50	£2.15	
X012	6-0-6V 1 1/2A	48x56x50	£2.55	
X024	9-0-9V 1A	48x56x50	£2.25	
X034	12-0-12V 1A	50x58x55	£2.75	
X040	29V 50mA	30x36x25	65p	
X039	22V 100mA	38x45x33	85p	
X048	20-0-20V 2A	65x78x58	£4.60	
X047	20V 2 3/4A	85x80x66	£3.90	
X053	30-0-30V 1A	58x68x58	£4.10	
X061	0-12-15-20-24-30V 1A	57x68x52	£3.95	
X062	0-12-15-20-24-30V 2A	76x64x74	£5.35	
X051	24V 500mA	50x58x36	£2.50	
X071	0-19-25-33-40-50V 1A	65x79x70	£5.50	
X072	0-19-25-33-40-50V 2A	72x98x78	£6.95	
X045	20-0-20V 500mA	47x57x38	£2.00	
X058	Bell transformer in neat white plastic case.	42x75x58mm	Output 4 8 or 12V 1A £1.60p	

Notes Types 061 and 062 can supply any of the following voltages 3 4 5 6 8 9 10 12 15 18 20 24 or 30V, 12-0-12 or 15-0-15V Types 071 and 072 can supply 6 7 8 10 14 15 17 19 21 25 33 40 or 50V or 25-0-25V X081 Miniature output type, primary 1k2, secondary 8R 200mW 15 x 20 x 17mm **35p**
 X082 Matching transformer in screen case with flying leads Pri 50R, Sec 125k 40 x 38 x 35mm Price **55p**.

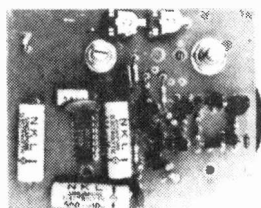
RELAYS and SOLENOIDS

12V DC enclosed 2x10A c/o contacts **£1**. Open construction relay with 2 10A c/o contacts, coil rated 24V ac but works well on 6V DC **60p**.
 240V ac enclosed, 11 pin plug in base 3 10A c/o contacts, **£1.20**.
 240V ac open, 2 15A c/o contacts **£1.50**.
 Solenoid, rated 48V DC, but work on 24V 10mm push or pull action Single hole fixing Size 27 x 18 x 15mm Made by Varley Only **40p**.

FERRIC CHLORIDE

Anhydrous technical quality in 11lb double sealed packs 11lb **£1.00**; 3lb **£2.18**; 10lb **£5.60**; 100lb **£39.00**

1 WATT AMPLIFIERS



PC board as illustrated contains LM380 amplifier + pot + switch Just needs a battery and speaker to go! Panel also contains 10 silicon transistors R's etc for experimenting with Supplied with connection data
Only £1.25

WIRE & FLEX

Flex pack — 5m of 5 different colours, thick or thin 25m for **30p**
 25 way (14/0076) cable with braided overall screen and sheath **40p/m**

COMPONENT PACKS

200 miniature resistors, 1/4, 1/2, 1W **£1.00**
 400 assorted resistors, 1/4, 1/2, 1W **£1.30**
 200 poly, mica, ceramic capacitors **£1.20**
 200 electrolytics, but many unmarked **£1.00**
 100 Mullard C280 polyesters, 0.01-1uF **£1.00**
 150 wirewound resistors, 2-10W **£1.60**
 200 PC resistors, 1/4 and 1/2W **60p**
 20 asstd pots, inc sliders **£1.70**
 200 transistors, mostly unmarked, inc. power devices About 75% useable **£1.35**

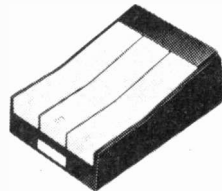
7lb BARGAIN PARCEL

Mixed components from odd 'job lots' not worth sorting out — resistors, capacitors, pots, switches and other small components, also panels with transistors, diodes etc at a very low price — **£3.00**.

COMPUTER PANELS

A dozen boards with top grade components — transistors, inc power types, zeners, trim pots, IC's, resistors and capacitors Hundreds of parts for just **£2.75**.

'KEYNECTOR' MAINS CONNECTOR



Essential equipment for the showroom, workshop, factory, laboratory, home and hobby bench, the 'Keynector' provides quick, efficient and safe temporary mains connection. Bared terminal wires are simply inserted into clamps operated by 3 piano like keys — polarity marked. Safety is ensured by the clever design which cuts off power when the fused housing is in the open or OFF position. With power on the springloaded keys cannot be depressed. In addition, the neon lamp only glows if earthing is correct, so pointing out possible mis-wiring to equipment or plug. The 'Keynector' will accept 3 cored mains cables up to 13 Amps, can be permanently wall or bench mounted or operated as a free standing unit in complete safety. The unit is attractively presented within a heavy duty moulded housing with contrasting white keys. Individually boxed and supplied with installation and operating guide 76 x 50 x 126mm
Price £4.96

EDGE CONNECTORS

High quality 0.1" pitch double sided, gold plated. Selling at less than 1/3 their original price
 18 way **41p** 21 way **47p**
 32 way **72p** 40 way **90p**
 49 way **111p**

SOLAR CELLS

These silicon chips size 19x6.5mm will give 50µA @ 1/2V in sunlight, and can be banked for greater power. Prices 3 for £1.10 for £3.25 for £7.100 for £25. Ideal for powering small CMOS projects, etc

S-DECS & T-DECS

S-DEC Breadboard **225p**
 T-DEC Breadboard **325p**

POWER PACK

Woodgrained metal case 90x80x75mm containing mains transformer giving 6V @ 200mA 2 co-ax sockets PC board with 1 1/2" fuseholder R's C's, etc **Only 75p**.

EARPIECES & SPEAKERS

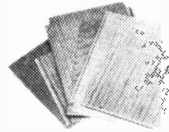
8R 2 1/2" 0.3W speaker **50p**, 64R 2 1/2" 0.3W **65p**, Magnetic earpiece 3 1/2" mm jack **20p**, Crystal earpiece 3 1/2" mm jack **38p**

PANEL METERS

6x48x35mm 50µA 100µA 1mA **£3.75**;
 118x73x38mm 50µA 100µA **£5.00**.
 Edgewise 89x35x57mm 1mA **£3.45**



VEROBOARD



Our packs of vero offcuts are one of our biggest sellers — and no wonder, they are amazing value! Each pack contains 7 or 8 pieces to make up a total area of 100 sq. ins. All packs are the same price, **£1.30 each** and are available as follows
 Pack A, all 0.1" pitch
 Pack B, all 0.15" pitch
 Pack C, mixed 0.1 & 0.15"
 Pack D, all 0.1" plain
 Also available by weight 1lb **£3.95** 10lbs **£32.50**

Regular size vero
 17x3 3/4x0.1" **£2.00**, 10 strips **£15**
 17x3 3/4x0.15" **£1.76**; 0.1" plain **£1.63**

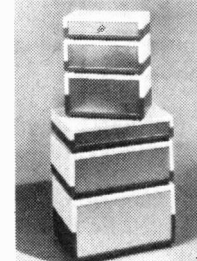
DIP Breadboard size 6.15x4.5" can accommodate 20 x 14 pin IC's **£2.35**

VQ Board, size 148 x 75mm 0.1" pitch Copper strips in rows of 4 to facilitate construction with IC's. Layout sheet provided **85p**

VERO PINS AND TOOL

Spot face cutter for 0.1 or 0.15 pitch **75p**
 0.1" pins single sided **30p/100**
 0.1" pins double sided **35p/100**
 0.15" pins single sided **30p/100**
 0.15" pins double sided **35p/100**

VEROCASES



Plastic top and bottom ally panels front and back
 1237 154x85x40 **£2.53**
 1238 154x85x60 **£2.79**
 1239 154x85x80 **£3.32**
 3007 180 x 120 x 40 **£3.30**
 3008 180 x 120 x 65 **£3.50**
 3009 180 x 120 x 90 **£3.74**
 1410 205x140x40 **£3.51**
 1411 205x140x75 **£4.05**
 1412 205x140x110 **£5.12**

VERO PLASTIC BOXES

Professional quality two tone grey polystyrene with threaded inserts for mounting PC boards
 2518 120x65x40 **£2.17**
 2520 150x80x50 **£2.45**
 2522 188x110x60 **£3.23**

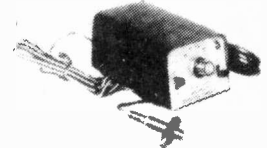
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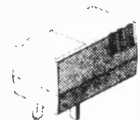
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K042. As above but 5 of each value **£8.70.**

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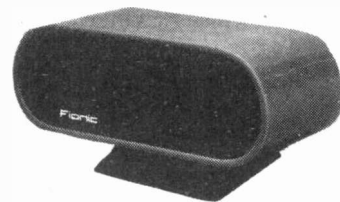
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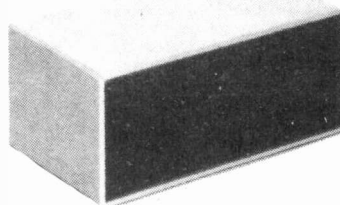
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Made of Perspex in attractive colours (white, black, brown or red) with black-tinted front panel. Back panel is drilled for switch etc. Overall size is 138x51x81mm. Price **£1.50.**



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A solid brushed aluminium sleeve size 102x75x45mm has a translucent red perspex front and a drilled rear panel to take 2 min. push button switches + min DPCO slide switch + 35mm dia crystal mic insert (Used for alarm signal). These cases can be supplied with all these components mounted on the back panel for **£1.75,** or with a blank panel for **£1.25.**



CLOCK CHIPS

MK50253N **£3.95**
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Both supplied with data.

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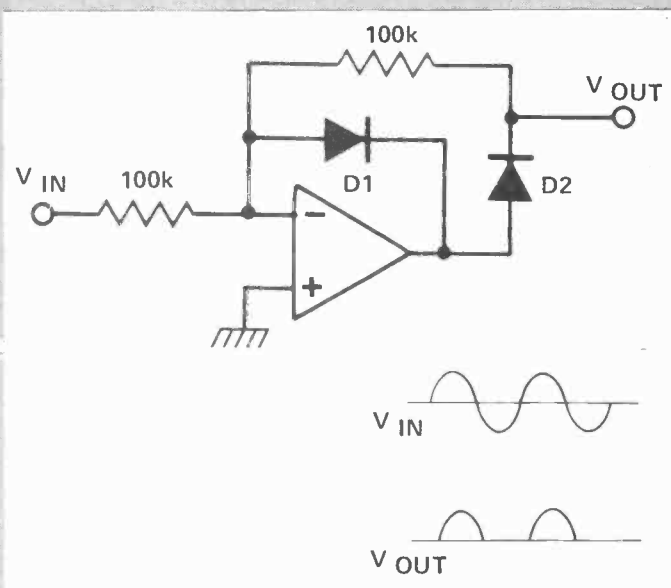
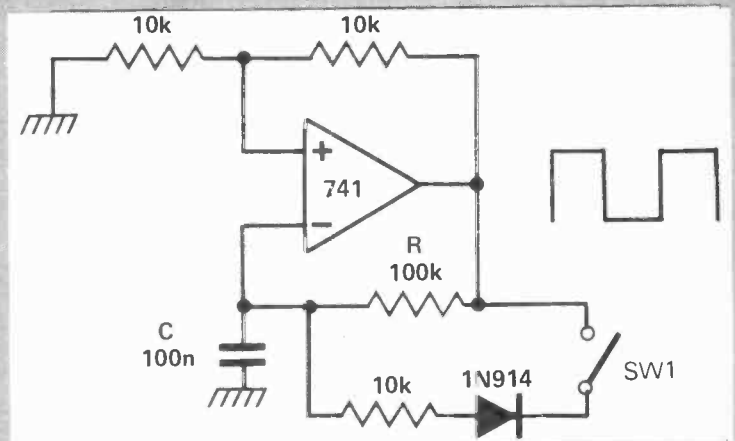
OP AMPS

PART 2

In the first part of this series Tim Orr discussed the theory and operation of op-amps. This month he moves on to give some circuit applications for this ubiquitous device, and explains how and why it can do what it does!

Single Op Amp Oscillator

This circuit has a Schmitt trigger and a 'sort of integrator' all built around one op-amp. The positive feedback is via the 10k resistors. The 'integration', or rather, the timing, is controlled by the RC network. The voltage at the inverting input follows that of the RC charging exponential, except that it is confined to be within the upper and lower hysteresis levels. Thus the hysteresis levels and the RC time constant determine the frequency of the operation. It is possible to make the output square wave have a large mark to space ratio. By closing the switch SW1, the discharge time of the capacitor becomes eleven times faster than the rise time. Thus a square wave with an 11:1 mark space ratio is generated.



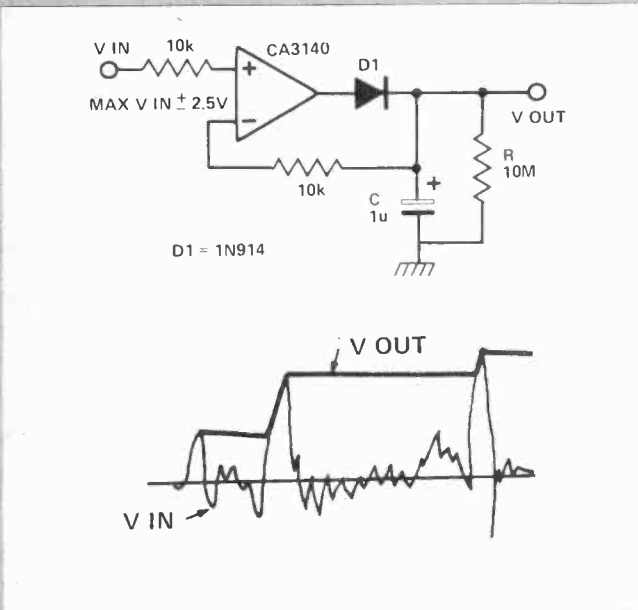
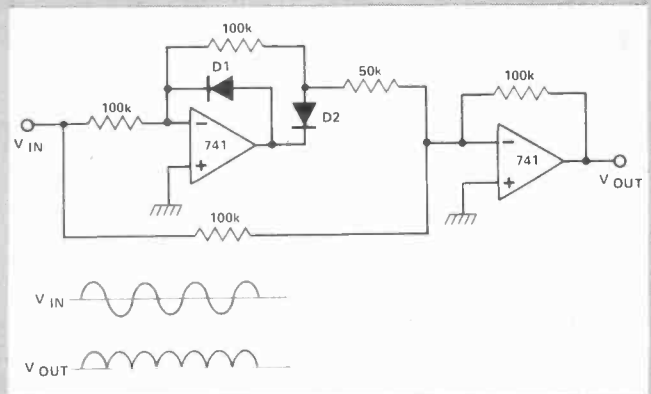
Precision Half Wave Rectifier

Rectifying small signals with any accuracy can be very difficult with just diodes due to their forward voltage drop of about 0.6 V. However, an op-amp can be used to reduce this voltage drop to apparently nothing. Consider the circuit shown. There is negative feedback so that 'virtual earth' circumstances exist. When V_{in} is positive, D1 conducts to maintain the virtual earth, D2 is reverse biased and so the output is just a 100k resistor connected to 0 V. When V_{in} goes negative, the output rises positively, D2 is turned on and D1 turned off. As the virtual earth is being maintained, the output voltage is the exact inverse of the input voltage. This is true for all negative inputs. Therefore, the output is composed of positive going half sinewaves. A precision half wave rectification has occurred. In fact the diode error is very small, being equal to

$$\frac{600 \text{ mV}}{\text{(surplus voltage gain)}}$$

Therefore as the input frequency increases, and the surplus voltage gain decreases, the amount of precision also falls.

By adding the original and the half wave rectified signals together in the right ratio, it is possible to fill in the half cycle gaps and thus to generate a precise full wave rectification. The addition of one summing op-amp and three resistors is all that is needed as shown opposite.

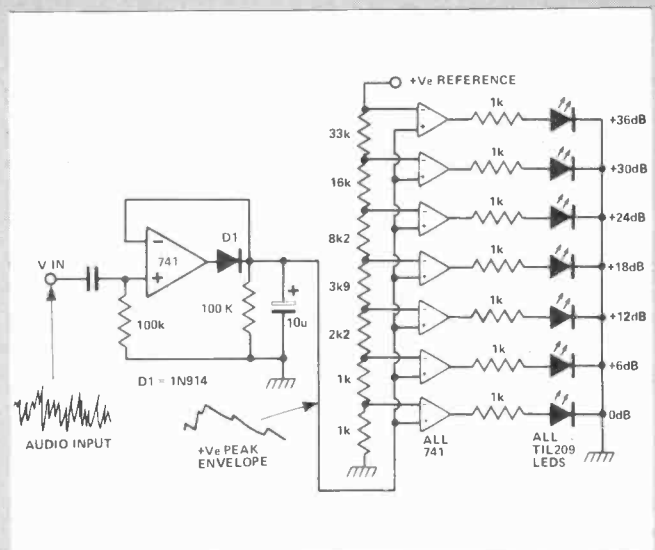


Precision Peak Voltage Detector with a Long Memory Time

The circuit shown has negative feedback only for positive signals. That is, the inverting input can only get some feedback when diode D1 is forward biased and this can only occur when the input is positive. When a positive input signal is applied the output of the op-amp rises until the inverting input reaches the same potential. In so doing, the capacitor C is also charged to this potential. When the input goes negative, the diode D1 becomes reverse biased and so the voltage on the capacitor remains there, being slowly discharged by the op-amp input bias current and the resistor R (10M). The op-amp used has a MOS FET input, having an exceptionally low input bias current of 10 pico amps. Thus the discharge of the capacitor is dominantly controlled by the resistor R, giving a time constant of ten seconds. Thus the circuit detects the most positive peak voltage and remembers it.

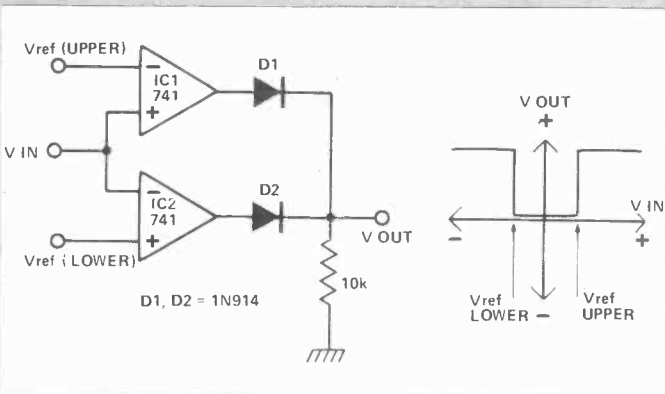
Led Bar PPM Display for Audio

The peak voltage detector can be used to control an illuminated audio level monitor displaying the same characteristics as a PPM (Peak Programme Meter). A bar column of LEDs is arranged so that as the audio signal level increases, more LEDs in the column light up. The LEDs are arranged vertically in 6 dB steps. A fast response time and a one second decay time has been chosen so as to give an accurate response to transients and a low 'flicker' decay characteristic. The op-amps that drive the LEDs are being used as comparators. On each of their inverting inputs they have a DC reference voltage, which increases in 6 dB steps up the chain. All of their non-inverting inputs are tied together and connected to the positive peak envelope of the audio signal. Thus as this envelope exceeds a particular voltage reference, that op-amp output goes high and the LED lights up. Also, all the LEDs below this are illuminated.



Basic Summing Circuit (Mixer)

A virtual earth amplifier can be used to mix several signals together. The output voltage is a mixture of all the inputs. The amount of an input that appears at the output is inversely proportional to the input resistor. If the input voltages are fed into potentiometers before being fed to the mixer, then their individual levels can be manually adjusted. This is the basis of most audio mixers, although only the cheaper units use op-amps. Most op-amp mixers will degrade the signal to noise ratio of the signals by more than a good discrete component amplifier.

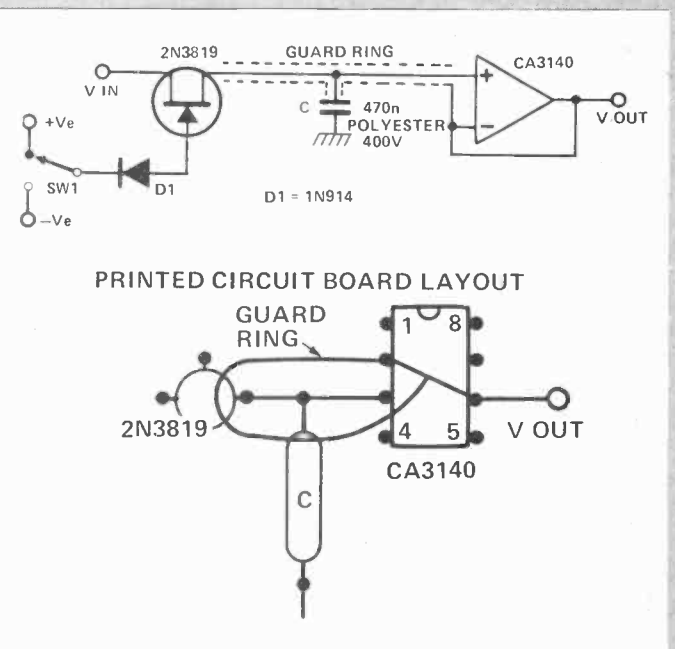


Window Comparator

A window comparator gives an output which in this case is 0 V, when an input voltage lies in between two specified voltages. When it is outside this 'window', the output is positive. The two op-amps are used as voltage comparators. When V_{IN} is more positive than V_{ref} (upper) the output of IC1 is positive and D1 is forward biased. Otherwise the output is negative, D1 reverse biased and hence V_{out} is 0 V. Similarly, when V_{IN} is more negative than V_{ref} (lower), the output of IC2 is positive; D2 is forward biased and thus V_{out} is positive. Otherwise V_{out} is 0 V. Thus only when V_{IN} lies within the window set by the reference voltages is V_{out} 0 V.

High Performance Sample and Hold

It is often necessary to have a circuit that will sample an analogue voltage and then remember it for a long time without any significant corruption of that voltage. This is known as a sample and hold circuit and one use of it is to store the voltage from the keyboard connected to an electronic music synthesiser. The voltage is then used to control the pitch of a voltage controlled oscillator and so it is very important to have a high performance sample and hold. A drift of less than one semitone, (80 mV), in ten minutes is required. A sample and hold is simply an electronic switch, a storage capacitor and a high input impedance voltage follower. In the circuit shown, when switch SW1 is positive the FET is turned on, and has a resistance of about 400Ω. Thus the input voltage charges up the capacitor through the FET. When SW1 is negative, the FET is turned off, (pinched off), and can have a resistance of thousands of Megohms. To get a long storage time the op-amp must have a very low input bias current. For the CA3140, this current is about 10 pico amps, i.e., 10^{-11} amps. Therefore the rate at which the capacitor will be discharged by this current can be worked out from the equation, $C(dv/dt) = i$



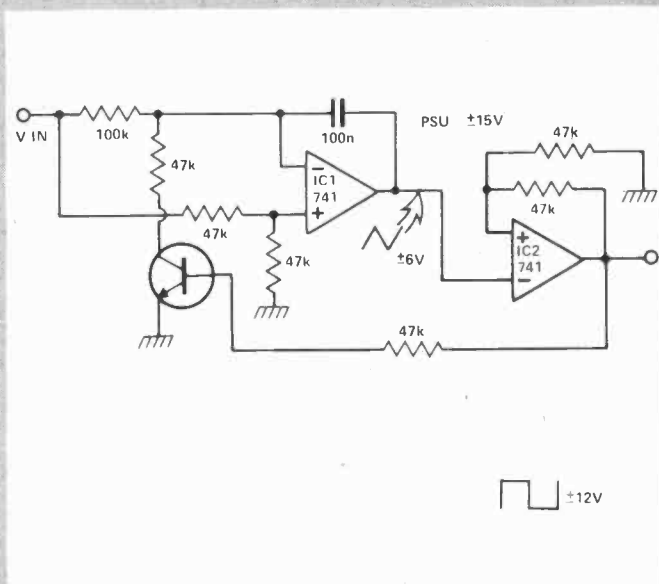
where dv/dt is the rate of change of voltage on the capacitor.
Therefore:

$$\frac{dv}{dt} = \frac{i}{C} = \frac{10^{-11}}{0.47 \times 10^{-8}} = 22 \mu\text{V/s}$$

This is a very low drift rate, much better than we need. However, the actual drift rate will probably be in excess of this, due to surface leakage on the printed circuit board, leakage through the FET, and internal leakage in

the capacitor. It is advisable to use a high voltage, non-polarised capacitor in this circuit to keep the leakage currents to a minimum. Also, to stop surface leakage a simple PCB trick can be used, that of making a guard ring around the sensitive components.

Normally any potential stored on the capacitor may leak to ground across the surface of the PCB, but if we make the surrounding surface a conducting track held at the same potential as that of the capacitor then the potential difference is virtually always zero, and hence the surface leakage is greatly reduced.



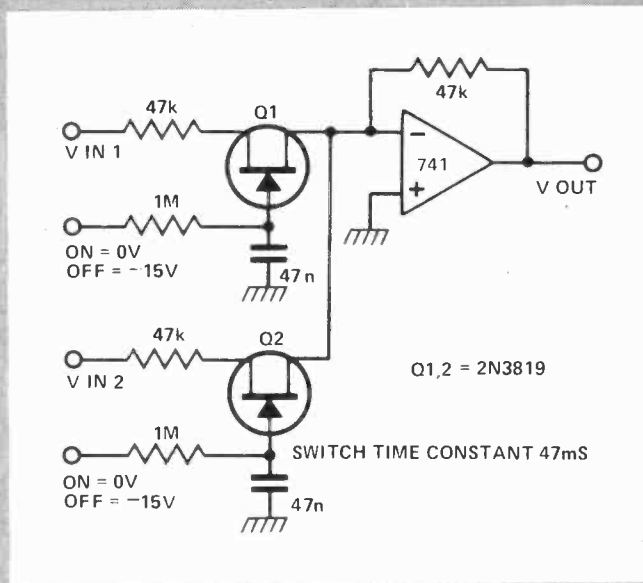
Linear Voltage Controlled Oscillator

This oscillator is very similar to the triangle square wave oscillator shown in Part 1, except that this one is voltage controlled. The integrator and Schmitt trigger action are the same as before, but the feedback has been altered. The input voltage V_{in} is applied differentially to the integrator via the resistor network. The larger the value of V_{in} , the faster the integrator ramps up and down. Thus the frequency of the operation is determined by an external positive control voltage. The frequency is linearly proportional to this control voltage.

When the output of the Schmitt is low, Q1 is off and so all the input voltage is applied to the inverting input. Half of the input voltage is always applied to the non-inverting input. Therefore the integrator's output ramps downward until the Schmitt flips into its positive state. Now, Q1 is switched on and the voltage at the inverting input is negative with respect to the non-inverting input. Hence the integrator now ramps upwards.

Silent Audio Switching

Sometimes electronic switches for audio signals are required. FETs can be used to perform the switching, but they can cause distortion, the resultant output impedance is not very low and clicks generated by the switching signal can break through. The circuit shown virtually eliminates all of these problems. By using an op-amp a very low output impedance is obtained as well as the possibility of selecting or mixing one or more of many input channels. Because of the virtual earth mixing, the voltage across any FET that is switched on is very small. If the input voltage is 1V and the FETs ON resistance is 470R, then the voltage across the FET is about 10 mV. When large voltages are applied to a turned on FET, the distortion is large, but if the voltage is small, (10 mV say), the distortion could be less than 0.1%. Thus the virtual earth mixing enables low distortion operation. Lastly, to stop the generation of switching clicks, a time constant of 47 msec has been enforced at the gate of the FETs.



To be continued. Next month sees circuits for exponential voltage to current convertors, musical chime generators, triangle to square wave convertors, squarewave generators with auto level adjustment and variable mark-space ratio — amongst other things.

DATA SHEET

ICL 7106/7107 INTERSIL

DIGITAL PANEL METER

THE ICL7106 and 7107 are high performance, low power, CMOS 3½ digit A/D converters that contain all the necessary active devices on a single monolithic IC. Each has parallel seven-segment outputs which are ideal for use in a digital panel meter. The ICL7106 will directly drive a liquid crystal display including the backplane drive. The ICL7107 will directly drive instrument size LEDs without buffering. With seven passive components, display and power supply, the system forms a complete digital voltmeter with automatic zero connection and polarity. (see figs. 1 and 3).

Both ICs use the time-proven dual slope integration technique with all its advantages, i.e. non-critical components, high noise rejection, non-critical clock frequency and almost perfect differential linearity. Both the ICL7106 and 7107 can be used not only with its internal reference, but true ratiometric reading applications may also be accomplished over a full scale input range of 199.9 mV to 1.999 V.

The accuracy of conversion is guaranteed to plus or minus 1 count over the entire plus or minus 2000 counts and the auto-zero facility provides a guaranteed zero reading for 0 volts input. However, the chip does provide a true polarity output at low voltages for null detection. Both chips have an on-board clock and reference circuitry, as well as overrange detection.

The Clock

The chip carries the active parts of an RC oscillator which runs at about 48 kHz and is divided by 4 for use as the system clock. The integration period (1000 clock pulses) is therefore 83.3 ms. Each conversion requires 4,000 clock pulses, i.e. 3 readings per second. For optimum 50 Hz line frequency rejection, the clock should be set to a multiple of 50 Hz, e.g. 50 kHz.

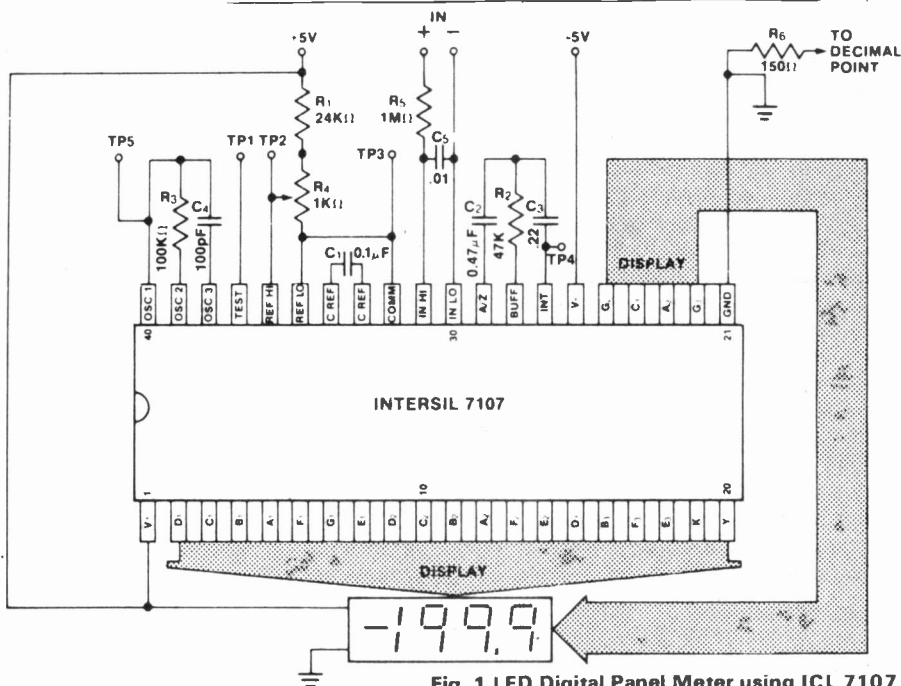


Fig. 1 LED Digital Panel Meter using ICL 7107

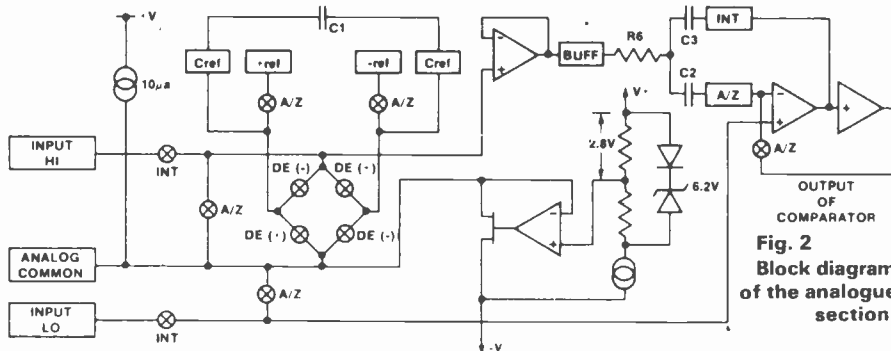


Fig. 2 Block diagram of the analogue section.

Fig. 4. Pinouts

(+) SUPPLY	36	OSC. 1
D (UNITS)	35	OSC. 2
C (UNITS)	34	OSC. 3
B (UNITS)	33	TEST
A (UNITS)	32	+ REF.
F (UNITS)	31	- REF.
G (UNITS)	30	+ REF. CAP.
E (UNITS)	29	- REF. CAP.
D (TENS)	28	COMMON
C (TENS)	27	INPUT HI
B (TENS)	26	INPUT LO
A (TENS)	25	AUTO-ZERO
F (TENS)	24	BUFFER
E (TENS)	23	INTEGRATOR
D (100's)	22	(-) SUPPLY
B (100's)	21	G (TENS)
F (100's)	20	C (100's)
E (100's)	19	A (100's)
AB (1000)	18	G (100's)
POLARITY (MINUS)	17	BACKPLANE/DIGITAL GND (7106)
	16	(7107)

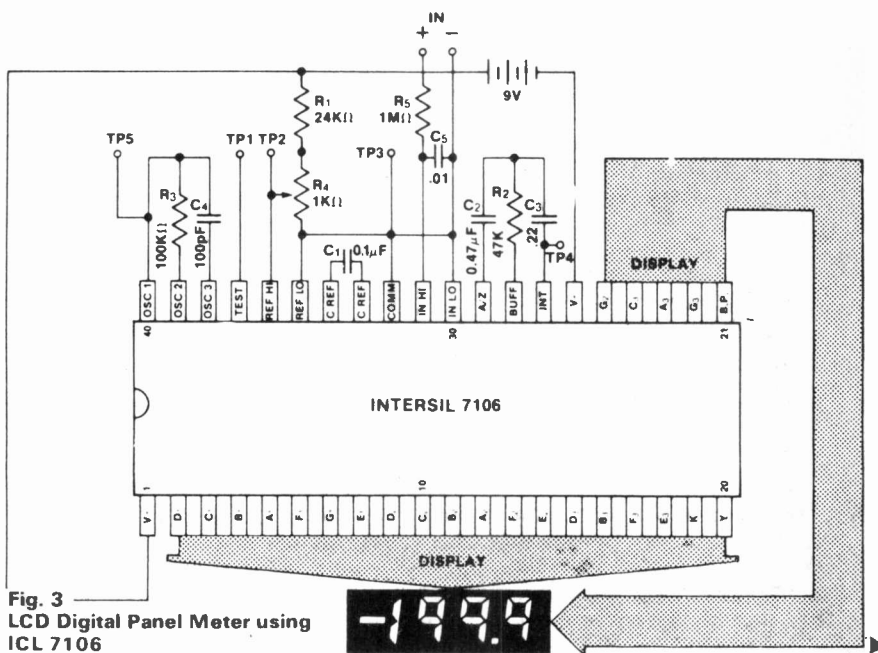
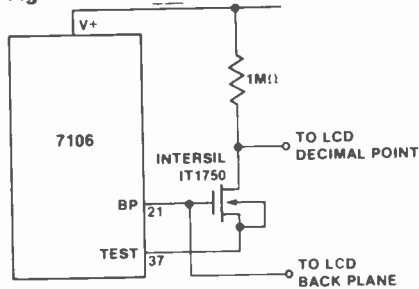


Fig. 3 LCD Digital Panel Meter using ICL 7106

Displays and DPs

The additional components required to build a DPM are a display (either LCD or LED), 4 resistors, 4 capacitors, and an input filter if required. Liquid crystal displays become polarised and damaged if a DC voltage is continuously applied to them, so they must be driven with an AC signal. To turn on a segment, a waveform 180 degrees out of phase with the backplane drive (but of equal amplitude) is applied to that segment. The 7106 generates the segment drive waveform for all digits internally, but does not generate segment drive for the decimal point. This must be done using an inverter or exclusive-OR logic (see fig. 5 below). For use with LED displays the 7107 pull-down FETs will sink about 8 mA per segment, which produces a bright display suitable for almost any indoor application. A fixed decimal point can be turned on by tying the appropriate cathode to ground through a 150 ohm resistor.

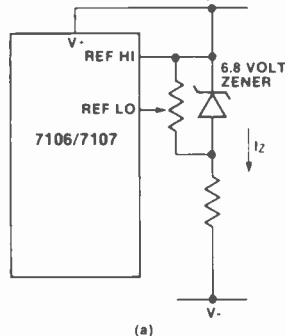
Fig. 5. LCD inverter



The Reference

For 200.0 mV full scale, the voltage applied between REF Hi and REF Lo should be set at 100.0 mV. For 2.000 V full scale, this should be 1.000 V. The reference inputs are floating, and the only restriction on the applied voltage is that it should lie in the range $V- to V+$.

Fig. 6. External reference

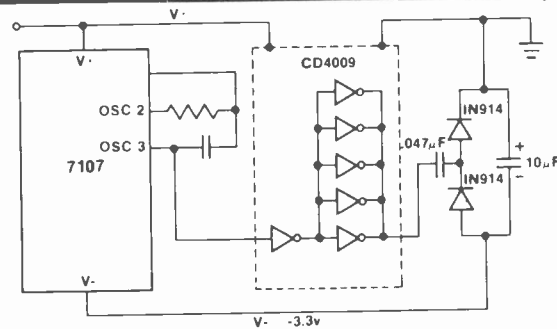


For many applications, the internal reference of 2.8 V between $V+$ and COMMON is adequate, but power dissipation in the 7107 LED version can wreck this. However, an external reference can be added as shown in Fig.6.

Electrical Specifications @ +25° C unless otherwise specified

Full Scale Voltage Range	$\pm 200\text{mV}$ (5.0V min $V+$ to $V-$) $\pm 2.0\text{V}$ (6.0V min $V+$ to $V-$)
Full Scale Digital Range	± 2000 Counts
Common Mode Voltage Range	$V+$ minus 0.5V to $V-$, plus 1V
Accuracy 10° C to 50° C with external reference	$< 1/2$ Count
Noise referred to Input	15µV typical
Zero width	0-1 transition at .7 to .9 counts
Turnover	< 1 Count
Input circuit	Differential
Input Bias Current	2pA
Input Impedance	$> 10^{12}$ ohm
Polarity	Automatic with neg sign displayed
Reference (Internal)	Internal 2.8V, referenced to $V+$
Reference (External)	Temperature Coefficient 100ppm/° C typical. External reference must be in the range $V+$ to $V-$
Recommended External Components	2V Full Scale $C_3 = \text{Int Cap } 220\text{n}$ $C_2 = \text{AZ Cap } 47\text{n}$ $C_1 = \text{Ref Cap } 100\text{n}$ $C_4 = \text{Clock Cap } 100\text{p}$ $R_6 = \text{Int Res } 47\text{k}$ $R_3 = \text{Clock Res } 100\text{k}$ $R_2 = \text{Short}$ 48kHz divided by 4 An internal divide by 4 counter is provided to count external oscillators down to 12kHz, the internal dual slope clock.
Display Outputs (LED ICL7107)	22 Current limited segment drives plus one current limited neg sign drive plus LED common Note: The 2 die in the 1k bit are in parallel
Display Outputs (LCD ICL7106)	22 segment drives plus one neg sign drive plus LCD back plane drive
LED (7107) current @ +5.0V Power Requirements	5.5 to 8.0ma LCD: 1ma @ 4.5 - 6V LED: 1ma @ 4.5 - 6V, plus LED current Dual
Power supply configuration (7107)	+4.5 to +6V and -3 to -6V @ 1ma Note: for inputs that remain within the CM voltage range only a single supply is required
Digital input Signals (7106)	Test Single 5 to 12V A high on the test input turns on all segments and the minus sign. 3 Readings per second with 12kHz internal clock (48kHz external clock). Accurate from .1 to 15 reading per second.
Read Rate	

Fig. 7. Deriving a negative supply



Power Supplies

The 7106 will run from a single 5 to 12 V supply. If INPUT Lo is shorted to COMMON, this will cause $V+$ to sit 2.8 V positive with respect to INPUT Lo, and $V-$ at 6.2 V negative with respect to INPUT Lo.

The 7107 requires dual supplies, +4.5 to +6 V and -3 to -6 V at 1 mA. A negative supply may be derived from +5 V using the circuit given in Fig 7.

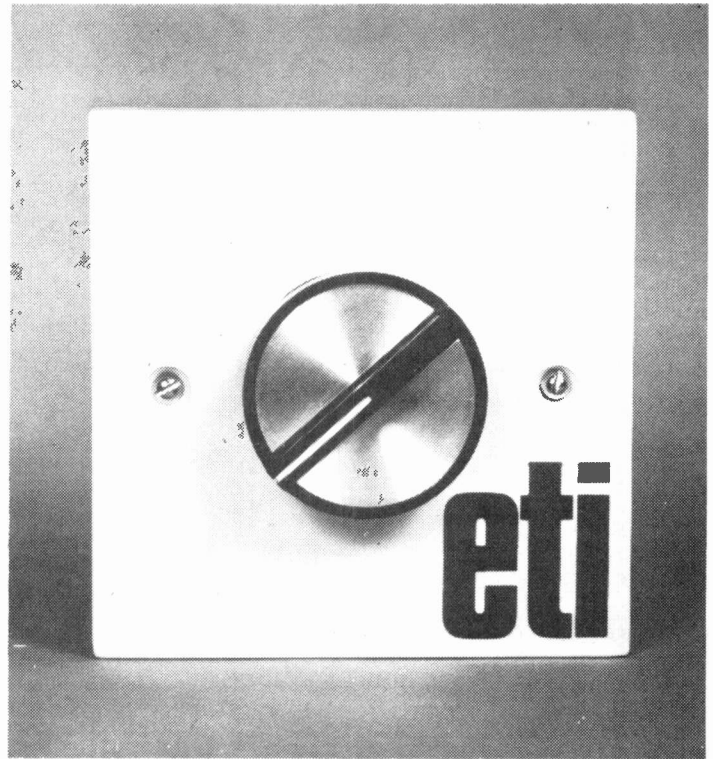
Evaluation kits for the 7016 and 7107 are available from Rapid Recall, 9 Betterton Street, Drury Lane, London WC2H 9BS. The kits are supplied with full data sheets and an application note, further Intersil application notes are also available on request.

The individual devices are becoming widely available, sources known to ETI include, Audio Electronics, Doram, Marshalls and Watford Electronics.



LIGHT DIMMER

A versatile design that provides a high quality light dimmer and, with the addition of a simple interface, a building block that forms the basis of many other light effect circuits.



THE DIGITAL LIGHT bulb has been with us for a few years now. What's a digital light bulb you ask — well in case you don't recognise the term it's just a clever, well if not clever, at least obscure, way of describing the common domestic light bulb we all know and love. These bulbs may just about be described as digital as, essentially, they are either on or off — we said we were being obscure and we were not joking.

Light Fantastic

Now this two state nature of le bulb ordinaire can be rather dull, however, the application of electronics makes a number of more interesting things possible. We can, for instance, vary a bulb's brightness smoothly from almost nothing to full output, sequence a number of lights according to a prearranged pattern, turn bulbs on and off in time with music and you can probably think of many other things in this vein. The circuit described here, although presented primarily as a light dimmer, can form the basis of many of these other systems.

Bright Idea

While it would be possible to control the brightness of a lamp by placing a variable resistor of a large power rating in series with same, this type of control would have a number of serious disadvantages, not the

least of which is the large amount of heat that would be generated. The use of phase control provides a means of accomplishing the desired effect that is both simple and efficient.

A Passing Phase

Phase control means simply that power is supplied to the load, in this case a lamp, for only part of each AC cycle. Usually phase control circuits are referred to the "zero crossing" of the AC supply and power is supplied to the load at some time after this point continuing then until the next zero crossing. In this way the energy supplied (light output) can be controlled.

Many domestic controllers use a circuit similar to that shown in Fig. 1. This consists of a simple phase control network with a diac to "fire" the triac that controls the load. We have chosen to use a different type of circuit (Fig. 2) that we feel gives a better and more reliable control. The triac is retained but the triggering circuitry is quite different, consisting as it does of a PUT (Programmable Unijunction Transistor) in a phase control network with triggering of the triac being accomplished by a pulse transformer.

As this unit is intended to form the basic building block of a number of different systems we have chosen not to mount the potentiometer RV1 directly onto the PCB as would have

been the case if this were simply a light dimmer. Instead the pot is connected via flying leads to the PCB as shown in our photos. This leads (please pardon the pun — we cannot resist puns or alterations) to a more versatile board. The basic dimmer can, for instance, depending on the configuration of these leads, either be at full brilliance upon switch on, dimming as RV1 is rotated or alternatively, be at minimum output at switch on bringing the light to full brilliance as RV1 is rotated.

Light Construction

Construction of the light dimmer should pose no problems if the specified components are carefully mounted onto the PCB according to the overlay shown in Fig. 3.

We specify a ready made pulse transformer although those masochists amongst you might like to make this component yourself by evenly winding thirty turns of 32 SWG wire on a half inch long quarter inch diameter ferrite rod to form the primary. After a layer of insulation a further thirty turns of the same wire forms the secondary.

The coil L1 is formed by winding fifty turns of 22 SWG wire on a ferrite rod that is one inch long by quarter inch diameter.

It can then be fixed on to the PCB using quick-set epoxy, after soldering the leads.

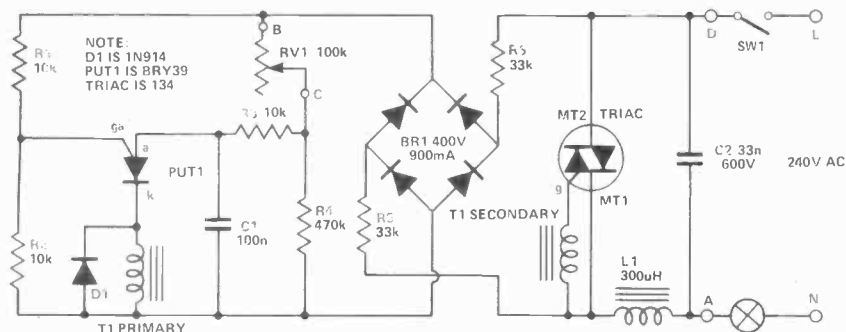


Fig. 2. Full circuit diagram of the light dimmer.



BUYLINES

In order to ensure satisfactory performance of this circuit we recommend that only the components specified in the parts list are used. These components are available from stockists of RS components, which means most people.

HOW IT WORKS

The light dimmer circuit can conveniently be broken down into two sections, the trigger circuitry and the triac itself that supplies power to the load.

We shall first discuss the trigger circuitry that is formed by PUT 1 and its associated circuitry. The BRY39 PUT (Programmable Unijunction transistor) is a four layer semiconductor device that is similar in action to a thyristor. The BRY39 has lead-outs connected to each of the four semiconductor layers that make up the device. Our application only requires three of the terminals, the anode (a), cathode (k), and the anode gate (ga) — the cathode gate (ka) is left unconnected. For a full description of this device you should refer to one of the many text books that deal with semiconductor devices.

For our purposes the BRY39 can be thought of as a switch which can either present a high impedance between its anode and cathode terminals (off) or a low impedance (on). The device is switched from the "off" to the "on" state by taking the anode gate negative with respect to the anode which is, of course, the same as taking the anode positive with respect to the anode gate. (The device can also be controlled by the cathode gate.)

When in the "on" state the device can only be returned to the "off" state by reducing the current through the device to a value below the holding current (usually a low value). In this respect the BRY39 is similar to a thyristor.

Thus the BRY39 is turned "on" when the voltage at the junction of R3 and C1 reaches a value that is just greater than that at the junction of R1 and R2.

The trigger circuitry is powered by the unsmoothed full-wave rectified output of

BR1. The bridge is fed via dropper resistors R5 and R6 of which more later.

The relationship between the voltage applied to the BRY39's anode and cathode is dependent upon the value of RV1. A full analysis of the phase control network of the anode circuit (RV1, C1, R3 and R4) would require an article in its own right. However, it can be thought of more simply by considering C1's action as "slowing up" the rise in the full-wave rectified voltage at the PUT's anode. Thus C1 introduces a phase lag at this point. The component values have been chosen to provide the required range of control.

As the PUT is triggered the energy stored in C1 is applied to the primary of the pulse transformer, this induces a pulse in the secondary of T1 which is responsible for firing the triac. D1 prevents any back EMF which would upset circuit operation.

The load is controlled by the triac which can be thought of as a biconducting version of an SCR. The signal applied to the gate controls the triac's action for current in either direction. The pulse induced in the secondary of the pulse transformer causes the triac to conduct, supplying power to the load until the next zero crossing of the mains waveform causes the current in the triac to fall below its holding value thus turning off the triac.

Note that with the triac on there is no power available to the trigger circuit. The only current required by the trigger circuit is that required to charge C1 and a very small amount consumed by R1 and R2 across the supply. The total current is thus very small and the dropper resistors R5 and R6 can be low wattage components.

Capacitor C2 and coil L1 are provided to reduce the effects of RF1.

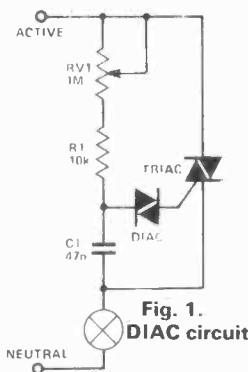


Fig. 1. DIAC circuit

Loaded Question

So far we have described the basic light dimmer but by connection of the interface (trendy word) circuit shown in Fig. 5 the versatility of the unit can be greatly extended. With this interface circuit installed a DC voltage of between 5 and 7 V applied to the LED that forms the mains and as such should be treated with respect at all times.

Just a couple of final points. The first being that the maximum load we recommend for this circuit is 500 W, which should be adequate for most domestic applications. The second point to note is that this circuit is not isolated from one half of the opto-isolator, provides for full control of the load connected to the dimmer.

The unit can now provide remote control of loads by simply running a length of wire between the control pot and the dimmer (this is not recommended with the basic unit as the control leads are not isolated from the mains). The circuit can now provide a sound to light unit by simply connecting it to an amplifier or a sequencer by driving it from, for example, a clocked CMOS counter.

We are working on a few of these ideas and would hope to present some of them in a couple of months time.

ETI

PARTS LIST

RESISTORS

R1,2,3	10 k
R4	470 k
R5,6	33 k

POTENTIOMETERS

RV1	100 k lin with switch
-----	-----------------------

CAPACITORS

C1	100 n Polyester
C2	33 n 600 V DC

SEMICONDUCTORS

PUT 1	BRY 39
TRIAC	6A 400 V TO66 case
BRI	400 V 900 mA

TRANSFORMER

T1	1:1 pulse (see text)
----	----------------------

COIL

L1	See text
----	----------

MISCELLANEOUS

PCB	as pattern.
-----	-------------

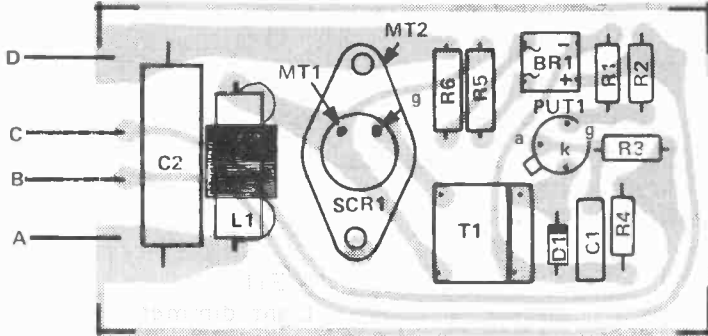


Fig. 3. PCB overlay for light dimmer.

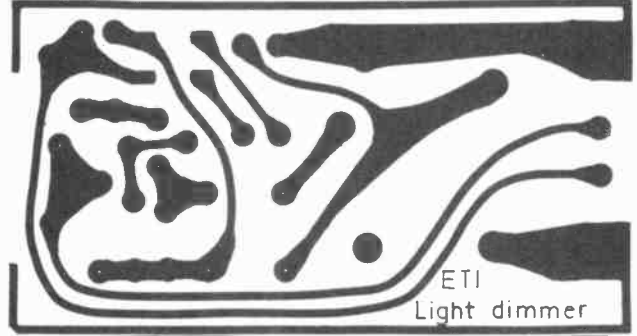


Fig. 4. Foil pattern shown full size.

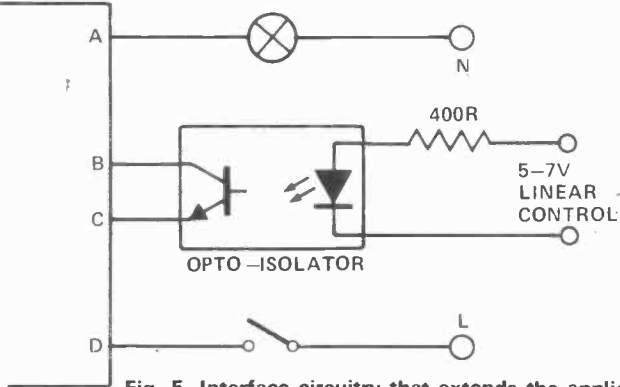
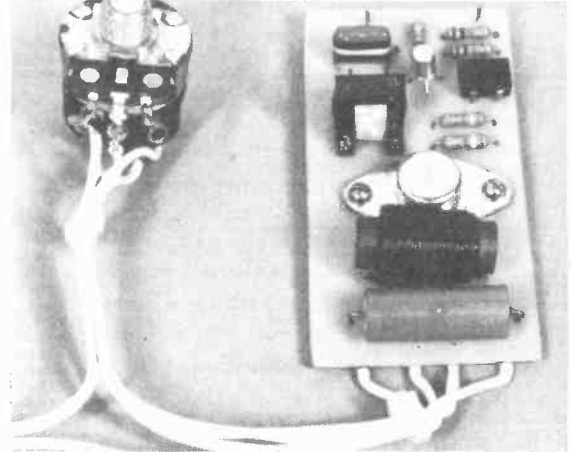


Fig. 5. Interface circuitry that extends the applications of the basic circuit as described in the text.



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SOFTWARE

System 68

ETIBUG 2 is the second software PROM for the System 68 CPU card. The IC fits into socket marked IC9 ready for use. The ETIBUG monitor does an automatic test for the presence of ETIBUG2 (test for an 'E' at location E000) during its command, and if it is inserted ETIBUG will automatically branch to it, so there is no need to alter any other part of the card.

New Commands

The new commands included in ETIBUG2 are intended to make machine code programming easier. The first command will dump 128 bytes of memory to the VDU. This command is entered by typing 'H' followed by the hex address from which the dump is to begin. The dump always begins at the top of the VDU 'page' and fills half the screen. If the command is not 'H' then control passes to 'X TEST'.

'X'ecuting your programs

The second new command allows a program to be run without the long-winded procedure of modifying the Stack dump area to change the program counter (PC), to the address where you want execution to begin. The command is operated by entering X and then the hexadecimal address of the start of your program. (This command will not operate if the stack pointer is not pointing to A042 when executed).

More Interruptions

One of the most useful features of the 6800 during Machine Code programming is the Software Interrupt (3F instruction). When this instruction is found it causes a Stack dump of the registers, a display of this data on the VDU and a branch back to the CONTRL loop. Thus you can code several bytes of program followed by a 3F followed by some more coding and another 3F, etc. When the 3F instruction dumps the registers it dumps the address of the 3F instruction as the PC address, thus a subsequent G command from the keyboard causes control to be passed back to that 3F instruction and thus it is re-executed. To continue by using ETIBUG or MIKBUG it is necessary to update the stored PC by 1 and then use the G command. With ETIBUG2 in your system you need only enter the command letter C to Continue executing after the 3F instruction. Like the Xecute command the Continue command updates the stored PC and then branches into the G command.

424F52494E4720535452494E4753

From the heading of this paragraph you can see how boring and complex it can be to enter a string of ASCII characters into memory using the Memory Examine/Modify command as each character has to be entered by using its ASCII code rather than its keyboard code.

The ETIBUG2 'K' followed by a hex address command allows you to specify a starting address and enter a string of characters from the keyboard into memory until an EOT (Hex 04) character is entered, upon which control jumps back to the Hex. Dump Subroutine.

Shifting Memories

The ETIBUG2 S command allows areas of memory to be copied from one location to another. The 'from' address can be any valid hex address covering RAM, PROM, I/O device addresses, etc; the 'to' address can also be any valid hex address but will usually be RAM. A 'Not RAM' check has not been included as it may be possible to use this command to Shift data from memory to a device port (or vice-versa) and thus use the command as for I/O operations.

The Shift command is started by entering the command letter S. ETIBUG2 will then ask for a START ADDR, a TO ADDR and a LENGTH all of which require a valid four digit hexadecimal input. At the end of the copy control returns to the CONTRL loop. As well as the above commands.

Tape Out

This subroutine outputs a block of data to a cassette unit via the TTYOUT subroutine. The parameters for the output must be stored by the user in address locations A018-A021 before using the subroutine.

The routine starts the tape by pulsing the TAPSTRT flip-flop and then waits about 5 seconds before starting the output.

Output first is the Start address, length and six byte label from the parameter area. Data is then output from the Start Addr until the number of bytes specified by the Length parameter have been output. As each data byte is output it is added to the checkdigit byte (which starts at zero), this checkdigit byte is output as the last character of each block. The routine allows a 5 second delay before stopping the tape and returning to the user program which called this subroutine.

The TAPOUT routine can be called from a user program as a sub-routine or can be called by jumping to XED8F.

Tape In

The TAPIN routine does the reverse of the TAPOUT routine. When the routine is executed and the tape started, the first bytes input are read into the parameter area and then the data is read into the area defined by the Start ADDR and Length now defined by the parameter area. As each byte of data is read in a checkdigit is generated in the same way as that generated by the TAPOUT routine. When the Length parameter indicates that all data has been read in the routine reads one more byte which it assumes to be the output checkdigit. Both the output checkdigit (A022) and the generated checkdigit (A023) are stored in the parameter area for user checking.

TAPIN can also be used by previously setting up the Start Addr and Length in the parameter area and executing TAPOUT3 (EDA7). If used in this way note that the length specified should be one less than the length expected and that the last data byte will appear at A022 instead of the location expected. This is because TAPOUT expects the checkdigit to follow the last data byte, if your tape was not generated on a System 68 it may not have a checkdigit following the data (although most tape systems do have one).

Tape In or Out

The cassette I/O routines act on a block of data at each execution, the parameters for the address, length, label, etc for this block have to be set up before output and are also available to the user after input of a block. To save you checking the parameters by dumping the appropriate area of RAM we have included a TAPE CHECK command which is called by entering the command letter T. The data for a tape I/O are stored as follows.

A018,9	Address of start of block of data.
A01A,B	Length of block of data excluding this parameter data.
A01C-21	Six character ASCII label area.
A022	Checkdigit byte for output (Auto-generated).
A023	Checkdigit byte from input (Auto-generated).

For a valid read the checkdigit which was on the tape (A022) should be the same as that generated during the read (A023), the label area is not used by ETIBUG2 but can be used to identify a record by the user.

The T command performs a formatted print of these parameters for use before output or after input.

TTYIN

This subroutine accepts data from a UART whenever the DAV bit indicates that a byte has been received by the UART. After input the DAV flip-flop is reset. Data is input to ACCA and status to ACCB.

TTYOUT

This subroutine outputs data to a UART if the UART is not already BUSY. There are two entry points —

TTYOUT assumes that the index register points to the address of the next byte for output.

TTYOUT2 assumes that the output data is already in ACCA.

Data is output from or via ACCA with the UART status being saved in ACCB.

ETIBUG2 completes the basic PROM software for System 68 for the time-being, next we hope to bring you a Tiny BASIC or ASSEMBLER.

ETIBUG2 can be obtained in an MM5204 PROM from Bywood Electronics for £25.95 plus VAT.

ETIBUG 2 LISTING

This is a complete listing of the ETIBUG2 PROM which has been written to make machine code programming on System 68 easier.

Address	Op-code	Label	Mnemonic	Description	Address	Op-code	Label	Mnemonic	Description
EC00	45			LETTER 'E' FOR ETIBUG	ED19	42		B	
EC01	C1 48	H TEST	CMP B H	IS COMMAND H?	ED1A	44		D	
EC03	26 31		BNE X TEST	NO, JUMP TO X-TEST	ED1B	20			
EC05	BD EE47		JSR EE47	GET ADDRESS FROM KBD	ED1C	54		T	
EC08	CE 8800	H DUMP	LDX 8800		ED1D	4F		O	
EC0B	FF A014		STX A014	SET VDU CURSOR TO TOP	ED1E	20			
EC0E	5F		CLR B		ED1F	04			END OF TEXT
EC0F	CE A00C	NEXT RO	LDX A00C		ED20	0D	MESS 4		CARRIAGE RETURN MESSAGE 4
EC12	BD EEC8		JSR EEC8	PRINT ADDRESS	ED21	54		T	
EC15	FE A00C	NEXT H	LDX A00C	LOAD ADDRESS OF BYTE	ED22	41		A	
EC18	BD EECA		JSR EECA	PRINT BYTE	ED23	50		P	
EC1B	FF A00C		STX A00C	STORE ADDRESS OF NEXT BYTE	ED24	45		E	
EC1E	5C		INC B		ED25	20			
EC1F	C5 07		BIT B 07	HAVE 8 BYTES BEEN PRINTED?	ED26	43		C	
EC21	26 F2		BNE NEXT H	NO, LOOP BACK TO NEXT H	ED27	48		H	
EC23	BD EECC		JSR EECC	YES, PRINT SPACE	ED28	45		E	
EC26	C5 0F		BIT B 0F	HAS A ROW BEEN COMPLETED?	ED29	43		C	
EC28	26 EB		BNE NEXT H	NO, LOOP BACK TO NEXT H	ED2A	4B		K	
EC2A	86 0D		LDA A 0D	YES, LOAD CR CHARACTER	ED2B	3B		:	
EC2C	BD EFD1		JSR EFD1	PRINT CARRIAGE RETURN	ED2C	53		S	
EC2F	C5 7F		BIT B 7F	IS DUMP FINISHED?	ED2D	54		T	
EC31	26 DC		BNE NEXT RO	NO, DO NEXT ROW	ED2E	41		A	
EC33	7E EEE3		JMP EEE3	YES, JUMP TO CONTROL	ED2F	52		R	
EC36	C1 58	X TEST	CMP B 'X	IS COMMAND X?	ED30	54		T	
EC38	26 09		BNE C TEST	NO, JUMP TO C TEST	ED31	20			
EC3A	BD EE47		JSR EE47	GET ADDRESS OF PROGRAM START	ED32	41		A	
EC3D	FF A048		STX A048	STORE ADDRESS AT A048	ED33	44		D	
EC40	7E EF0F	RUN	JMP EF0F	JUMP TO 'RUN' IN ETIBUG	ED34	44		D	
EC43	C1 43	C TEST	CMP B 'C	IS COMMAND C?	ED35	52		R	
EC45	26 09		BNE K TEST	NO, JUMP TO K TEST	ED36	20			
EC47	FE A048		LDX A048	TRANSFER PC TO X-REGISTER	ED37	04			END OF TEXT
EC4A	08		INX	INCREMENT X-REGISTER	ED38	4C	MESS 5		MESSAGE 5
EC4B	FF A048		STX A048	TRANSFER X BACK TO PC	ED39	45		E	
EC4E	20 F0		BRA RUN	JUMP TO RUN ROUTINE	ED3A	4E		N	
EC50	C1 4B	K TEST	CMP B 'K	IS COMMAND K?	ED3B	47		G	
EC52	26 29		BNE S TEST	NO, JUMP TO S TEST	ED3C	54		T	
EC54	CE ED16		LDX MESS 3	LOAD START OF MESS 3	ED3D	48		H	
EC57	BD EE7E		JSR EE7E	PRINT MESSAGE 3	ED3E	20			
EC5A	BD EE47		JSR EE47	GET ADDRESS FROM KBD	ED3F	04			END OF TEXT
EC5D	FF A018		STX A018	STORE ADDRESS	ED40	4C	MESS 6		MESSAGE 6
EC60	FE A018	K LOOP	LDX A018		ED41	41		L	
EC63	BD EFAC		JSR EFAC	GET CHARACTER FROM KBD	ED42	42		A	
EC66	A7 00		STA A X	STORE CHARACTER	ED43	45		B	
EC68	A1 00		CMP A X	WAS CHARACTER STORED?	ED44	4C		E	
EC6A	27 03		BEQ K LOOP 2	YES, JUMP TO K LOOP 2	ED45	20		L	
EC6C	7E EEE3		JMP EEE3	NO, JUMP TO CONTROL	ED46	20			
EC6F	08	K LOOP 2	INX	INCREMENT ADDRESS COUNTER	ED47	04			END OF TEXT
EC70	FF A018		STX A018	STORE NEXT ADDRESS	ED48	43	MESS 7		MESSAGE 7
EC73	81 04		CMP A 04	WAS CHARACTER EOT?	ED49	48		H	
EC75	26 E9		BNE K LOOP	NO, LOOP BACK TO K LOOP	ED4A	4B		K	
EC77	7E EC08		JMP H DUMP	JUMP TO HEX DUMP	ED4B	44		D	
EC7A	00			NO OPERATION	ED4C	49		I	
EC7B	00			NO OPERATION	ED4D	47		G	

EC7C	00			NO OPERATION	ED4E	20			END OF TEXT
EC7D	C1	53	S TEST	IS COMMAND S?	ED4F	04			PULSE TAP STRT FLIP-FLOP
EC7F	26	43		NO, JUMP TO T TEST	ED50	B7	7205	TAP IN	CLR A023
EC81	CE	ED00		LOAD ADDRESS OF MESS 1	ED53	F7	A023		LDX A018
EC84	BD	EE7E		PRINT MESSAGE 1	ED56	CE	A018		LDX A018
EC87	BD	EE47		GET "FROM" ADDRESS	ED59	BD	EDD5	TAP IN 2	JSR TTY IN
EC8A	FF	A018		STORE ADDRESS	ED5C	A7	00		STA A X
EC8D	CE	ED11		LOAD ADDRESS OF MESS 2	ED5E	08			INX
EC90	BD	EE7E		PRINT MESSAGE 2	ED5F	8C	A022		CPX A022
EC93	BD	EE47		GET "TO" ADDRESS	ED62	26	F5		BNE TAP IN 2
EC96	FF	A01A		STORE ADDRESS	ED64	FE	A018	TAP IN 3	LDX A018
EC99	CE	ED38		LOAD ADDRESS OF MESS 5	ED67	FF	A024		STX A024
EC9C	BD	EE7E		PRINT MESSAGE 5	ED6A	FE	A01A		LDX A01A
EC9F	BD	EE47		GET LENGTH FROM KBD	ED6D	FF	A026		STX A026
ECA2	FF	A01C		STORE LENGTH	ED70	FE	A024	TAP IN 4	LDX A024
ECA5	FE	A01C	S LOOP	LOAD LENGTH	ED73	BD	EDD5		JSR TTY IN
ECA8	27	18		IF ZERO, GO TO EXIT 1	ED76	A7	00		STA A X
ECAA	09			DECREMENT LENGTH	ED78	BB	A023		ADD A A023
ECAB	FF	A01C		STORE LENGTH	ED7B	B7	A023		STA A A023
ECAE	FE	A018		LOAD FROM ADDRESS	ED7E	08			INX
ECB1	A6	00		LOAD CHAR AT FROM ADDRESS	ED7F	FF	A024		STX A024
ECB3	08			INCREMENT FROM ADDRESS	ED82	FE	A026		LDX A026
ECB4	FF	A018		STORE NEW FROM ADDRESS	ED85	09	A026		DEX
ECB7	FE	A01A		LOAD TO ADDRESS	ED86	FF	A026		STX A026
ECBA	A7	00		STORE CHAR AT TO ADDRESS	ED89	26			BNE TAP IN 4
ECBC	08			INCREMENT TO ADDRESS	ED8B	B7	7206		STA A 7206
ECBD	FF	A01A		STORE NEW TO ADDRESS	ED8E	39			RTS
ECC0	20	E3		BRANCH BACK TO S LOOP	ED8F	B7	7205	TAP OUT	STA A 7205
ECC2	20	39	EXIT 1	GO TO EXIT 2	ED92	F7	A022		CLR A022
ECC4	C1	54	T TEST	IS COMMAND T?	ED95	CE	FFFF		LDX FFFF
ECC6	26	35		NO, JUMP TO EXIT 2	ED98	BD	EDF0		JSR DELAY
ECC8	CE	ED20		YES, LOAD ADDRESS OF MESS 4	ED98	CE	A018		LDX A018
ECCB	BD	EE7E		PRINT MESSAGE 4	ED9E	BD	EDE3	TAP OUT 2	JSR TTY OUT
ECCE	CE	A018		LOAD ADDRESS OF START	EDA1	08			INX
ECD1	BD	EEC8		PRINT ADDRESS OF START	EDA2	8C	A022		CPX A022
ECD4	CE	ED38		LOAD ADDRESS OF MESS 5	EDA5	26	F7		BNE TAP OUT 2
ECD7	BD	EE7E		PRINT MESSAGE 5	EDA7	FE	A01A	TAP OUT 3	LDX A01A
ECDA	CE	A01A		LOAD ADDRESS OF LENGTH	EDAA	00			NO OPERATION
ECDD	BD	EEC8		PRINT LENGTH	EDAB	00			NO OPERATION
ECE0	CE	ED48		LOAD ADDRESS OF MESS 7	EDAC	00			NO OPERATION
ECE3	BD	EE7E		PRINT MESSAGE 7	EDAD	27	16		BEW TAP OUT 4
ECE6	CE	A022		LOAD CHECK SUMS	EDAF	09			DEX
ECE9	BD	EEC8		PRINT CHECK SUMS	EDB0	FF	A01A		STX A01A
ECEC	86	04		LOAD A WITH EOT CHARACTER	EDB3	FE	A018		LDX A018
ECEE	B7	A022		STORE EOT AFTER LABEL	EDB6	BD	EDE3		JSR TTY OUT
ECF1	CE	ED40		LOAD ADDRESS OF MESS 6	EDB9	BB	A022		ADD A A022
ECF4	BD	EE7E		PRINT MESSAGE 6	EDBC	B7	A022		STA A A022
ECF7	CE	A01C		LOAD ADDRESS OF LABEL	EDBF	08			INX
ECFA	BD	EE7E		PRINT LABEL	EDC0	FF	A018		STX A018
ECFD	7E	EEE3	EXIT 2	GO TO CONTROL	EDC3	20	E2		BRA TAP OUT 3
ED00	48		MESS 1	H	EDC5	CE	A022	TAP OUT 4	LDX A022
ED01	49			I	EDC8	BD	EDE3		JSR TTY OUT
ED02	46			F	EDCB	CE	FFFF		LDX FFFF
ED03	54			T	EDCE	BD	EDF0		JSR DELAY
ED04	20				EDD1	B7	7206		STA A 7206
ED05	4D				EDD4	39			RTS
ED06	45			M	EDD5	F6	7201	TTY IN	LDA B 7201
ED07	4D			E	EDD8	C5	10		BIT B 10
ED08	52			M	EDDA	27	F9		BEQ TTY IN
ED09	59			R	EDDC	B6	7200		LDA A7200
ED0A	3A			Y	EDDF	B7	7204		STA A 7204
ED0B	46			:	EDE2	39			RTS
ED0C	52			F	EDE3	A6	00	TTY OUT	LDA A X
ED0D	4F			R	EDE5	F6	7201	TTY OUT 2	LDA B 7201
ED0E	4D			O	EDE8	C5	08		BIT B 08
ED0F	20			M	EDEA	27	F9		BEQ TTY OUT 2
ED10	04				EDEC	B7	7202		STA A 7202
ED11	20		MESS 2	END OF TEXT	EDF0	8C	0000	DELAY	RTS
ED12	54			T	EDF3	26	01		CPX 0000
ED13	4F			O	EDF5	39			BNE DELAY 2
ED14	20				EDF6	09		DELAY 2	RTS
ED15	04			END OF TEXT	EDF7	7D	0000		DEX
ED16	4B		MESS 3	K	EDFA	7D	0000		TST 0000
ED17	45			E	EDFD	00			TST 0000
ED18	59			Y	EDFE	20	F0		BRA DELAY

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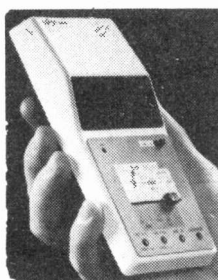
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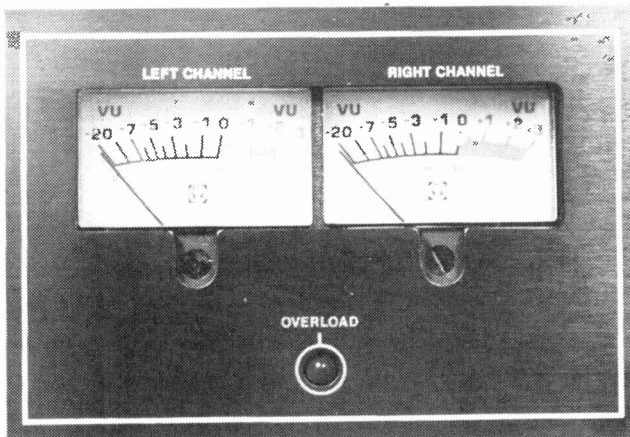
This month Ron Harris lends both ears to the new Koss E-10 electrostatic headphones. Placed at the top of Koss's range, and costing £180 a pair they promise much. Do they deliver? Read on

HEADPHONE LISTENING has much to commend it — isolation from the wallpapered box which produces so much colouration in any loudspeaker system for one thing. Neighbours the world over would be a happier race if we all took to hanging our transducers around our heads instead of knocking down their living-room walls with them.

In terms of absolute quality too, electrostatic (and the better moving coil) units have few if any equals amongst loudspeakers, and their cost will always be lower. So for someone starting down the slippery slope to hi-fi bliss, and who either lives in a flat or yearns for greater accuracy than his budget allows, headphones must provide a serious alternative to those ubiquitous wooden boxes.

Energise . . .

This brings us neatly onto the energiser itself. Superbly finished in black metal with a wood grain panel, the box gives new life to the theory of collapsed matter. For its size it is impossible **heavy**, due of course to the two huge transformers present within. The meter and overload circuitry is contained on a single large PCB, with all connections being made via removable plugs. Although untidy to look at, the internal construction is to a very high standard, and we can envisage no problems being caused here.



Close-up of the clever bits — VU meters and overload indicator LED

Two VU meters are provided to monitor signal level, and these operate in conjunction with the overload LED positioned beneath them. Sockets exist for two sets of phones, and the single on/off switch switches the audio back to the speakers once the headphones are switched off. Back panel connections are by spring terminal, and Koss provide four suitable leads to accomplish this.

In practise the overload facility worked well, cutting

off the audio (and lighting the LED) for about ten seconds once the trigger level is exceeded. This level is represented by full scale deflection on the meters, which appear to leap into the red all too readily! We found the cut-off point to be too low for our liking sometimes, but accept that it is a perfectly good compromise.

On heavy rock signals, with any bass boost all (not needed really — see later!) the overload operated at a level which would not always satisfy the devilish tastes for loudness exhibited in this field. In fairness though this is a minor point, and personally I tend to agree with Koss's choice, as sustained listening at even near maximum allowed level amounts to audio suicide of the eardrums.

Down to sound

Now to the sixty-four thousand watt question — how do they sound? In a word they don't! Without qualification the E10s provided the most neutral and uncoloured sound yet to assail our ears. It was very very easy to forget the phones totally, and listen through to the earlier links of the chain and thus to the music itself, assuming high quality source equipment of course.

Expect no mercy — the E10s will ruthlessly expose shortcomings in anything of lesser stature, be it electronics or records, but their even response means that surface noise is not emphasised unduly as is the case with a rising treble characteristic, and no tonal correction was found necessary at any stage in the listening tests.

Here is a transducer to make you question your ideas of fidelity. All speakers possess a character of their own, and probably the E10s do as well. But this is so inobtrusive as to be negligible — and we've waited a long time to be able to say that about any piece of hi-fi!

Pecuniary conclusions

The only possible drawback to the E10 Auditors is their price — £180 all in for phones, energiser, PSU and leads. Quality never comes cheap of course, but we did wonder how much the meters and associated circuitry added to the price.

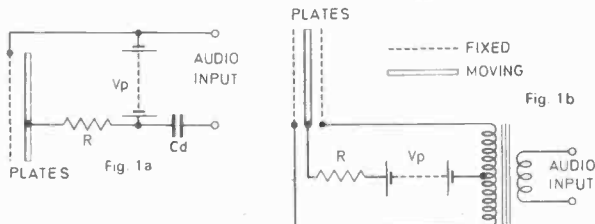
Still, as we said earlier £180 wouldn't buy a pair of loudspeakers in this class, and so maybe we shouldn't quibble — but seeing as how we're at it — how about some more headroom on the overload?

Overall then, the E10s are probably the nearest thing to transparent transducers on the market, but cost is high and heavy rock fanatics who have a thing for un-natural boom in the bass may not be impressed by their lack of colouration in that area. Definitely a connoisseur's item and one that all hi-fi followers should hear at least once!

HOW IT WORKS

Like other electrostatic headphones, the E10 employ the electrostatic push-pull principle. Referring to fig. 1a, the audio is applied across the plates superimposed upon the polarising voltage V_p . Since one plate is fixed and one can move freely, the latter will be vibrated by electrostatic forces much the same as those that hold dust to LPs and LPs to turntable mats. V_p is there to provide an initial displacement about which the audio signal can induce movement. Resistor R loads the polarising signal, and C_d decouples the audio input.

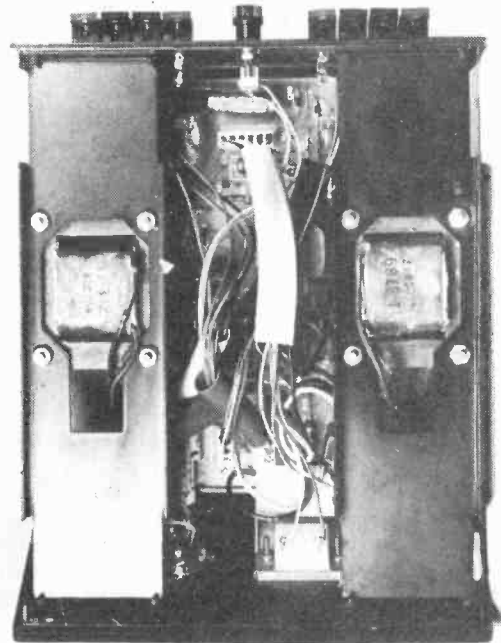
The push-pull design overcomes some of the drawbacks of the basic principle and lowers distortion, especially even harmonics. Fig. 1b shows the basis of the design. A second fixed plate is added, so that the moveable plate sits in a sandwich. The audio signal is fed



in through an isolating transformer, the secondary of which is centre-tapped to provide anti-phase signals for the two plates.

This is the task of the energiser, and those transformers can be a limiting factor in the performance. Koss have made their inductors massive, such that a 20 Hz signal can pass unhindered. (In theory).

In the E10 energiser the overloaded sensing is set to operate at around 5 V (pink noise) signal at the input. This represents around 103 dB SPL at the ears, which explains the Koss setting mentioned in the text. The energiser presents a load to the amplifier which varies in phase angle, linearly, from a $+30^\circ$ at 20 Hz to -30° at 15 kHz and an impedance characteristic with minimum of $3 R$ (20 Hz) and maximum of $180 R$ at 800 Hz



Internal view of the energiser box, note the massive audio transformers.

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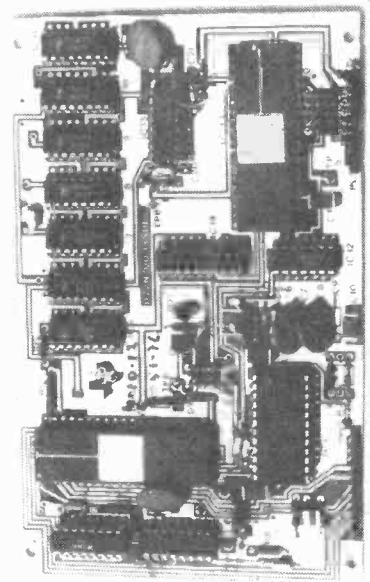
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DIGITAL ELECTRONICS

RIPPLE COUNTERS are useful and simple, but they are not ideal for high counting speeds, nor for large counter chains. The problem arises from the use of the output of each flip-flop as the clock for the next flip-flop, so that changes must "ripple through" all the stages of the counter. This, as indicated in the previous section, causes difficulties with time delays.

Although these delays are not large, perhaps 60 nS or less per flip-flop, they accumulate to a significant amount over a large number of counter stages and can cause the race hazards mentioned earlier.

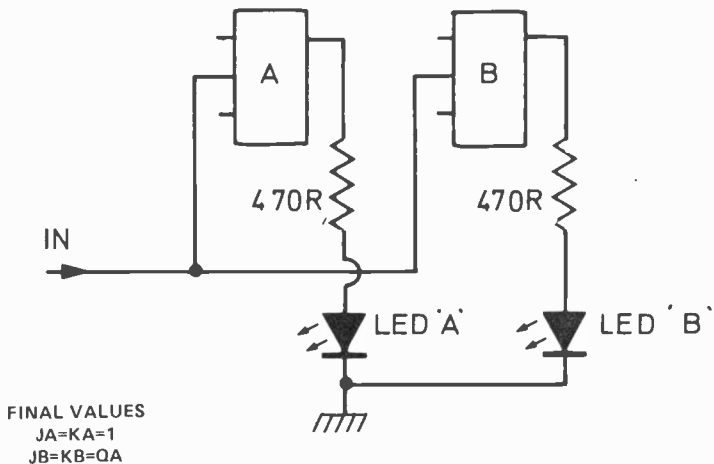
Synchronous Counters

A different principle is used for synchronous counters. The input pulses are used to clock *each* flip-flop of a chain, hence the name synchronous. The count sequence is then determined by voltages applied to the J and K terminals, and these voltages must be obtained in such a way that any given count on the flip-flop will cause the J and K voltages to be set to the voltages needed to change to the next digit up or down.

This is much more easily illustrated by an example which we can test on our board. In this example we shall follow the pattern of design steps (with some modifications) which is usually used for synchronous counters.

Basic Two-Step

Let us imagine a very basic counter using two flip-flops and resetting at the count of four. We must start by making a table showing the count, the present state, and the next state for each flip-flop. This means that for each number of the count we list the value of Q (1 or 0) and also the value to which Q will change at the next count. For example, when the count is 1 (01), the next count is 2 (10) and both outputs will change — A from 1 to 0, and B from 0 to 1. On the next count (3), A changes from 0 to 1, and B does not change. The complete table for two flip-flops is shown in Fig 1(b).



COUNT	A		B		J K VALUES			
	Q PRESENT	Q NEXT	Q PRESENT	Q NEXT	JA	KA	JB	KB
0	0	1	0	0	1	X	0	X
1	1	0	0	1	X	1	1	X
2	0	1	1	1	1	X	X	0
3	1	0	1	0	X	1	X	1

Fig. 1 (Above) A simple synchronous counter, no J-K connections shown.

(a) Circuit. Note that the input clock is taken to each stage.
(b) Table of changes, with J and K values for the changes.

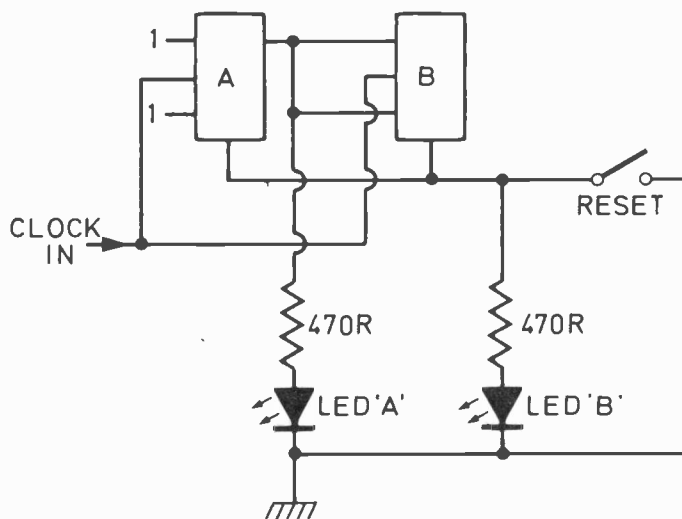


Fig. 2 (Above). Complete two-stage synchronous counter circuit, with J-K connections shown. Try this out on your blob-board.

BY EXPERIMENT PART 6

Now we have to decide what voltages are needed at J and K of each flip-flop to carry out the changes from present state to next state. Here we have some options — for example, if we want to change from 1 to 0, we may have $J=K=1$, or $J=0$ and $K=1$; either state will carry out the change. When this is possible, we can write $J=X$, $K=1$, where X means don't care, since either value of J is equally suitable.

Add more columns to the table to indicate these values of J and K for each flip-flop, and we are ready to start designing. The object now is to obtain the J and K voltages for each flip-flop from somewhere else in the circuit in such a way that all the J and K voltages are correct for each stage of the count. The formal method of doing this involves a technique called *Karnaugh mapping*, but is seldom necessary for only a few counter stages. It is rather difficult to apply for a large number of stages, so only the 'intuitive' look-and-see method will be discussed here.

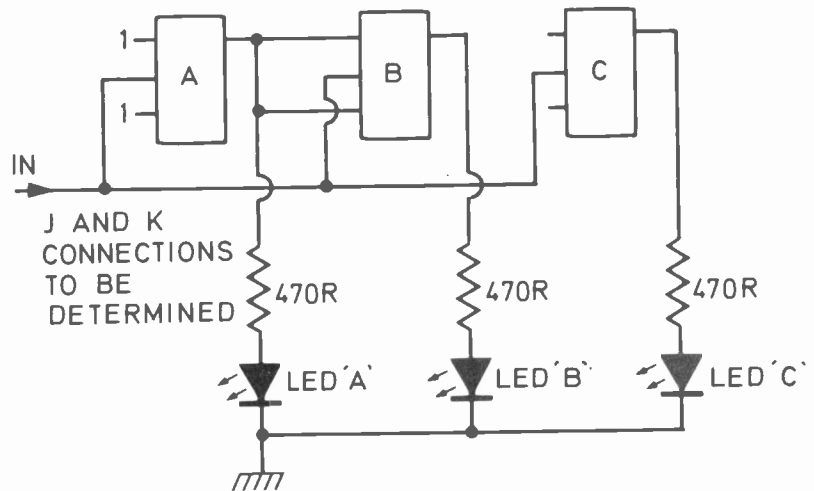
Table Talk

At the zero count, $Q_a=0$, $Q_b=0$ and the change at the end of the clock pulse will be from $Q_a=0$ to $Q_a=1$. This will happen if $J_a=1$ and for $K_a=0$, or $K_a=1$. We therefore fill in a 1 in the J_a column, and an X (either value) in the K column.

Still at the zero count, $Q_b=0$ and does not change at the end of the clock pulse. This can be done if $J_b=0$, $K_b=X$, so that these values 0 and X appear in the J_b and K_b columns.

These columns are filled in, similarly for each change listed — remembering to use X in any case where a value is unimportant — using the J-K table that we used in Part 4 of this series of articles.

We can now inspect the complicated tables to see if any values can be fixed or derived from values of Q_a or Q_b . The tables for J_a and K_a are easily dealt with — since the values are either 1 or X, we can use 1 for all these values, and make $J_a=1$, $K_a=1$, as



COUNT	PRESENT			NEXT			J _A	K _A	J _B	K _B	FIRST		FINAL	
	Q _A	Q _B	Q _C	Q _A	Q _B	Q _C					J _C	K _C	J _C	K _C
0	0	0	0	1	0	0	1	1	Q _A	Q _A	0	X	0	0
1	1	0	0	0	1	0	1	1	Q _A	Q _A	0	X	0	0
2	0	1	0	1	1	0	1	1	Q _A	Q _A	0	X	0	0
3	1	1	0	0	0	1	1	1	Q _A	Q _A	1	X	1	1
4	0	0	1	1	0	1	1	1	Q _A	Q _A	X	0	0	0
5	1	0	1	0	1	1	1	1	Q _A	Q _A	X	0	0	0
6	0	1	1	1	1	1	1	1	Q _A	Q _A	X	0	0	0
7	1	1	1	0	0	0	1	1	Q _A	Q _A	X	1	1	1

J_C=Q_A AND Q_B
K_C=J_C

Fig. 3 (Above). A three-stage synchronous counter.

Top: (a) Circuit, J and K connections still to be determined.
Bottom: (b) Table of changes, showing how J and K values are determined.
The "first" J_C-K_C table shows possible values of J_C and K_C, the "final" table shows the most convenient values to use.

for the ripple counter. The J_b , K_b tables are slightly more involved, but for each definite value of one quantity (J or K) there is an X for the other, so that we can again connect J and K. We then find that the values of J and K are identical to the values of Q_a , so that J_b and K_b can be connected to Q_a .

For practical work on synchronous counters it is useful to have a clock pulse line, and one of the spare lines on the board can be used. Connect up the circuit as shown, with a slow clock pulse taken to each clock input, and wire connections linked from Q_a to J_b and K_b . Use LEDs as before to check the state of each flip-flop output. Connect a common reset line to each flip-flop and to a switch so that the

counter can be reset. Switch on and check that the count is correct and that resetting to zero is possible.

Third Stage Development

Let us now extend this to a third stage, building on what we have done before. Once again we can build up a table of values of Q, J and K for each stage, but we have made life easier for ourselves by having done the two stage counter, so we can ignore the J_a , K_a and J_b , K_b columns and concentrate on the J_c , K_c column.

Using the same principles as before, we fill in the values of J and K which will be needed at each clock pulse or flip-flop, concentrating on the necessary values, and putting an X

where the value is immaterial. When we do this (Fig. 3b) we find two important states. One is at the count of 3, where Jc must change from 0 to 1; the other is at the count of 7 when Kc similarly changes from 0 to 1.

The change of Jc from 0 to 1 occurs when the count changes to 110 so that we could use an AND gate connected to Qa and Qb. The output of this gate will be zero for any count up to 2 and then will be 1 at a count of 3. It will change to zero again to become 1 at the count of 7, but the value of Jc is unimportant beyond the count of 3 anyway.

Looking at Kc we find that the important value of 1 occurs at a count of seven when Jc may also be 1. We can therefore connect Jc and Kc together and feed from an AND gate supplied with Qa and Qb.

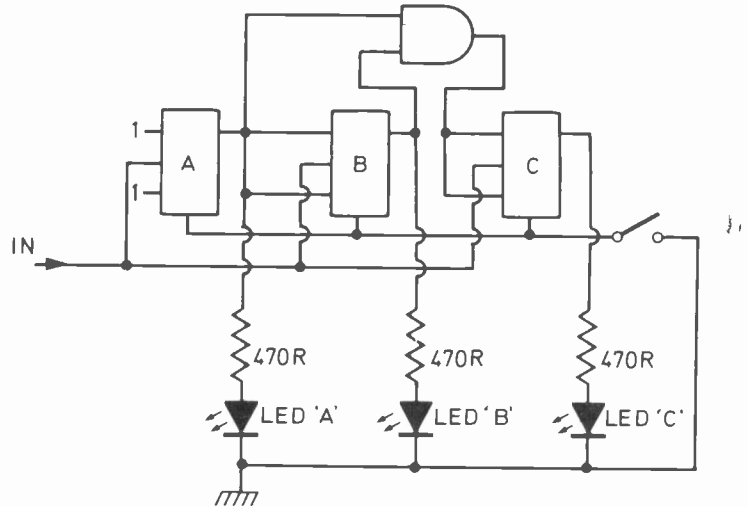


Fig. 4 (Above). The circuit of the three-stage synchronous counter. Try this out on your blob-board.

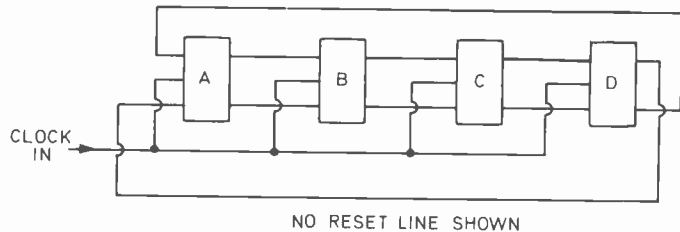
Third Stage On Board

Making up a three-stage synchronous counter on the circuit board needs some additional connections. Since we are not using AND gates, the gate used will have to be made up from a NAND gate and an inverter. As the 7400 contains four two-input NAND gates and the 7414 contains six inverters, one of which is used for the clock oscillations, there is no shortage of gates. We are working with a low frequency clock, so there should be no ill-effects caused by the number of wires soldered across the board, but a high speed counter would have to be built on a PCB designed for the purpose, using copper tracks on each side and with decoupling capacitors between +ve and -ve lines close to each flip-flop. Such PCBs can be made up quite rapidly by using the new sketch'n'etch technique (P.B. Electronics) for one-off PCBs.

Can you now go one step further to design a four stage synchronous counter and try it out on the board?

Twisted Logic

A different type of synchronous counter is shown in Fig. 5. This is a Johnson, or 'twisted-ring', counter and consists of four flip-flops connected so that the output of one drives the J and K inputs of the next. Three of the connections are made up with Q to J and \bar{Q} to K, but the feedback connection is made with Q to K and \bar{Q} to J — hence the alternative name of twisted-ring. Remembering that \bar{Q} is always the inverse of Q, can you plan out the values of Q and \bar{Q} for each counter? Use the table headings



CLOCK	JB QA	$\bar{K}B$ $\bar{Q}A$	JC QB	$\bar{K}C$ $\bar{Q}B$	JD QC	$\bar{K}D$ $\bar{Q}C$	KA QD	JA QD
0								
1								
2								
3								
4								
5								
6								
7								

Fig. 5. A Johnson counter of four stages.

Top: (a) The circuit, note the "twisted ring" connection.

Bottom: (b) Table to complete so that the counter action can be predicted.

Below: (c) Truth table. Build the circuit on your blob-board and complete this table.

shown in Fig. 5(b) and remember that Qa = Jb, Qb = Jc, Qc = Jd, Qd = Ka and so on.

A Johnson counter uses a completely different count sequence from conventional binary counters, and the maximum count number is twice the number of flip-flops. The counters are synchronous, very easy to design and also very simple to decode for use with lamp indicators.

Build up the four stage (count of 8) Johnson counter of Fig. 5(c) on your circuit board and check that your calculations are correct.

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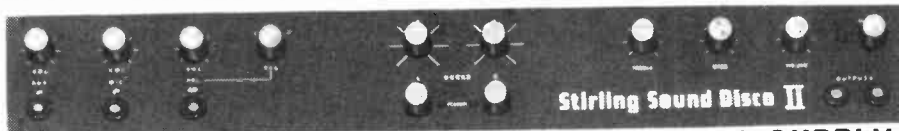
To be continued

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1				
2				
3				
4				
5				
6				
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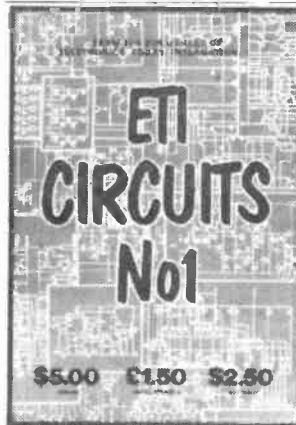
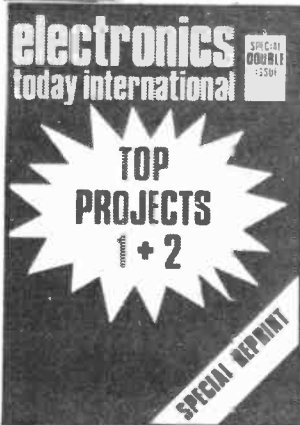
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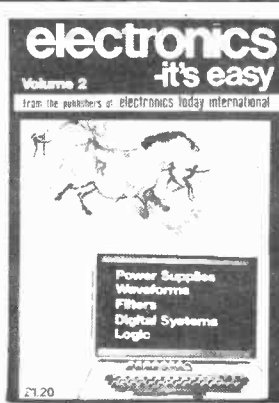
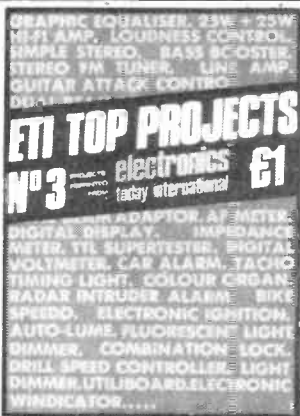
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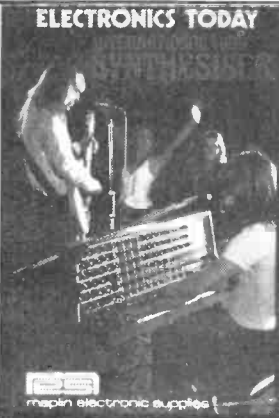
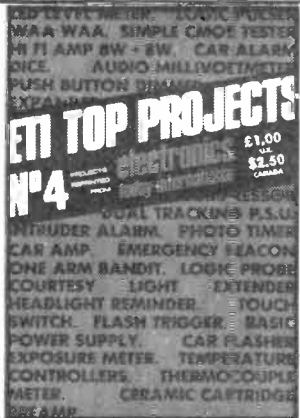
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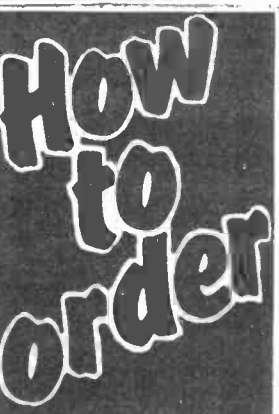
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microfile.....

Gary Evans looks at a couple of earth bound micro systems and then journeys to a stella system for a game of intergalactic proportions.

THE FIRST ITEM WE look at is from a company thought by some to like the cloak and dagger game, but then so do quite a few semiconductor manufacturers, Science Of Cambridge — don't mention Sinclair. At the time of going to press they have just launched their MK14 with an advertisement in a magazine that is generally not associated with a dedicated commitment to micros.

SCAMP and Chips

The MK 14 is described as a keyboard addressable microprocessor. At a price of just under forty four pounds one might not expect all that much but the SCAMP based system provides a hex keyboard, eight digit LED display, 512 bytes PROM with resident monitor, 256 bytes of RAM together with 4MHz crystal plus power supply stabiliser.

I do not have much information of the MK14 and so I can say nothing about the versatility of the monitor, the ease with which the system can be extended, the quality of the documentation and any number of other interesting topics.

The MK14 comes as a thirty-one piece kit and is, apparently, available now. At just less than forty four pounds this kit should, if nothing else, provide the cheapest way of getting hands on experience with a micro which, in my opinion, is the only way to understand these little fellows.

Before leaving the MK14 it is interesting to note that Science Of Cambridge have chosen the National SCAMP as the heart of their system. This device has been overshadowed by the likes of the 8080, 6800 and lately the Z80. Suffering as it does from a limited instruction set, lack of many on board registers, limited addressing modes and inability to handle stacks it is fair to say that the reception afforded to this MPU by the OEM boys was less than enthusiastic. Despite large campaigns to try and rekindle interest in this area it seems that National are resigned to the fact that SCAMP will forever be known as a Simple Cost effective AMateur Processor.

The fact that demand for the SCAMP has not been overwhelming of late means that there should be plenty of stocks of this device and hopefully Science Of Cambridge will have no supply problems with the MK14.

Zee Micros Mit Z80

Another product launched recently is the latest in micro-computers based on the Z80. The system, from the Micros company, costs £550 and includes a Z80 CPU, monitor in ROM, 2K bytes of RAM, audio cassette interface, video monitor interface, UHF TV modulator,

53 key contactless ASC11 keyboard, power supplies and cabinet. Doesn't sound too bad does it.

The company has under development a BASIC compiler, teletext decoder (I would like to see that — it seems such an obvious move) and a selection of games.

My appetite has been wetted by the above description and I shall try to bring you more information plus photos next month.

Meanwhile, if you want further details contact Micros at 1 Station Road, Twickenham, Middx.

Star Software

Until now there does not seem to have been much point in publishing programs in anything other than the machine language of anything but the most popular of micros. However, the arrival of a range of systems with a BASIC interpreter resident on our market would seem to indicate that there will soon be a demand for programs written in this high level language.

We have been sent a BASIC program which, although too long to publish in full, I feel might be of some interest to many of you. The program provides the opportunity for you to emulate my current hero, that handsome clean cut Luke Skywalker, from the film Star Wars. In case you have been off planet for the last year or so I'll sum up the story for you.

Good guys beat up bad guys. ▶

ZWAM!
ZWAM!



```

10 FOR I=1 TO ...
11 PRINT ...
12 PRINT ...
13 PRINT \ PRINT ...
14 PRINT "DO YOU WANT INFORMATION ABOUT ...
15 PRINT \ PRINT ...
17 N1=-49 \ N2=-19 \ N3=-01
20 A4$="HEADING"
50 A4$="SHIP ATTITUDE (PITCH)"
70 A6$="CHANGE"
95 G1$="NO" THEN GO TO 150
100 IF K$="NO" THEN GO TO 150
101 PRINT "YOU ARE THE PILOT OF A REBEL X-WING FIGHTER, CARRYING"
102 PRINT "A PROTON TORPEDO WHICH TO ATTACK THE GIANT ARTIFICIAL"
103 PRINT "PLANET, THE DEATHSTAR, THAT THE TYRANT, GRAND MOFF TARKIN"
104 PRINT "IS USING TO TERRORISE THE GALAXY. YOUR OBJECTIVE IS TO FLY"
105 PRINT "TO A TRENCH IN THE SURFACE OF THE STAR, FLY ALONG IT AND LAUNCH"
106 PRINT "THE TORPEDO THAT WILL DESTROY THE DEATHSTAR"
107 PRINT "AT THE NEAR END OF THE TRENCH, WHICH IS 2000 METRES LONG"
108 PRINT "BY 35 METRES WIDE, IS YOUR FIRST TARGET POINT, A RECTANGLE"
109 PRINT "30 METRES WIDE AND 100 METRES LONG CENTRED ON THE CO-ORDINATES"
110 PRINT "X=0, Y=0. IN ORDER TO CALIBRATE YOUR SHIP'S MISSILE LAUNCH"
111 PRINT "SYSTEMS, YOU MUST FINISH A MANOEUVRE WITHIN THIS AREA BEFORE"
112 PRINT "ENTERING THE TRENCH."
113 PRINT "YOUR FIGHTER HAS A WINGSPAN OF FIVE METRES, THEREFORE"
114 PRINT "YOU MUST FLY WITHIN THE LAST 2000 METRES OF YOUR ATTACK. IF"
115 PRINT "(THE Y-AXIS) FOR THE END OF THE TRENCH, THE LOWER"
116 PRINT "TARGET, AND BELOW THE TORPEDO YOU STAY IN THE TRENCH, THIS STARTS AT 200"
117 PRINT "WILL RELEASE THE LONGER YOU STAY IN THE TRENCH, YOUR POSITION"
118 PRINT "NOTE! THE LONGER YOU STAY IN THE TRENCH, YOUR POSITION"
119 PRINT "THE CRITICAL ALTITUDE BECOMES, TO ASSIST YOU, YOUR POSITION"
120 PRINT "METRES, SO GET LOW, FAST, AIRSPEED, RANGE AND BEARING TO"
121 PRINT "ON THE X-Y GRID, HEADING, AIRSPEED, RANGE AND BEARING TO"
122 PRINT "TARGET (TO THE CENTRE OF THE CALIBRATION RECTANGLE) ARE GIVEN."
123 PRINT "AT THIS POINT YOU MUST BE BELOW 200 METRES, HEADING ON A"
124 PRINT "COURSE OF NOT MORE THAN +/- 5 DEGREES."
125 PRINT "YOU CONTROL YAW AND PITCH YOUR SHIP. <0.5, AND THE"
126 PRINT "THROTTLE 0.5 WILL ACCELERATE YOUR SHIP. <0.5, AND THE"
127 PRINT "DEATHSTAR DEFENCE SCREENS WILL SLOW YOU DOWN."
128 PRINT "YOU ARE FLYING ON A HEADING OF 0 DEGREES AT POSITION"
129 PRINT "X=200, Y=-15000. \ PRINT \ PRINT \ PRINT \ PRINT"
130 PRINT "10000 METRES. \ PRINT \ PRINT \ PRINT \ PRINT"
    
```

Fig. 1. An extract from Robin Hill's Star Wars program (this talented lad was also responsible for the cartoon). The full BASIC program is available from ETI.

The game program simulates the final bust up that involves a pilot (you) taking his (space) ship down a narrow channel at a (critical) high speed the aim being to release a bomb at the end of the channel at the precise moment in time that will cause it to enter a narrow shaft. While trying this manoeuvre you can expect to be shot at. We have only room to show a brief extract from the program, if you want the whole lot please send 25p in

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4-7pf	27pf	150pf	1000pf	3900pf	
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6	14p	18p	18p
7	14p	18p	18p

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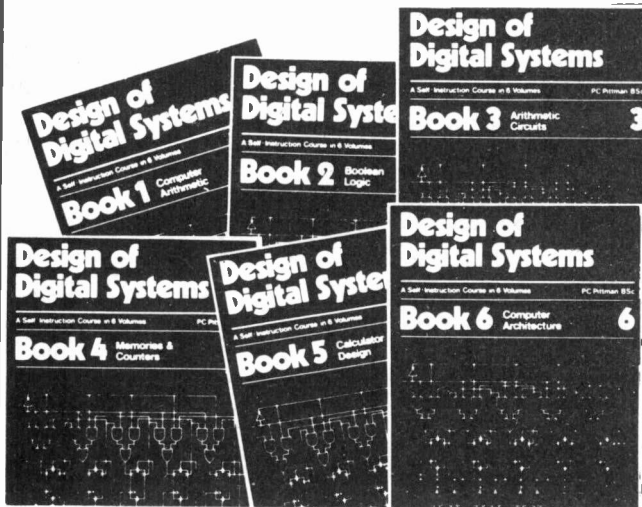
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SIT up its the COPS

Regular readers will be able to cast their minds back to the MM57109 calculator chip mentioned a few months ago. This was a programmable calculator chip which could be interfaced to PROM, RAM, LEDs and Flags as well as to an MPU. Well, the MM57109 was part of the Calculator Oriented Processor System (COPS) from National Semiconductor. Two new COPS based chips have now been announced which use calculator style logic to give complex timing applications a new simplicity.

STAC (Standard Timer And Controller) is a 28 pin IC which uses a calculator style keyboard and LED readout to perform the functions of a digital clock and appliance timer. Typically STAC is connected to a 10 position keypad and a four digit LED display. The chip will run from 50 or 60 Hz and in 7 or 8 day cycles. The keys allow fast and slow setting of time and day and alarm times, manual over-ride, test mode and data entry mode.

Alarming Facilities

STAC is basically a four digit mains driven clock which operates from a low power supply of about 9 volts. The first obvious additional feature of STAC is that it has four alarm times and four alarm outputs, but that's not all. At each alarm time each of the four alarm outputs may be switched on, off or left as it is. One of the problems of a central heating system is that at the end of an ON cycle the main tank is full of hot water which will not get circulated as the pump is turned off with the water heating system. With STAC you could program the boiler to turn off at 10.00 but the pump to continue circulating the heated water until 11.00. In this application the boiler could be connected to STAC output 1 and the pump to STAC output 2, your anti-burglar lights are controlled by STAC output 3 and your morning 'wake-up' alarm by STAC output 4.

So far STAC seems to be quite a nice home timing system except that you may not want the anti-burglar lights on every night, perhaps only on Fridays and Saturdays when you are usually out. Similarly you do not want the alarm to wake you on Saturdays and Sundays. No problem for STAC, it has a day counter (1-7 or 1-8) and the facility to switch as per program each day or to ignore switching and simply perform as a clock. This facility opens up applications which should be familiar to many schools and Open University students. Now you can go away for the weekend and program STAC to record your TV or Radio lessons at 10.30 on Friday night and 6.30 on Sunday morning (especially if one is

radio and the other TV). STAC will turn on the radio at 10.25 on Friday, the tape at 10.29, TV 6.25 Sunday and TV recorder at 6.29.

Standard Interval Timer (SIT)

The second COPS based chip is called SIT and like STAC uses the mains frequency, simple power supply, keyboard and display. With SIT the features include 99 hr, 59min, 59.9 secs timing range; count up or down; metronome and relay driver outputs; sequential cycling and 4 event stopwatch mode.

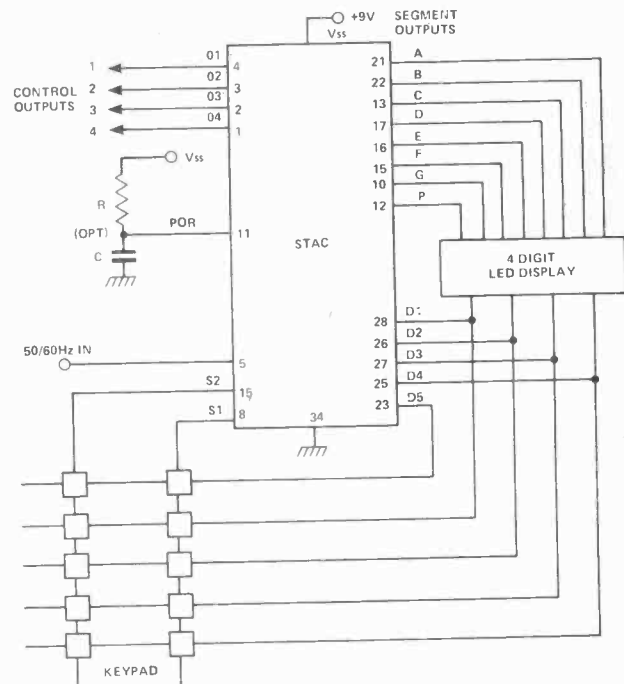


Fig. 1. Typical STAC circuit

The timing period data is entered from a numeric keyboard which is also used to enter commands to indicate up/down counting, stopwatch or timer mode, RUN, CLEAR and HOLD commands.

Keying 'RUN' places the working register on the top of the four entry stack and then rolls the stack to the next entry and the count continues. Thus the last four times at which RUN was enabled are stored for viewing.

'SEQ' is similar to RUN except when pressed the working register is cleared at each enable time. Thus the stack contains the last four times between SEQ enables.

'HOLD' operates in one of two ways depending on whether RUN or SEQ initiated the operation. In either mode it does whatever is required by RUN or SEQ and then stops the count after rolling the stack and clearing the working register if required. The unit will now wait for the next operation of RUN or SEQ.

Four indicator lines are available to show when the stack is at entry a, b, c, or d, each of these lines can directly control an LED lamp. These outputs are also useful in the timing sequence mode to provide activation signals to external equipment.

For further details of STAC, SIT or other COPS chips contact National Semiconductor at 19 Goldington Rd, Bedford. The chips should cost under £10 each and may be available from National outlets.

ETI

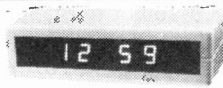
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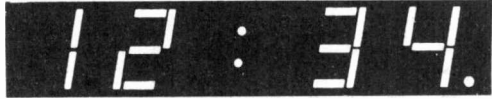
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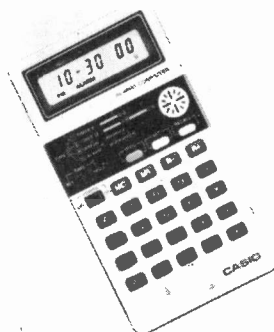
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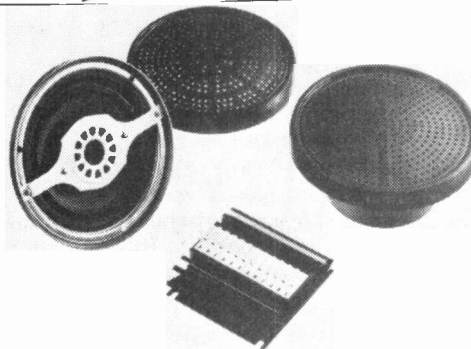
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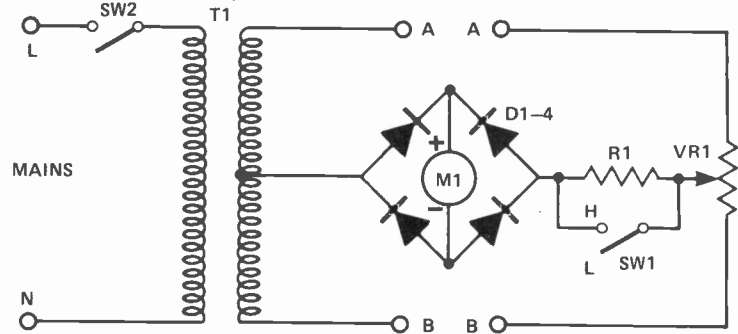
Capacity checker

D. Chivers.

This bridge was originally designed to find values for odd, unmarked or undecipherable capacitors. While not being of great accuracy, it does give a very good indication as to the value of the capacitor.

A known value component is placed across terminals A-A, polarity is not important, but polarised capacitors must not be used, and cannot be tested. The capacitor under test is inserted in B-B, the unit is switched on and VR1 rotated until a maximum value reading is obtained on meter M1. At this point, a reading is taken from the calibration scale on the pot which initially must be calibrated in ratios, ie:

1000:1, 100:1, 10:1, 1:1, 1:10, 1:100 etc. The unknown value is then calculated from this reading. Original calibration is from known values.

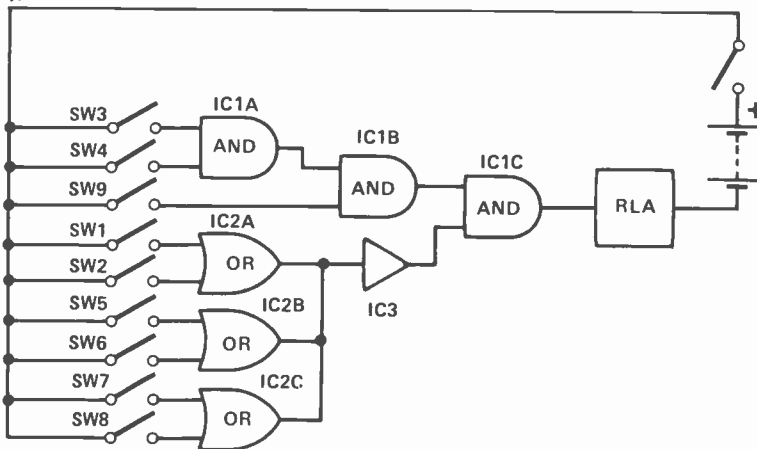


	H	L
10n	X	
100n	X	X
1u		X

M1 = 100uA
D1-4 = 1N4001
R1 = 25k
VR1 = 10k Lin
T1 = 240V/3V-0-3V

To increase the range of the circuit switch SW1 has been included to bypass R1. Since the frequency used is 50 Hz from the mains, ranges are limited; if

another source were used, driving an audio output transformer, the versatility of the unit would then be further increased.

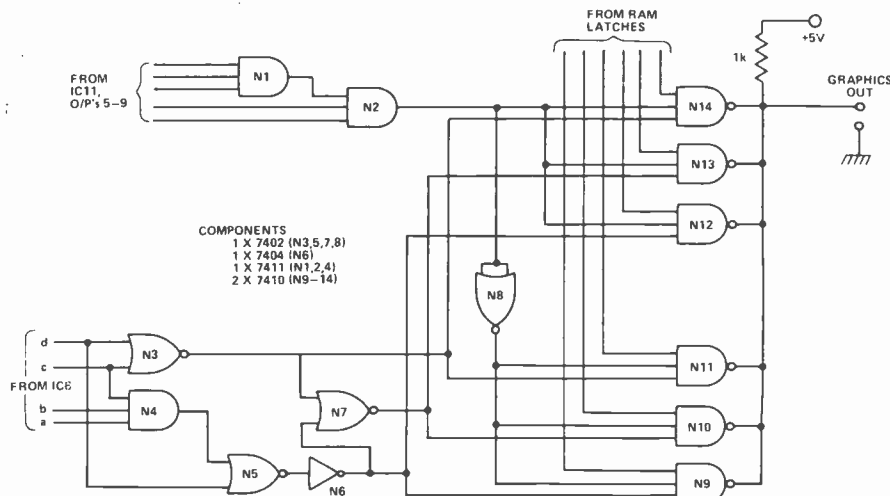


Selective alarm controller

S. Butler.

This circuit provides greater versatility than the simple "in-series" switches mode of alarm, but is still cheap and easy to build.

When SW3 and 4 are closed, the output of the AND gate goes high. This high is fed to the second AND gate only when SW9 is pressed. The output of this gate goes high and providing no other switches are pressed, it will operate the relay: if any other switches are pressed, the OR gives an output to the inverter and cuts off the power to the AND gate, preventing the coil being energised.

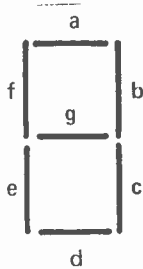


Seven to binary with a special bit!

T. Nash.

This circuit, which uses only four TTL or CMOS ICs, converts a seven segment digit to binary, with indication of the 'special' characters: minus, E (exponent or overflow), and optionally blank. Both types of 6, 7 & 9 can be handled, and for ease of manipulation blank is encoded as binary zero.

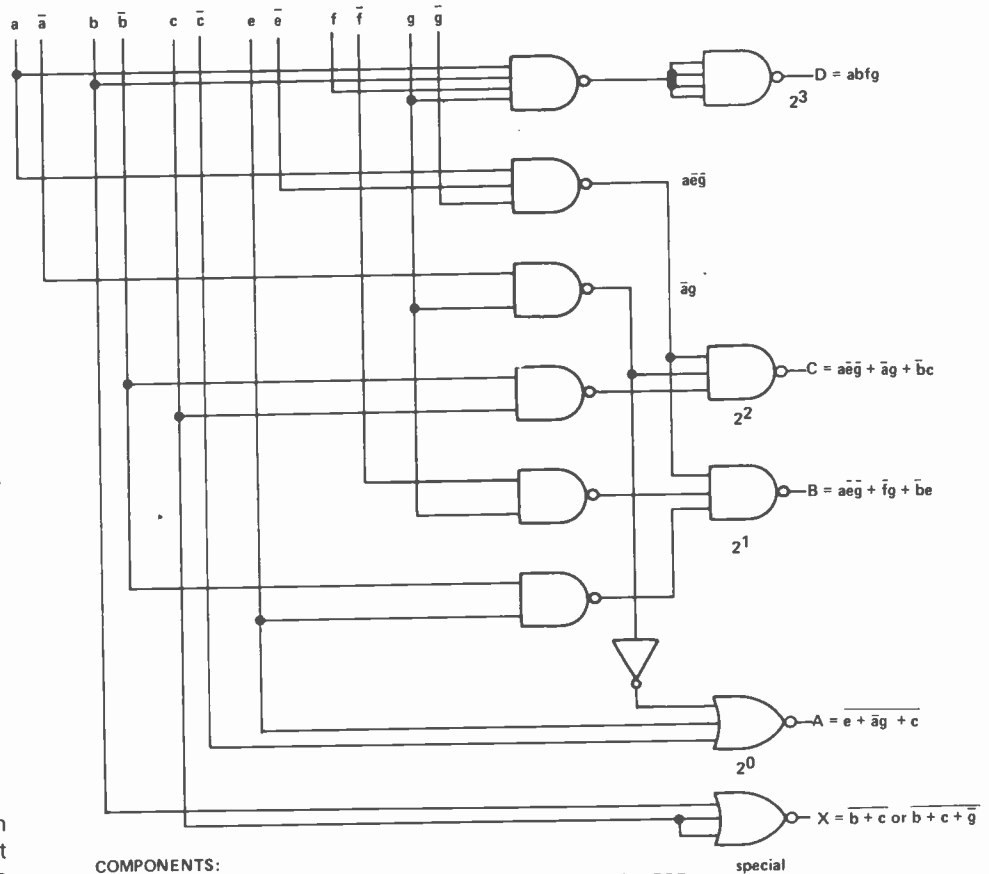
For a calculator - microprocessor interface the 'X' output should be fed to the sign position for ease of testing; this method is more economical in time and memory space than testing for a specific binary value. The extra bits needed for the equivalent ASCII character could also be added at the interface.



The segment identification shown above is the standard seven segment lettering system and so should be familiar to most constructors.

The letters also refer in this case to the circuit diagram and the truth table given below on the right hand side of the page.

No power supply connections are shown for the circuit as this depends on which version, TTL or CMOS is constructed.



COMPONENTS:

- 1 x 7400/4011
- 1 x 7410/4023
- 1 x 7420/4012
- 1 x 7427/4025/4000 (4000 SHOWN)

FIRST VARIATION SETS X FOR BLANK, SECOND DOES NOT.

* FOR TTL AND 4025 VERSIONS, use 3 input nor.

SEE DIAGRAM

TRUTH TABLE

7-SEG	a	b	c	d	e	f	g	D	C	B	A	X
BLANK	0	0	0	0	0	0	0	0	0	0	0	*
0	1	1	1	1	1	1	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	1	0
2	1	1	0	1	1	0	1	0	0	1	0	0
3	1	1	1	1	0	0	1	0	0	1	1	0
4	0	1	1	0	0	1	1	0	1	0	0	0
5	1	0	1	1	0	1	1	0	1	0	1	0
6	0	0	1	1	1	1	1	0	1	1	0	0
7	1	0	1	1	1	1	1	0	1	1	0	0
8	1	1	1	0	0	0	0	0	1	1	1	0
9	1	1	1	1	0	0	1	0	1	1	1	0
-	0	0	0	0	0	0	1	0	1	1	1	1
E	1	0	0	1	1	1	1	0	0	1	1	1

Graphics for the 560 VDU

M. Jackson

This circuit can be added to the 560 VDU published in ETI in September 1976 to allow the display of simple graphics. The rows and columns of each character position are gated by, N1 to N8 to make up the graphic character sections. This information is ANDed with the RAM data to determine whether or not a particular section is on or off.

The graphics/character selection may be controlled by the spare bit in RAM after it has been latched.

Note: RCLK must be disconnected otherwise blank lines will appear in the graphics display.

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Channel splitter for radio control

G. Bathe.

This circuit is designed to replace the electromechanical reed units used as channel-splitters in radio controlled models.

The circuit is based on the MC 1310P integrated circuit, a chip that is primarily a stereo decoder for use in stereo radio tuners. When used as a stereo decoder, the MC 1310P automatically switches itself from the mono mode to the stereo mode whenever its input contains the 10 kHz subcarrier of a stereo multiplex signal at a sufficiently high level (16 mV), and switches back to the mono mode when the 19 kHz subcarrier ceases to be present. Pin 6 of the integrated circuit drives a stereo indicator lamp to give a visual indication of whether the circuit is operating in the stereo or mono mode.

It is this lamp driver facility of the MC 1310P that makes it an ideal chip to use as a channel-splitter. When used as a channel-splitter the circuit is not tuned to the 19 kHz of the stereo decoder but to the audio frequency that the circuit is required to detect, and the lamp driver output from pin 6 is used to drive a power transistor controlling a motor or other device.

The output from the detector of a radio receiver is amplified by the BC 108 and then fed into a series of MC 1030P channel-splitters (connected in parallel) each tuned to a different audio frequency.

The audio frequency to which the channel-splitter responds is determined by the tuning circuit R1, VR1 and C1, and is given by the formula:-

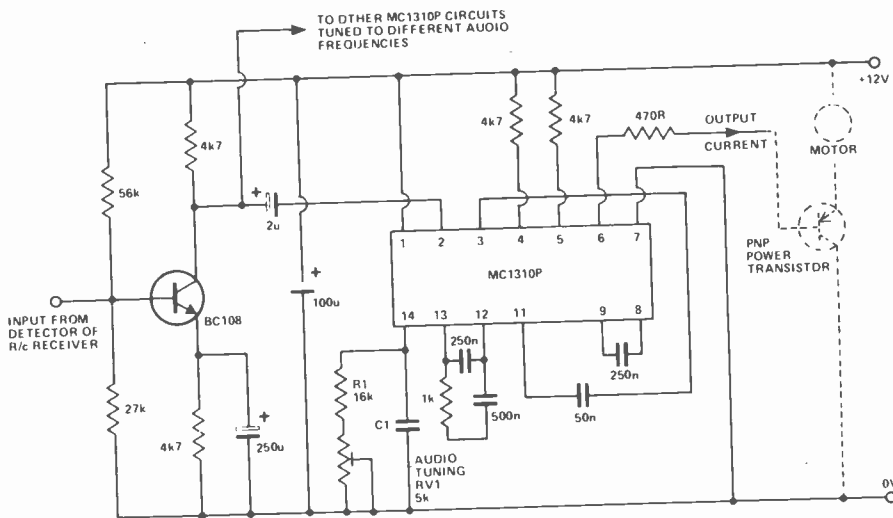
$$f = \frac{1}{2\pi C_1 (R_1 + RV_1)} \text{ Hz}$$

The value of C1 is chosen to give the required tuning range for the preset RV1. For example, if C1 is 10,000 pF, then the tuning range is approximately 750 Hz to 1,000 Hz.

The output is a switched current output between Pin 6 of the chip and the positive supply rail. This current should not exceed 35 mA and so a 470 ohm resistor is inserted in the output connection from Pin 6 as short circuit protection. If a voltage output is required then a resistor can be connected from Pin 6 to the positive supply and the voltage output taken from Pin 6.

The MC 1310P is triggered when the input to Pin 2 contains its tuned frequency at a level greater than 16 mV. It can be triggered by noise if the noise level is greater than 16 mV. Some radio control transmitters tend to transmit noise when they are not transmitting a

tone, and if this is the case the transmitter should be modified to prevent noise being transmitted. This could be done by making the transmitter transmit an extra unused tone whenever it is not transmitting one of the used audio tones.



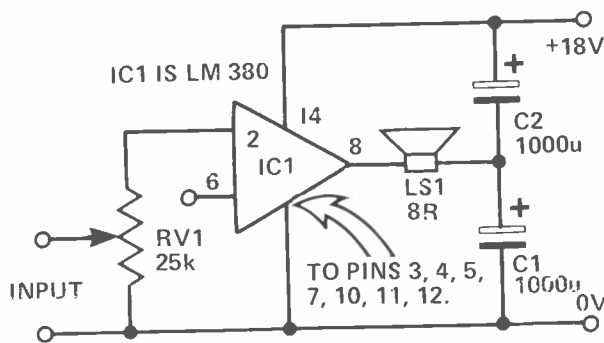
Novel loudspeaker coupling circuit

P. Mills.

In most amplifier designs the speaker is fed by a high value capacitor to provide DC blocking, but this may result in a heavy switch-on surge, as the capacitor charges up.

An alternative approach, which is worthy of experiment, is shown in the diagram below. Here the ground side of the speaker is connected to the junction of two equal high value capacitors (1000 uF is typical), across the supply.

The amplifier output voltage will be at $V_s/2$, and so will the voltage across C1 (if C1 and C2 are equal); so as the supply voltage builds up, the DC voltage across the speaker will remain zero, eliminating the switch-on surge. C1 and C2 will also provide supply smoothing. The circuit is shown with the LM380, but could be applied to any amplifier circuit, providing that the DC voltage at the output is half the supply voltage.



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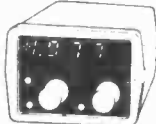
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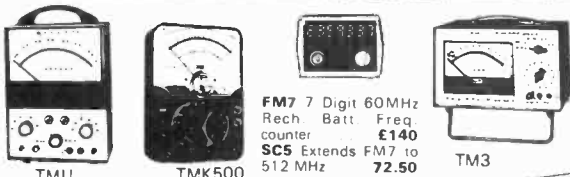
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FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo

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 47k Ω at 1kHz

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

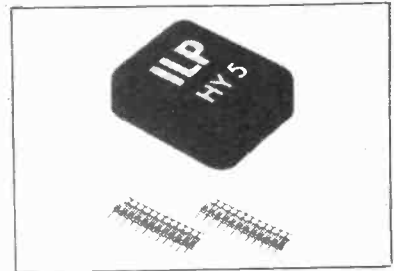
ACTIVE TONE CONTROLS: Treble \pm 12dB at 10kHz Bass \pm at 100Hz

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

OVERLOAD: 38dB on Magnetic Pick-up **SUPPLY VOLTAGE:** \pm 16 50V

Price £5.22 + 65p VAT P&P free

HY5 mounting board B1 48p + 6p VAT P&P free.



HY30 15 Watts into 8 Ω

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

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

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

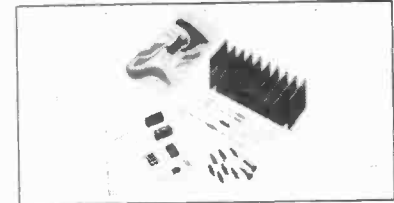
SPECIFICATIONS:

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

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

SUPPLY VOLTAGE: \pm 18V

Price £5.22 + 65p VAT P&P free.



HY50 25 Watts into 8 Ω

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

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

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

SPECIFICATIONS: **INPUT SENSITIVITY:** 500mV

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

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

SUPPLY VOLTAGE: \pm 25V **SIZE:** 105.50 x 25mm

Price £6.82 + 85p VAT P&P free



HY120 60 Watts into 8 Ω

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

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

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

SPECIFICATIONS:

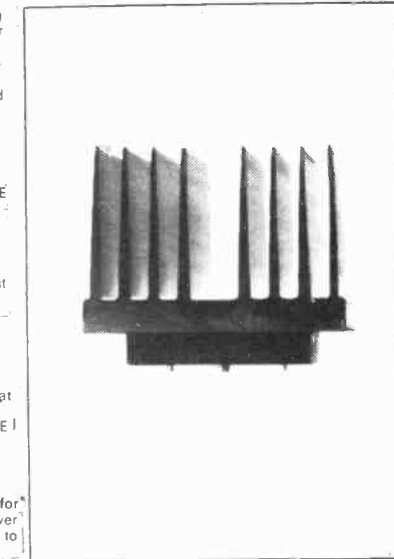
INPUT SENSITIVITY: 500mV

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

SIGNAL/NOISE RATIO: 90dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:** \pm 35V

Size: 114 x 50 x 85mm

Price £15.84 + £1.27 VAT P&P free.



HY200 120 Watts into 8 Ω

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

FEATURES: Thermal shutdown — very low distortion — Load line protection — Integral Heatsink — No external components

APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address

SPECIFICATIONS:

INPUT SENSITIVITY: 500mV

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

SIGNAL/NOISE RATIO: 96dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:** \pm 45V

SIZE: 114 x 100 x 85mm

Price £23.32 + £1.87 VAT P&P free.

HY400 240 Watts into 4 Ω

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

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

APPLICATIONS: Public address — Disco — Power slave — Industrial

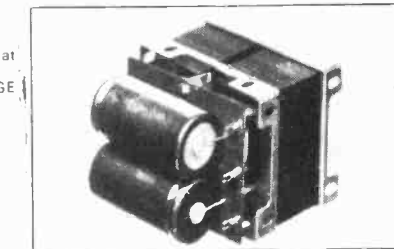
SPECIFICATIONS:

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

SIGNAL/NOISE RATIO: 94dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:** \pm 45V

INPUT SENSITIVITY: 500mV **SIZE:** 114 x 100 x 85mm

Price £32.17 + £2.57 VAT P&P free.



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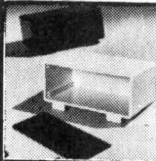
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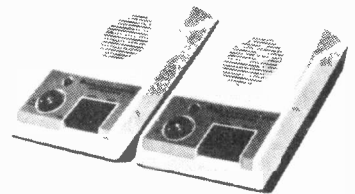
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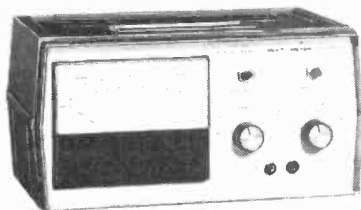
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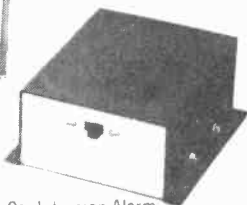
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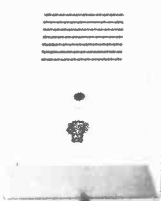


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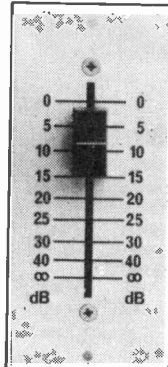
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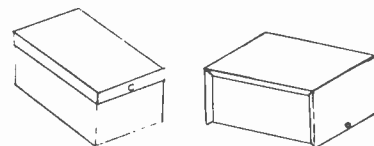
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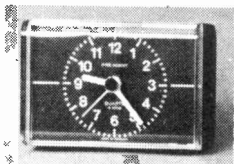
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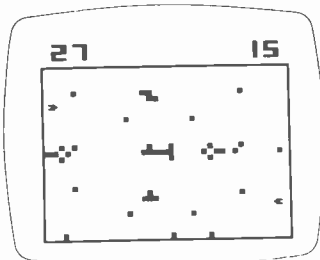
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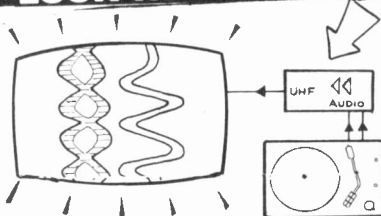
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Ace	36	Marshalls	18
Airamco	65	Metac	36
Ambit	76	Mini-Kits	12
Audio Electronics	82	Mountiandene	12
Bamber	30	Sentinel Supply	90
Baron	8	Sintel	76
Baydis	8	Sterling Sound	69
Bi-pak	4 & 5	Surefire	65
Bywood	6 & 25	Swanley	12
Cambridge learning	24	Technologies	86
C. N. Stevenson		Techomatic	35
Chiltmead	58	Telecraft	24
Chromatronics	2	Teleplay	57
Chromasonics	73	Tempus	84
Crimson Electric	36	Trampus	82
EDA	86	Tritron	
Electrovalve	85	12, 23, 24, 65, 80, 90	
Greenbank	84	Personnel Computer	
Greenweld	45/48	World	85
Henrys	11, 57, 83	Powertrail	30
ILP	38, 77, 83	Progressive Radio	62
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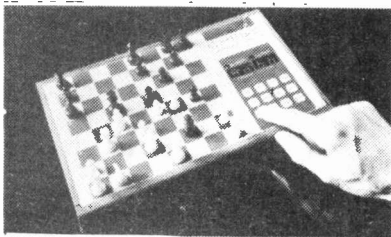
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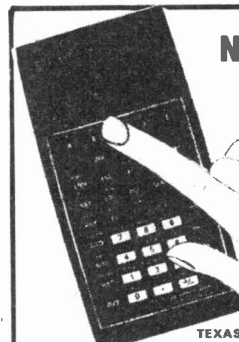
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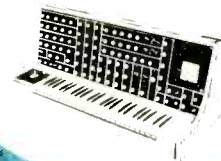
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