electronics today INTERNATIONAL

MARCH 1979

50p

STAGE LIGHTING CONTROLLER

Cellular Logic * Analogue To Digital

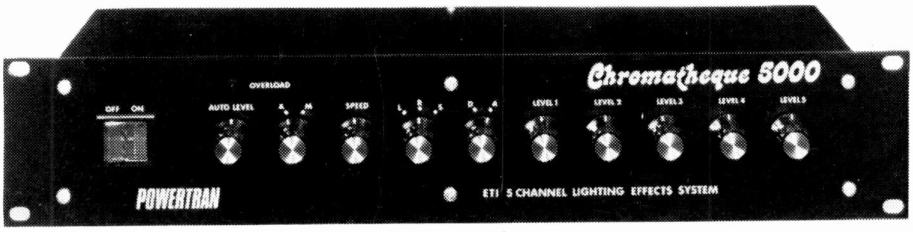
Visual Hi-Fi * Magnetic Amplifiers

...NEWS....PROJECTS....MICROPROCESSORS....AUDIO...

CHROMATHEQUE 5000

5 CHANNEL LIGHTING EFFECTS SYSTEM

All kits also available as separate packs (e.g P.C.B., component sets, hardware sets, etc.) Prices in FREE CATALOGUE



COMPLETE KIT ONLY

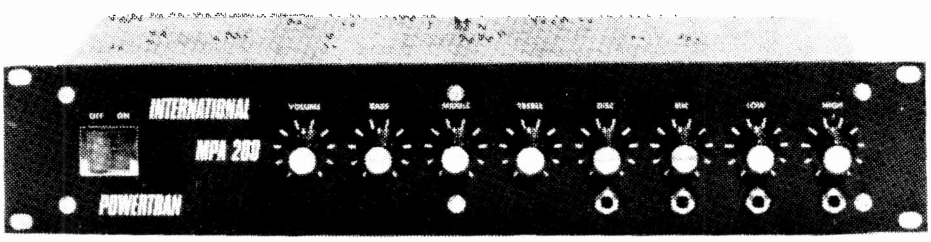
£49.50 + VAT!

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward

Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. — Complete right down to the last nut and bolt!

LAST MONTH'S FRONT COVER FEATURE!

100 WATT (rms into 8Ω) MIXER/AMPLIFIER



COMPLETE KIT ONLY

£49.90 + VAT!

Parts to build power amp module only. (PCB, res, caps, s/cs)	**£10.60** + VAT
Custom designed toroidal transformer with mounting clamp	**£10.50** + VAT
Parts for power supply only (caps, rects, fuses, F. holders)	**£3.40** + VAT

Kit includes fully finished metalwork, fibreglass PCB, controls, wire, etc. Complete right down to the last nut and bolt!

TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

The kit includes fully finished metalwork fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal trim!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations All the controls mount directly on the main board, all connections to the board are made with connector plugs and contruction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

Cabinet size 24.6" x 15.7" x 4.8" (rear) 3.4" (front)

COMPLETE KIT ONLY

£172.00 + VAT!

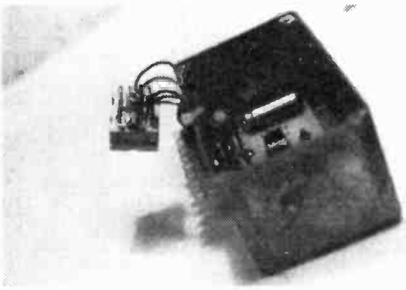
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

POWERTRAN

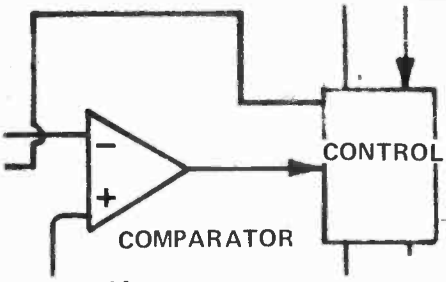
ORDERING INFORMATION AND MORE KITS ON PAGE 6

electronics today INTERNATIONAL

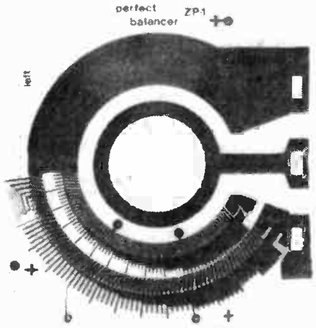
MARCH 1979 VOL 8 NO 3



Strike a Light p27



p14



Gold in them hills p75

FEATURES

PROJECTS

INFORMATION

OUR THANKS TO LAMBETH TOWN HALL FOR THE COVER PICTURE THIS MONTH, A SCENE FROM THEIR PRODUCTION OF TREASURE ISLAND.

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PUBLISHED BY Modmags Ltd., 25-27 Oxford Street, London W1R 1RF
DISTRIBUTED BY Argus Distribution Ltd. (British Isles)
Gordon & Gotch Ltd. (Overseas)
PRINTED BY QB Limited, Colchester

ABC

Electronics Today International is normally published on the first Friday of the month prior to the cover date

It's W-W-WINTER S-S-

74 SERIES TTL IC's

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.07	7427	£0.21	7472	£0.19	74107	£0.22	74165	£0.65
7401	£0.09	7428	£0.25	7473	£0.22	74110	£0.35	74166	£0.75
7402	£0.09	7430	£0.08	7474	£0.22	74111	£0.55	74167	£2.00
7403	£0.09	7432	£0.20	7475	£0.27	74118	£0.75	74174	£0.60
7404	£0.09	7433	£0.28	7476	£0.22	74119	£1.10	74175	£0.60
7405	£0.09	7437	£0.20	7480	£0.40	74121	£0.22	74176	£0.55
7406	£0.22	7438	£0.20	7481	£0.80	74122	£0.35	74177	£0.55
7407	£0.22	7440	£0.10	7482	£0.65	74123	£0.38	74180	£0.80
7408	£0.12	7441	£0.45	7483	£0.55	74136	£0.50	74181	£1.25
7409	£0.12	7442	£0.38	7484	£0.82	74141	£0.50	74182	£0.55
7410	£0.09	7443	£0.68	7485	£0.65	74145	£0.54	74184	£1.00
7411	£0.15	7444	£0.68	7486	£0.22	74150	£0.65	74190	£0.68
7412	£0.14	7445	£0.64	7489	£1.60	74151	£0.45	74191	£0.68
7413	£0.22	7446	£0.60	7490	£0.30	74153	£0.45	74192	£0.65
7414	£0.45	7447	£0.45	7491	£0.60	74154	£0.80	74193	£0.60
7416	£0.22	7448	£0.52	7492	£0.32	74155	£0.48	74194	£0.55
7417	£0.22	7450	£0.09	7493	£0.28	74156	£0.48	74195	£0.55
7420	£0.09	7451	£0.09	7494	£0.70	74157	£0.48	74196	£0.60
7421	£0.19	7452	£0.09	7495	£0.45	74160	£0.55	74197	£0.58
7422	£0.15	7453	£0.09	7496	£0.48	74161	£0.60	74198	£1.00
7423	£0.20	7454	£0.09	74100	£0.80	74162	£0.60	74199	£1.00
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Incorporating a short circuit protection and current limiting:

Voltage Regulation	2-30v
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AC Input Maximum	25v

Eliminates the use of batteries and thus saves £s — can be used time and time again. **ONLY £7.60+V.A.T.**

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500 off	£9.00
1,000 off	£15.00
10,000 off	£130.00

Single-sided Fibre-glass Board. S143.

12″×3½″ approx. 2 pcs

£0.60

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No. THY3A/200	3 Amp.	200 volt	TO64	32p
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No. THY5A/50	5 Amp.	50 volt	TO66	25p
No. THY5A/400	5 amp.	400 volt	TO66	40p
No. THY5A/600	5 Amp.	600 volt	TO66	50p
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S84 8 Amp. 400 volt TO220 Plastic **80p**

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μA723C TO99 **38p** 72723 14 pin Dil **38p**

LM309K TO3 **£1.20**

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No. 16132	100 200mA Sil. diodes like OA200	40p
No. 16133	150 75mA Sil. Fast switching diodes 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.7 case	40p
No. 16137	30 NPN Plastic trans. like BC107/8	40p*
No. 16138	30 PNP Plastic trans. like BC177/8	40p*
No. 16139	25 NPN trans. like 2N697/2N1711 TO39	40p
No. 16140	25 PNP trans. like 2N2905 TO39	40p
No. 16141	30 NPN trans. like 2N706 TO18	40p
No. 16143	30 NPN Plastic trans. like 2N3906	40p*
No. 16144	30 PNP Plastic trans. like 2N3905	40p*
No. 16145	30 PNP Germ. trans. like OC71	40p
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NKT303	20	30	30-100	**25p** per pair
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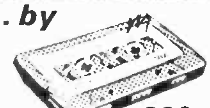

C90

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HEAD-CLEANING CASSETTE 45p each

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FET's

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16177	1 pack Assorted Hardware nuts/bolts, etc	40p
16179	20 Assorted tag strips and panels	40p
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16184	15 Assorted Fuses 100mA 5 amp	40p
16188	60 ½W resistors mixed values	40p
16187	30 metres stranded wire assorted colours	40p
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S24	6 x 1K	LIN Single	40p*
S25	6 x 5 K	LIN Single	40p*
16193	6 x 22 K	LIN Single	40p*
16195	6 x 47 K	LOG Single	40p*
16194	6 x 47 K	LIN Single	40p*
S27	6 x 100 K	LIN Single	40p*
S28	6 x 100 K	LOG Single	40p*
S29	6 x 500 K	LOG Single	40p*

Slider 60mm TRAVEL

S30	6 x 2 5 K	LOG Single	4op*
S32	6 x 50 K	LIN Single	40p*
S34	4 x 5 K	LOG Dual	40p*
S36	4 x 100 K	LOG Dual	40p*
S37	4 x 1 3 MEG	LOG Dual	40p*
S94	6 x 220 K	LIN Single	40p*
S95	6 x 100 K	LOG Single	40p*
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S38 Mixed slider pots—various values and sizes, our mix only **£1.00***
S39 6 x Chrome slider knots **40p***

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S90 Wirewound Pots Linear 1 Watt rapng Mixed—useful values 5 for **£1.00***

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6mm Shaft

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No S56	mixed values 400mW Zener diodes 11 33V	
No S57	10 mixed values 1W Zener diodes 3 10V	
No S58	10 mixed values 1W Zener diodes 11-33V	

SILICON POWER TRANS. N.P.N.

S97 BD371 2 Amp 1 2w 60Vceo Hfe 40-400 Case TO92 with heat tab — 5 for
S98 2N5293 R C A 36w 4 Amps 75Vceo Hfe 30-120 — 5 for

Crystal Ear Pieces
S126 Less plug **£0.20**

Plugs for above
No 16106 2 5 plastic **£0.09**
No 1697 3 5 plastic **£0.11**

Mono Crystal Cartridge
S127 GP91/1SC Special Offer **£1.00**

Nickel Cadnium Rechargeable Batteries, 1.25v
S128 3500D Cell size = U2 **£2.50**
S129 900C Cell size = ½U11 **£0.90**
S130 Complete kit of parts to build nickel cadnium charger **£3.50**

Super Save Pak
S124 6×741P **£1.00**
S125 5×555 **£1.00**

S138 Surplus/End of Manufacturers Line/Pre-amp with Bass, Treble Volume Control & circuit diagram supplied **ONCE ONLY OFFER, £1.25.**

S137 20 Assorted Slider Knobs — Chrome Black **£1.00**

S131	2×12v Relays, plastic case	£0.70
S132	2×24v Relays, plastic case	£0.80
S133	1 Switch bank, 5-way incl silver knob	£0.75
S134	2× Magnets suitable for reed switches	£0.10
S135	1 Veroboard pak 2 pcs 45sq ins approx	£0.80
S136	15 Veroboard pak, 2 pcs 60sq ins approx	£1.10
16199	1 Veroboard pak, 30sq ins approx	£0.50
16200	15 Veroboard pak 30sq ins approx	£0.50

TOOLS
No 2011 5" wire cutters **£1.55**
No 2012 5" long wire plier **£1.45**

SUPER DUPER COMPONENT BOX
Min 3lbs in weight consisting of a fantastic assortment of Electronic Components — Pots, Resistors Condensers Switches, Relays Board-Semiconductors wire hardware etc etc etc
★ This is a large box and is sent separate to your order ★
S140. £2.50 including p&p.

TRANSFORMERS SALE OFFER
S141 0235 240v primary 0-55v at 2Amp secondary **£4.50*+£1.00 p&p.**
S142 0349 240v primary 0-20v at 2Amp secondary, **£3.50*+£0.86 p9p.**

COMPLETE AMPLIFIER KITS

STA15 15 watts per channel amplifier kit CONSISTS: 2×AL60 — 1×PA100 — 1×SPM80 — 1×2034 transformer — 2×coupling capacitors **£37.70 inc. V.A.T.+85p p&p.**

STA25 25 watts per channel amplifier kit CONSISTS 2×AL60 — 1×PA100 — 1×SPM120/45 — 1×2040 transformer — 1×RESERVOIR CAPACITOR — 2×coupling capacitors **£41.45 inc. V.A.T.+£1.16 p&p.**

STA35 35 watts per channel amplifier kit CONSISTS 2×AL80 — 1×PA100 — 1×SPM120 — 1×2041 transformer — 1 reservoir capacitor — 2×coupling capacitors **£48.45 inc. V.A.T.+£1.16 p&p.**

STA50 50 watts per channel amplifier kit CONSISTS 2×AL120 — 1×PA200 — 1×SPM120/65 — 1×2041 transformer — 1 reservoir capacitor — 2×coupling capacitors **£58.20 inc. V.A.T.+£1.16 p&p.**

STA125 125 watts per channel amplifier kit CONSISTS 2×AL250 — 1×PA200 — 2×SPM120/65 — 2×2041 transformers — 1×reservoir capacitors — 2×coupling capacitors **£72.85 inc. V.A.T.+£1.25 p&p.**

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	25p	BC177	12p	BF194	*9p	TIP32A	34p	2N1613	15p
AC126	14p	BC178	12p	BF195	*9p	TIP32B	35p	2N1711	15p
AC127	16p	BC179	12p	BF196	*12p	TIP32C	36p	2N1893	28p
AC128	16p	BC182	*9p	BF197	*12p	TIP41A	34p	2N2218	15p
AC128K	24p	8C182L	*9p	8F200	25p	TIP41B	35p	2N2218A	18p
AC176	16p	BC183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	BC183L	*9p	BFX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	BC184	*9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	BC184L	*9p	BFY51	12p	TIP42C	38p	2N2221A	16p
AC188	16p	BC212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	BC212L	*10p			TIP3055	42p	2N2222A	16p
AD161/		BC213	*10p	MPSA05	*22p	ZTX107	*6p	2N2369	10p
162 MP	80p	BC213L	*10p	MPSA06	*22p	ZTX108	*6p	2N2904	14p
AF139	30p	BC214	*10p	MPSA55	*22p	ZTX109	*7p	2N2904A	15p
AF239	30p	BC214L	*10p	MPSA56	*22p	ZTX300	*7p	2N2905	14p
BC107	6p	BC251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
BC108	6p	BCY70	12p	OC45	12p	ZTX302	*9p	2N2906	12p
BC109	6p	BCY71	12p	OC71	9p	ZTX500	*8p	2N2906A	14p
BC118	*10p	8CY72	12p	OC72	12p	ZTX501	*10p	2N2907	12p
BC147	*8p	BD115	40p	OC75	10p	ZTX502	*12p	2N2907A	13p
BC148	*8p	8D131	*35p	OC81	14p	2N696	*10p	2N2926G	*8p
BC149	*8p	BD132	*37p			2N697	10p	2N2926Y	*7p
BC154	*16p	BF115	17p	TIP29A	35p	2N706	7p	2N3053	12p
BC157	*9p	BF167	19p	TIP29B	36p	2N706A	8p	2N3055	35p
BC158	*9p	BF173	20p	TIP29C	38p	2N708	8p	2N3702	*7p
BC159	*9p	BF180	25p	TIP30A	36p	2N1302	12p	2N3703	*7p
BC169	*10p	BF181	25p	TIP30B	37p	2N1303	15p	2N3704	*6p
BC170	6p	BF182	25p	TIP30C	38p	2N1304	15p	2N3903	*11p
BC171	*6p	BF183	25p	TIP31A	32p	2N1307	18p	2N3904	*11p
BC172	*6p	BF184	25p	TIP31B	33p	2N1308	22p	2N3905	*11p
BC173	7p	BF185	25p	TIP31C	34p	2N1309	22p	2N3906	*11p

DIODES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AA119	5p	BAX16/		BYZ16	30p	OA85	7p	IS44	3p
AAZ13	4p	OA202	5p	BYZ17	28p	OA90	6p		
BA100	6p			BYZ18	28p	OA91	7p	IN5400	10p
BA115	5p	BY100	15p	BYZ19	28p	OA95	7p	IN5401	11p
BA144	5p	BY127	*10p	OA47	5p			IN5402	12p
BA148	10p	BYZ10	32p	OA70	5p	IN34	5p	IN5404	13p
BA173	10p	BYZ11	32p	OA79	7p	IN60	6p	IN5406	16p
BAX13/		BYZ12	32p	OA81	7p	IN914	4p	IN5407	17p
OA200	5p	BYZ13	30p			IN148	4p	IN5408	19p

LINEAR I.C.'s

TBA800	*£0.75	uA709	£0.20	748P	£0.28
TBA810	*£0.85	uA711	£0.25	uA748	£0.28
TBA820	*£0.65	uA703	£0.20	72558	£0.45
LM380	*£0.80	741P	£0.18	MC1310P	£1.25
LM381	*£1.25	72741	£0.20	76115	£1.25
72709	£0.20	uA741C	£0.20	NE555	£0.22
		72747	£0.55	SL414A	£1.80

ZN 414 RADIO CHIP 75*

OPTOELECTRONICS

DISPLAYS
No 1510 707 LED Display **£0.70**
No 1511 747 LED Display **£1.50**
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No S121 2 Bright Red **£0.09**
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No 1505 2 Green **£0.12**
No 1503 125 Yellow **£0.12**
No 1506 2 Yellow **£0.12**
No S82. Clear 2 Illuminating Red **£0.10**

2ND QUALITY LED PAKS
No 1507 10 Assorted Colours & Sizes **£0.75**
No S122 10× 125 Red **£0.60**
No S123 10× 2 Red **£0.60**

LED CLIPS
No 1508/ 125 125 **5 for £0.12**
No 1508/ 2 2 **5 for £0.15**
No S139 Infra-red Emitter, Fairchild FP1000 **£0.50**

P.O. RELAYS
S85 — 2 Off Post Office relays **40p**

SPECIAL REDUCTIONS
No 1514 NORP 12 **45p** each
No S76 OCP71 5 for **£1.00**
No SB3 5 NIXIE Tubes ITT 5870 ST **£2.00** (including Data).
No. S77 Noen Indicator Lamps 230 AC State Colour (Red, Amber and Green) **25p** each

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to take 6 x HP7's
Order No. 202 **10p** each

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Approx 200 Pieces, Assorted fall-out integrated circuits, including. Logic, 74 series, Linear, Audio and D T.L Many coded devices, but some unmarked — you to identify
Order No 16223 **£1.00**

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Order No S51 4 for **50p**

POWER SUPPLY STABILIZER BOARD
Unused ex-equipment stabilizer board Input 30V D.C Output 20V Complete with circuit diagram
Order No. S81 **£1.25**

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084—50 2 ??? round single pin fixing **30p**

ORDERING

Minimum postage and packing for Sale Orders **£0.50** PLUS any further postage as stated as per this Sale Advertisement.

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O/D 2015
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Birmingham B19 3JR

TELEPHONE: 021·233·2400

MAIL ORDER ONLY

ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

CAPACITORS

Electrolytic Axial Leads

Order Code: Cap 015 + µF + V d.c.

-10% to +50% Tol

µF \ V d.c.	16	25	40	63
1.0				8
1.5				8
2.2				8
3.3				8
4.7				8
6.8			8	9
10		7		9
15	7		8	10
22		7		12
33	7		8	
47		7	10	12
68	8			
100		8	12	
150	8	9		29
220	12		24	34
330			28	37
470		21	30	44
680	19	28	36	50
1000	23	28	55	
1500	32	36		
2200	39			

Electrolytic Can Type

Order Code: Cap HR + µF + Volts

High Ripple, IEC Grade 1, Low E.S.R.
Supplied complete with Vertical Fixing Clip

		Ripple 1A @ 85°C	1.4A @ 50°C	
2200 µF	16V			166
4700 µF	16V	2.6A	3.6A	184
10000 µF	16V	5.8A	8.1A	222
22000 µF	16V	9.8A	13.7A	346
2200 µF	25V	1.3A	1.8A	175
4700 µF	25V	4.6A	6.4A	201
10000 µF	25V	8.0A	11.2A	264
22000 µF	25V	12.8A	17.9A	438
1000 µF	40V	0.9A	1.2A	168
2200 µF	40V	2.4A	3.3A	188
4700 µF	40V	5.6A	7.8A	231
10000 µF	40V	9.2A	12.8A	367
1000 µF	70V	1.8A	2.5A	190
2200 µF	70V	4.0A	5.6A	235
4700 µF	70V	7.5A	10.5A	376
1000 µF	100V	4.0A	5.6A	222
2200 µF	100V	7.8A	10.9A	346

Miniature Low Value

Order Code:
Polystyrene, Axial, ±1% Tol., ≥63V D.C. Wkg — Cap 424
Ceramic Plate, Radial, Low K, 1.8pF–8.2pF ±.25pF Tol, 10-330pF ±2% Tol, 100V D.C. Wkg — Cap 632
Ceramic Plate, Radial, Med K, ±10% Tol, 100V D.C. Wkg — Cap 630
Ceramic Plate, Radial, High K, –20% to +80% Tol, 63V D.C. Wkg — Cap 629
+ Value

pF	424	632	630	629
1				
1.2				
1.5				
1.8		5		
2.2		5		
2.7		5		
3.3		5		
3.9		5		
4.7		5		
5.6		5		
6.8		5		
8.2		5		
10		5		
12		5		
15		5		
18		5		
22		5		
27		5		
33		5		
39		5		
47		5		
56		6		
68		6		
82		6		

pF	424	632	630	629
100	16	6		
120	16	8		
150	16	8		
180	16	6		
220	16	6		
270	18	8		
330	18	8		
390	18		5	
470	18		5	
560	16		5	
680	16		5	
820	16		5	
1000	16		5	5
1200	16		5	
1500	18		6	
1800	18		6	
2200	18		6	6
2700	18		6	
3300	18		6	
3900	18		6	
4700	23		7	6
5600	23			
6800	23			
8200	23			

nF	424	632	630	629
10	25			6
12	26			
15	26			
18	27			
22	28			8
27	38			
33	41			
39	43			

Tantalum Bead

Order Code: Cap PR + µF + Volts

20% Tol.

µF \ V d.c.	3.15	6.3	10	16	25	35
0.1						9
0.15						9
0.22						9
0.33						9
0.47						9
0.68						9
1						9
1.5						10
2.2				9		11
3.3				9	11	14
4.7				10	14	15
6.8		9		11	15	6
10		10	11	14	16	20
15		11	14	15	20	
22	11	14		16		
33		15	16	20		
47		16	20			
68	16	20				
100	20					

Electrolytic Radial Leads

Order Code: Cap 034 + µF + Volts

–10% to +50% Tol

µF \ V d.c.	6.3	10	16	25	35	40	50	63
.47								6
.68								6
1.0								6
1.5								6
2.2								6
3.3								6
4.7						6		7
6.8				6			7	8
10			6			7		8
15			6	7			8	10
22		6	7			8	10	
33			7	8		10		
47		7	8		10			
68			8	10				
100		8	10					
150		10						
220	10							

Polyester Radial Leads

Order Code:
Dipped Type, ±20% Tol, 250V D.C. Wkg. C280/352 Style — Cap 352
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 10.2mm Pitch Centres — Cap 360
Moulded Type, ±10% Tol, ≥100V D.C. Wkg 7.6mm Pitch Centres — Cap PHE280
+ Value

µF	352	360	PHE280
.001		5	6
.0015		5	6
.0022	5	6	7
.0033	5	6	7
.0047	5	6	7
.0068	5	6	7
.01	5	6	7
.015	5	7	8
.022	5	7	8
.033	5	7	8
.047	5	7	8
.068	6	8	9

µF	352	360	PHE280
.1	6	8	9
.15	7	9	
.22	8	10	
.33	10		
.47	12		
.68	15		
1.0	19		
1.5	27		
2.2	32		

Trimmers

250V D.C. Wkg. Film Dielectric, Miniature

		Order Code
1.4 – 4.1pF	19	Cap 808 A
2 – 8pF	19	Cap 808 B
2 – 20pF	21	Cap 808 C
5.5 – 59.5pF	29	Cap 808 D

500V D.C. Wkg. C004 EA Tubular Type

		Order Code
.8 – 3.8pF	46	Cap 802 3
.8 – 6.8pF	48	Cap 802 6
1 – 13pF	61	Cap 802 12
1.7 – 19.7	62	Cap 802 18

CASES

Small Desk Console — Boss Industrial Mouldings

Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
W161, D96, H39 (57)	186	Case BIM1005 OR
W215, D130, H47 (73)	268	Case BIM1006 OR

Plastic Boxes — Boss Industrial Mouldings

Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W62 D31	87	Case BIM2003 OR
L150 W80 D50	115	Case BIM2005 OR
L190 W110 D60	195	Case BIM2006 OR

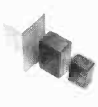
Instrument Case — Boss Industrial Mouldings

Covers Manufactured from 14SWG Aluminium
Chassis Manufactured from 18SWG Mild Steel
Covers Finished Orange
Chassis Finished Matt Black

		Order Code
W250 D167.5 H 68.5 (Chassis 153mm Deep)	1480	Case BIM3000 OR

Plastic Boxes with Metal Lids — Boss Industrial Mouldings

Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey



		Order Code
L85 W56 D29	97	Case BIM4003 OR
L111 W71 D42	130	Case BIM4004 OR
L161 W96 D53	182	Case BIM4005 OR

Diecast Boxes — Boss Industrial Mouldings

Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	104	Case BIM5003 NA
L152 W82 D50	181	Case BIM5005 NA
L192 W113 D61	280	Case BIM5006 NA

Professional Components for the Amateur

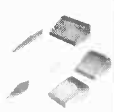
Small Desk Consoles — Boss Industrial Mouldings

Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots In Base

		Order Code
W105 D143 H32 (56)	206	Case BIM6005 OR
W170 D143 H32 (56)	271	Case BIM6006 OR
W170 D214 H32 (82)	375	Case BIM6007 OR

All Metal Desk Consoles — Boss Industrial Mouldings

Slope Front Console, Recessed Top
Two Piece All Aluminium Construction
Ventilation Slots In Rear and Base
Choice of 15° or 30° Sloping Front
Off White Top Panel, Blue Base



		Order Code
W102 D140 H28 (51) 15° slope	1018	Case BIM7151A
W165 D211 H33 (76) 15° slope	1350	Case BIM7154A
W254 D287 H33 (76) 15° slope	1572	Case BIM7156A
W356 D287 H33 (76) 15° slope	1823	Case BIM7158A
W102 D140 H28 (76) 30° slope	1018	Case BIM7301A
W165 D183 H28 (102) 30° slope	1202	Case BIM7303A
W254 D259 H28 (102) 30° slope	1572	Case BIM7306A
W356 D259 H28 (102) 30° slope	1823	Case BIM7308A

Eurocard Size Desk Console — Boss Industrial Mouldings

Slope Front Console
ABS Case, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel, Finished Grey

		Order Code
W169 D127 H45 (70)	375	Case BIM8006 OR

HARDWARE

D.I.L. Sockets

		Order Code
8 Pin Low Profile Socket Tin	11	DIL SKT 8
14 Pin Low Profile Socket Tin	13	DIL SKT 14
16 Pin Low Profile Socket Tin	14	DIL SKT 16
24 Pin Low Profile Socket Gold	66	DIL SKT 24
28 Pin Low Profile Socket Gold	78	DIL SKT 28
40 Pin Low Profile Socket Gold	127	DIL SKT 40

Heatsinks

Individual Type for 1 x T05 50°C/W	10	Sink 5F
Individual Type for 1 x T066 10.5°C/W	26	Sink TV2
Individual Type for 1 x T03 7.2°C/W	24	Sink TV3
Individual Type for 1 x T0126 17°C/W	23	Sink TV4
Individual Type for 1 x T0220 17°C/W	23	Sink TV5

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying	92	Pen 33PC
Single Sided P.C.B. Pins .040" Diam. 100 pcs	55/Pack	SS Pin 040
Double Sided P.C.B. Pins .040" Diam. 100 pcs	55/Pack	DS Pin 040

Fuseholders

Suit 20mm x 5mm fuses.

P.C.B. Mounting, Open Type	8	Fuse/H20B
Chassis Mounting, Open Type	17	Fuse/H20C
Panel Mounting, Screwdriver Slot	77	Fuse/H20PT
Panel Mounting, Finger Release	56	Fuse/H20P

Fuses

20mm x 5mm Glass.

Quick Blow, Range 100mA–5A	8	Fuse 20
Slow Blow, Range 250mA–5A	22	A/S Fuse 20

+ Rating

Lampholders, Panel Mounting

Similar In Style to Fuse/H 20P
Low Voltage Type Suits LES and M/F Bulbs.

Low Voltage, Red, Amber or Green	75	Lamp LV
Internal Neon 200/240V Red or Amber	95	Lamp N

+ Colour

Bulbs, Low Voltage, L.E.S.

6V, 0.36W; 6.5V, 1W; 14V, 0.75W.	22	Bulb LES

+ Voltage

RESISTORS

Carbon Film, Fixed

				Order Code
0.25W, E24 Values IR0-10M, 5% Tol.	1·5 ea.	90p/100 (Mult 10/Value)	£7.90/1000 (Mult 100/Value)	Res RD¼
0.5W, E12 Values IR0-4M7, 10% Tol.	2 ea.	1.25p/100 (Mult 10/Value)	£10.10/1000 (Mult 100/Value)	Res RD½

+ Value

Metal Film, Fixed

0.5W, E24 Values, SR1-IM, 2% Tol.	6 ea.	3.80/100 (Mult 10/Value)	£32.40/1000 (Mult 100/Value)	Res MR30
2.5W, E12 Values 10R-27K, 5% Tol.	13 ea.	7.90/100 (Mult 10/Value)		Res PR52

+ Value

Metal Glaze, Fixed

0.5W, E24 Values, IM-33M, 5% Tol.	10 ea.	5.40/100 (Mult 10/Value)	Res VR37

+ Value

Skeleton Presets, Miniature

		Order Code
0.1W, E3 Values, 100R-IM, Lin. Vertical Mounting	7	Min Preset V
0.1W, E3 Values, 100R-IM, Lin. Horizontal Mounting	7	Min Preset H

+ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	10	Std Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	10	Std Preset H

+ Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	34	Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	34	Pot Log

+ Value

POWERTRAN

FOR ELECTRONIC KITS OF DISTINCTION

PSI 4002 STUDIO MODEL

cabinet size 17.2" × 17.2" × 6.7"

COMPLETE KIT ONLY £196.90 + VAT

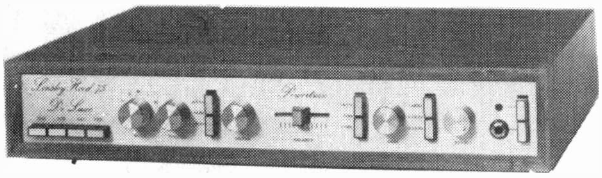
READ THE REVIEW
IN SOUND INTERNATIONAL DEC. '78 !

200 + 200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous — 800W peak!
0.03% THD at FULL power!
PLUS all the following features too!

- ★ Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- ★ Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- ★ Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0 775V (0dB)
- ★ Professional quality components, sturdy 19 rack mounting chassis complete with sleeve and feet for free standing work too.
- ★ Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experience constructors and newcomers to electronics.
- ★ Value for money — quality and performance comparable with ready-built amplifiers costing over £600!



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter versatile tone controls and tape monitoring whilst distortion is less than 0.01%

WIRELESS WORLD FM TUNER £70.20 + VAT

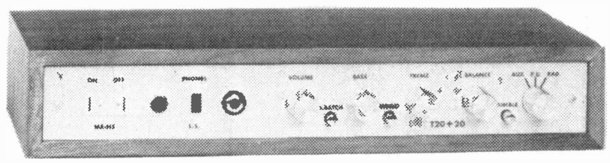
A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a m. rejection, push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder incorporating active filters for "birdy" suppression

LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided The mechanism is the Goldring-Lenco CRV with electronic speed control.

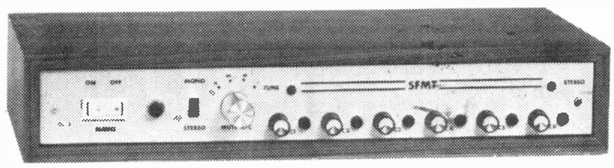
T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30 + 30) is also available for **£38.40** + VAT.



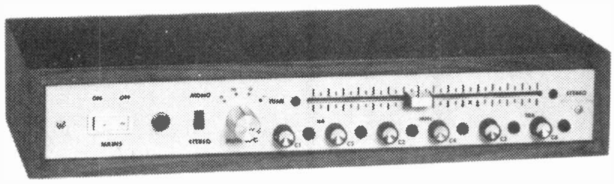
POWERTRAN SFMT TUNER £35.90 + VAT

This is a simple low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel) This unit matches well with the T20 + 20 and T30 + 30 amplifiers



WWII TUNER £47.70 + VAT

This cost reduced model of our highly successful Wireless World FM Tuner kit was designed to complement the T20 + 20 and T30 + 30 amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either. Facilities included are pre-aligned front-end module, switchable afc, adjustable switchable muting, LED tuning indication and both continuous and push-button channel selection (adjustable by controls on the front panel).



COMPLETE KITS: Our complete kits really are complete All of the projects shown on this page are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cables, nuts, bolts, etc., and full instructions — in fact everything!

All of the kits shown on this page are available as separate packs (except the Powertran SFMT Tuner) for those customers who wish to spread their purchase or perhaps make their own cabinets or metalwork. Prices are given in our FREE CATALOGUE.

PRICE STABILITY. Order with confidence irrespective of any price changes. We will honour all prices in this advertisement until April 30th, 1979, if the March, 1979, issue is mentioned with your order. Errors and VAT rate changes excluded

EXPORT ORDERS: No VAT Postage charged at actual cost plus 50p handling and documentation.
U.K. ORDERS. Subject to 12½% surcharge for VAT*(i.e. add ⅛ to the price). No charge is made for carriage. *or at current rate if changed.
SECURICOR DELIVERY: For this optional service (U K mainland only) add £2.50 (VAT inclusive) per kit.
SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m -4.30 p.m. Monday-Thursday

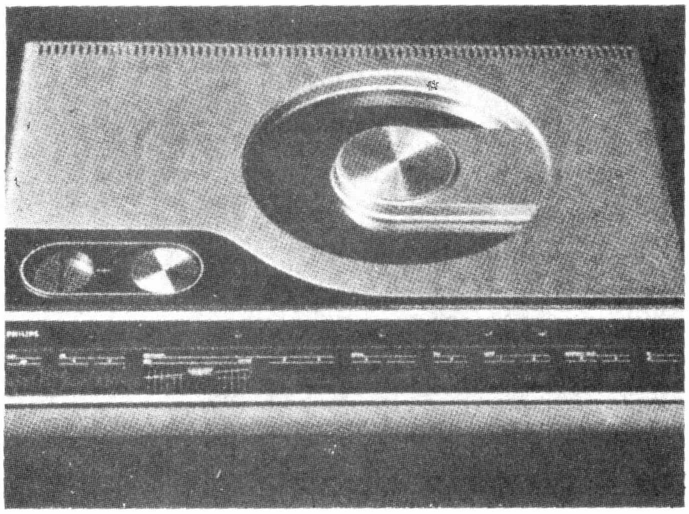
OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NM

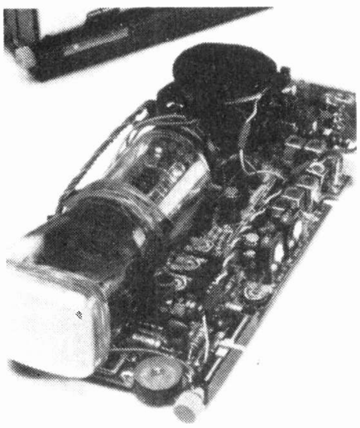
ANDOVER
(STD 0264) 64455

news digest......



VIDEO DISC REVISITED

It looks like the video disc is rearing its domestic head again. Philips have introduced a 60 minutes per side system, release and price for UK market have yet to be announced, but be prepared for yet another compatability war as other manufacturers join the fray.



SINCLAIR ANNOUNCE UK MICROVISION

A 'UK only standard' version of the top selling Microvision has been developed by Sinclair Radionics. Outwardly it has the same dimensions as the International version, but fewer controls. Good news for bank managers too, it costs less than half the previous version at less than £100. Further details from Sinclair Radionics, London Road, St Ives, Huntingdon, Cambs. PE17 4HJ.

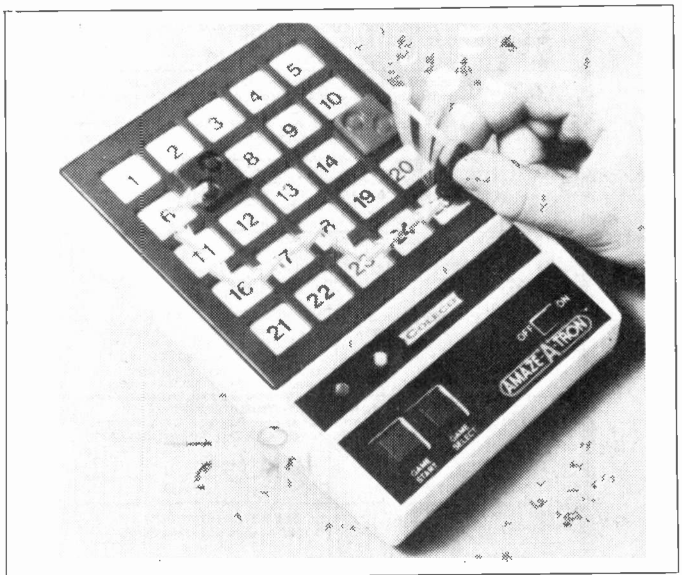
STRIKE A BLOW

We are reliably informed that due to the industrial action within the transport industry, copies of ETI have not reached some areas for last month's (February) issue. We apologise to our readers for this and hop you'll bear with us through the trouble.

Owing to the continuing — as we go to press — troubles, this issue too may be delayed. In some cases this may well be severe. If you read this later than you would normally have done so — thank you for sticking it out, and we promise normal service will be resumed as soon as possible.

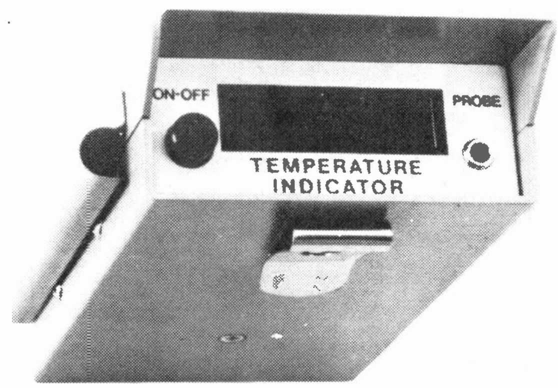
Ron Harris
Editor

HAND-HELD GAMES



After the inroads made into the leisure market by TV video games, a new generation of hand-held calculator-style games seem to be making their way across the Atlantic. The 'AMAZE-A-TRON' (groan) is a micro-based game specifically aimed at the 5 years and up age range. It is basically a maze game with a claimed one million variations. Also in the pipeline are 'ZAP' a missile game, 'DIGITS' a code game, and 'LIL GENIUS', a teaching type calculator. Prices will range from £9-£18 and will be marketed by Spectrum Electronic Games, 113-115 Gloucester Road, London SW7 4TE.

HOT STUFF



Details of a new pocket-sized thermometer, 'computerised' no less, have just arrived. Designated the ITS there are four models in the range, two cover the range 0-110°C and the other two from —35°C to 149°C. The LED display can handle Fahrenheit as well as Centigrade. More than 25 interchangeable probes are available for various applications, and its rugged high impact aluminium case is ideal for field use. Contact British Rototherm Co Ltd for further details at Kenfig Industrial Estate, Margam, Port Talbot, West Glam. SA13 2PW (South Wales).

WATFORD ELECTRONICS

33/35 CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME.
Tel. Watford 40588/9.

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.Os OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p TO ALL ORDERS UNDER £10. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE.
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POLYESTER CAPACITORS: Axial lead type. (Values are in µF). **400V:** 0·001, 0·0015, 0·0022, 0·0033 **7p;** 0·0047, 0·0068, 0·01, 0·015, 0·018 **9p;** 0·022, 0·033, **10p;** 0·047, 0·068 **14p;** 0·1, **15p;** 0·15, 0·22, **22p;** 0·33, 0·47 **39p;** 0·68 **45p.** **160V:** 0·039, 0·15, 0·22 **11p;** 0·33, 0·47 **19p;** 0·68, 1·0 **22p;** 1·5 **29p;** 2·2 **32p.** 4·7 **48p.** **DUBILIER: 1000V:** 0·01, 0·015 **20p;** 0·022 **22p;** 0·047 **26p;** 0·1 **38p;** 0·47 **48p.**

POLYESTER RADIAL LEAD (Values in µF). **250V:** 0·01, 0·015, 0·022, 0·027 **5p;** 0·033, 0·047, 0·068, 0·1 **7p;** 0·15 **11p;** 0·22, 0·33 **13p;** 0·47 **15p;** 0·68 **18p;** 1·0 **24p;** 1·5 **27p;** 2·2 **31p.**

FEED THROUGH CAPACITORS 1000pF/350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type. Values are in µF. **500V:** 10 **40p;** 4/ **68p; 250V:** 100 **65p; 63V:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 10, 15, 22 **8p;** 47, 32, 50 × **1p;** 63, 1 **27p; 50V:** 50, 100, 220 **25p;** 470 **5pp** 1000 **68p; 40V:** 22, 33 **7p;** 100 **12p;** 2200, 300 **62p;** 4700 **85p; 35V:** 10, 33 **7p;** 330, 470 **32p;** 1000 **49p; 25V:** 10, 22, 47 **8p;** 80, 100, 160 **8p;** 220, 250 **13p;** 470, 640 **25p;** 1000 **27p;** 1500 **30p;** 2200 **41p;** 3300 **58p;** 4700 **68p; 16V:** 10, 40, 47, 68 **7p;** 100, 125 **8p;** 220, 330 **14p;** 470 **16p;** 1000, 1500 **20p;** 2200 **34p; 10V:** 100 **6p;** 640 **10p;** 1000 **14p.**
TAG-END TYPE: 70V: 2000 **89p;** 4700 **135p; 50V:** 10 000 **255p; 40V:** 2500 **65p;** 3300, 4700 **70p;** 15 000 **450p. 25V:** 4700 **68p;** 2200 **48p; 325V:** 200 + 100 + 50 + 100 **190p.**

TANTALUM BEAD CAPACITORS **35V:** 0.1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2.2µF, 3·3, 4·7, 6·8. **25V:** 1·5, 10. **20V:** 1·5. **16V:** 10µF **13p** each. **16V:** 15, 22 **25p.** 47 35p, 100 **50p.** **10V:** 15, 22, 33, **20p;** 100 **35p.** **6V:** 47, 68, 100 **30p; 3V:** 100 **20p.**

POTENTIOMETERS (AB or EGEN)
Carbon Track, ¼W Log & ½W Linear values
500Ω 1KΩ & 2KΩ (lin only) Single gang **27p**
5KΩ-2MΩ single gang **27p**
5KΩ-2MΩ single gang O/P switch **60p**
5KΩ-2MΩ dual gang stereo **70p**

OPTO ELECTRONICS ★
LEDs plus Clips
TIL209 Red **13p**
TIL211 Grn **17p**
TIL212 Yellow **18p**
.2" Red **14p**
.2" Amber Green Yellow **18p**
Spare Clips **2p**
LS400 **255p**
OCP71 **120p**
ORP61 **85p**
ORP12 **63p**
2N5777 **45p**
7 Segment Displays
TIL307 **675p**
TIL312 .3" CA **105p**
TIL313 .3" CC **105p**
TIL321 .5" CA **115p**
TIL322 .5" CC **115p**
DL704 .3" CC **99p**
DL707 3" CA **99p**
DL747 .6" CA **180p**
FND357 **120p**
.3" Grn. CA **180p**
6" Grn. CA **225p**
Liquid Crystal Display
3½ Digit **875p**
4 Digit **975p**

OPTO ISOLATORS
TIL 111/2 **85p**
TIL114 **95p**
TIL117 **110p**

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF **6p**
0·015, 0·02, 0·04, 0·05, 0·056µF **7p**
0.1µF, 0·2 **9p.** **50V:** 0.47µF **12p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **22p**

CERAMIC CAPACITORS 50V
Range: 0·5pF to 10,000pF **3p**
0·015µF, 0·022µF, 0·033µF **4p**
0.047µF **4p;** 0.1µF **6p.**

PRESET POTENTIOMETERS
0.1W 50Ω—5MΩ Miniature Vertical & Horizontal **8p**
0·25W 100Ω—3·3MΩ horiz. larger **10p**
0·25W 200Ω—4·7MΩ Vert. **10p**

SILVER MICA (Values in pF) 3·3, 4·7, 6·8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 **9p** each
250, 300, 330, 360, 390, 600, 820 **16p** each
1000, 1800, 2000, 2200 **20p** each

RESISTORS — Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL	1-99	100+
¼W	2.2Ω-4.7M	E24	1.5p	1p
½W	2.2Ω-4.7M	E12	2p	1.5p
1W	2.2Ω-10M	E12	5p	4p
2% Metal Film 10Ω-1MΩ			6p	4p
1%0.5W 51Ω-1M		E24	10p	8p

100+ price applies to Resistors of each type not mixed values.

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p;** 1.5nF to 47nF **10p**

MINIATURE TYPE TRIMMERS
2.5-6pF; 3-10pF; 10-40pF **22p**
5-25pF; 5-45pF; 60pF; 88pF **30p**

COMPRESSION TRIMMERS
3-40pF, 10-80pF; 25-190pF **25p**
100-500pF **45p;** 1250pF **65p**

THERMISTORS: VA1034, 1039, 1040, 1055, 1056, 1058, 1066, 1067, 1098, 1100 **20p** each.

GAS & SMOKE DETECTORS
TGS 812 & 813 **415p;** Socket **25p**

JACKSONS VARIABLE CAPACITORS
Dielectric
100/300pF **140p**
500pF **165p**
6 1 Ball Drive 4511/DAF **115p★**
Dial Drive 4183 6 1/36 1 **650p★**
Drum 54mm **30p★**
0·1-365pF **245p**
00 2 365pF **275p**
0 2 365pF with slow motion Drive **325p**
00 208/176 **285p**
... with slow motion drive **325p**
C804-5pF 10 15 25 50pF **175p★**
100, 150pF **215p★**
'L' 3x310pF **495p**
00·3x25pF **430p**

DIODES

	p
AA119	18
AAZ15	15
BY100	24
BY126	14
BY127	14
CR033	157
OA9	75
OA47	12
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	7
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2★	5
IN4003★	6
IN4004/5★	6
IN4006/7★	7
IN4148	4
IS44	20
3A/100V★	15
3A/400V★	20
3A/600V★	27
3A/1000V★	30
6A/600V	50

★BRIDGE RECTIFIERS (plastic case)

	p
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 OIL	40

INTERSIL Evaluation Kit
LCD **2633p**
LED **2193p**

DENCO COILS
'DP' VALVE TYPE
Range 1-5 B,Y,R,W **86p**
6-7 B,Y,R **75p**
1-5 Green **92p**
'T' 1-5 B,Y,R,W **93p**
B9A Valve Holder **25p**
RDT2 **92p**
RFC 5 chokes **91p**
RFC 7 (19mH) **96p**
1FT 13/14/15/16/17 **85p**
1FT 18/1.6 **99p**
1FT 18/465 **105p**
TOC1 **86p**
MW5FR **82p**
MW/LW 5FR **103p**

RF CHOKES
1µH, 4.7, 10, 22, 33, 47, 100, 200, 470, 750, 1mH, 2.5, 5, 10 **35p each**
43mH, 100 **60p each**

ZENERS
Range 2V7 to 39V 400mW **9p each**
Range 3V3 to 33V 1.3W **17p each**

VEROBOARD★ 0.1 0.15 0.15 (copper clad) (plain)

	0.1 (copper clad)	0.15 (copper clad)	0.15 (plain)
2½ x 3¼"	46p	39p	24p
2½ x 5"	55p	50p	31p
3¾ x 3¾"	55p	50p	—
3¾ x 5"	62p	67p	43p
2½ x 17"	169p	135p	92p
3¾ x 17"	218p	180p	120p
4¾ x 17"	280p	—	183p

Pkt of 35 pins **30p**
Spot face cutter **85p**
Pin insertion tool **120p**

NOISE
Z5J **160**

VARICAPS
MVAM2 **135**
MVAM115 **120**
BA102 **25**
BB104 **40**
BB105B **40**
BB106 **40**

SCRs★ Thyristors

1A50V	38
1A100V	42
1A200V	47
1A400V	52
1A600V	70
5A100V	32
7A300V	35
8A300V	48
8A600V	43
8A500V	58
8A600V	85
12A300V	59
12A500V	92
BT106	150
C106D	38
TIC44	22
TIC45	25
2N4444	140
2N5060	28
2N5062	30
2N5064	35

VERO WIRING PEN★
Plus Spool **325p**
Spare spool (wire) **80p★** Combs **7p** each

FERRIC CHLORIDE★
1lb bag Anhydrous **65p + 30p p. & p.**

DALO ETCH RESIST PEN★ + spare tip **75p**

TRIACS★

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
16A100V	95
16A400V	105
16A500V	120
25A800V	295
40669 (T2800D)	99

COPPER CLAD BOARDS★

	Fibre Glass Single-sided	Double-sided	SRBP 7.5 x 7.5
6 x 6	75p	90p	60p
6 x 12	130p	175p	

DIL SOCKETS★ Low Profile (TEXAS)
8 pin **10p;** 14 pin **12p;** 16 pin **13p;** ex pin **20p;** 20 pin **27p;** 22 pin **30p;** 24 pin **30p;** 28 pin **42p;** 40 pin **55p;** 64 pin **245p.**

DIAC★
ST2 **20**

SOLDERCON PINS★
100 pins **50p;** 1000 pins **400p**

TRANSISTORS

	p
AC107★	28
AC117★	35
AC125★	20
AC126★	20
AC127★	20
AC128★	20
AC141★	24
AC141K★	38
AC142★	24
AC142K★	38
AC176★	20
AC187★	20
AC188★	20
ACY17★	35
ACY18★	40
ACY19★	40
ACY20★	40
ACY21★	35
ACY22★	40
ACY28★	40
ACY39★	78
ACY41★	39
ACY44★	39
AD149	70
AD161★	42
AD162★	42
AF106	70
AF114★	30
AF115★	30
AF116★	30
AF117★	30
AF118★	55
AF121★	48
AF124★	55
AF125★	35
AF126★	50
AF127★	35
AF139★	35
AF178★	70
AF180★	70
AF186★	50
AF239★	42
AFZ11	128
ASY26★	40
ASY27★	45
ASY50★	95
ASY76★	95
ASZ21	60
BC107★	9
BC107B★	10
BC108★	9
BC108B★	12
BC108C★	12
BC109★	9
BC109B★	12
BC109C★	12
BC113	20
BC114	19
BC115	19
BC116	19
BC117	20
BC118	19
BC119★	28
BC134	19
BC135	20
BC136	18
BC137	20
BC140★	28
BC142★	25
BC143★	25
BC147	7
BC147B	10
BC148	7
BC148B	10
BC148C	10
BC149	8
BC149C	10
BC153	14
BC154	14
BC157	10
BC158	11
BC159	11
BC160★	27
BC167A	11

	p
BC168C	12
BC169C	10
BC170	10
BC171	11
BC172	10
BC177★	17
BC178★	17
BC179★	17
BC182	9
BC183	9
BC184	9
BC182L	10
BC183L	10
BC184L	10
BC186	21
BC187★	28
BC212	9
BC212L	10
BC213	9
BC213L	11
BC214	9
BC214K	14
BC214L	10
BC307B	14
BC308	13
BC327	15
BC328	13
BC338	12
BC441★	30
BC461★	30
BC477★	25
BC547	11
BC548	11
BC549C	13
BC557	13
BC558	12
BC559	20
BCY30★	57
BCY34★	75
BCY39★	80
BCY40★	78
BCY42★	48
BCY43★	75
BCY58★	22
BCY59★	22
BCY70★	15
BCY71★	17
BCY72★	17
BCY78★	20
BCZ11	145
BD115★	62
BD121★	95
BD123★	98
BD124★	115
BD131★	45
BD132★	45
BD133★	43
BD135★	38
BD136★	37
BD137★	36
BD138★	50
BD139★	45
BD140★	50
BD142★	59
BD144★	198
BD145★	198
BD181★	125
BD205★	110
BD378★	65
BD434	42
BD517★	65
BD695A★	75
BD696A★	75
BDY11	220
BDY17★	195
BDY60★	110
BDY61★	165
BF115★	34
BF154★	25
BF158★	29
BF160	30
BF161	60
BF167	30
BF173★	25

	p
BF17?★	24
BF178★	25
BF179★	30
BF180★	20
BF181★	30
BF182★	33
BF183★	30
BF184★	30
BF194	10
BF195	10
BF196	10
BF197	10
BF198	18
BF199	18
BF200★	32
BF224A	18
BF244	24
BF244B	30
BF256★	50
BF257★	26
BF258★	30
BF259★	32
BF336	30
BF394	22
BF594	40
BF595	38
BFR39	25
BFR40	25
BFR41	28
BFR79	28
BFR80	28
BFR81	28
BFR98	105
BFX29★	26
BFX81★	130
BFX84★	24
BFX85★	24
BFX86★	28
BFX87★	23
BFX88★	24
BFY18★	50
BFY50★	20
BFY51★	20
BFY52★	20
BFY53★	28
BFY55★	45
BFY64★	40
BFY71★	20
BRY39★	39
BSX20★	18
BSX26★	75
BSX29★	43
BSX78★	55
BSY95A★	25
BU105★	140
BU205	190
BU208	228
E421	96
E5567	65
MD8001★	158
ME1120	25
ME4102	10
ME6002	14
MJ400★	90
MJ491★	190
MJ2955★	99
MJE340★	50
MJE370★	55
MJE371★	60
MJE520★	45
MJE521★	65
MJE2955★	99
MJE3055★	70
MPF102	30
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPS3904	40
MPSA05	24
MPSA06	24
MPSA12	42
MPSA55	24

	p
MPSA56	24
MPSA70	34
MPSU02	58
MPSU05	48
MPSU06	54
MPSU52	65
MPSU55	53
MPSU56	56
MPU131★	39
OC23★	150
OC25★	120
OC26★	150
OC28★	99
OC29★	160
OC35★	80
OC36★	99
OC41★	48
OC42★	32
OC43★	55
OC44★	31
OC45★	20
OC46★	28
OC70★	19
OC71★	25
OC72★	30
OC74★	45
OC75★	45
OC76★	36
OC77★	78
OC79★	76
OC81D★	28
OC82D★	48
OC83★	48
OC84★	44
OC122★	48
OC123★	48
OC139★	85
OC140★	85
OC141★	85
OC170★	40
OC171★	40
OC200★	48
OC201★	75
OC203★	85
OC204★	85
SJE5039★	95
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	47
TIP30A	47
TIP30B	64
TIP30C	65
TIP31★	40
TIP31A★	40
TIP31B★	40
TIP31C★	66
TIP32★	45
TIP32A★	49
TIP32B★	70
TIP32C★	70
TIP33★	80
TIP33A★	80
TIP33B★	100
TIP33C★	105
TIP34★	85
TIP34A★	85
TIP34B★	110
TIP34C★	110
TIP35★	219
TIP35A	225
TIP35B★	240
TIP35C★	270
TIP36★	280
TIP36A★	265
TIP36B★	300
TIP36C★	325
TIP41A★	63
TIP41B★	73
TIP42A★	64
TIP42B★	82
TIP2955★	63
TIP3055★	60

	p
TIS43	36
TIS44	45
TIS45	45
TIS46	45
TIS47	50
TIS48	50
TIS49	50
TIS50	47
TIS74	47
TIS90	18
TIS91	22
ZTX107	11
ZTX108	11
ZTX109	11
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	18
ZTX303	21
ZTX304	24
ZTX311	17
ZTX314	24
ZTX320	30
ZTX326	40
ZTX341	20
ZTX500	13
ZTX501	14
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250★	85
40251★	97
40311★	50
40313★	125
40315★	55
40316★	85
40317★	52
40319★	71
40320★	56
40323★	60
40324★	85
40326★	52
40327★	62
40347★	80
40348★	101
40360★	43
40361★	43
40362★	48
40406★	55
40407★	50
40408★	75
40411★	285
40412★	63
40467★	95
40594★	80
40595★	90
40603★	58
40636★	125
40673★	68
2N697★	21
2N698★	39
2N699★	39
2N706A★	19
2N707★	50
2N708★	19
2N914★	32
2N916★	27
2N918★	30
2N920★	51
2N930★	18
2N1131★	22
2N1132★	22
2N1303★	50
2N1304★	50
2N1305★	28
2N1306★	35
2N1307★	50
2N1308★	46
2N1613★	23
2N1670★	150
2N1671B★	215
2N2160★	105

	p
2N2217★	48
2N2218A★	31
2N2219A★	22
2N2220A★	20
2N2221A★	23
2N2222A★	20
2N2303★	45
2N2368★	21
2N2369A★	15
2N2483★	28
2N2484★	30
2N2646★	48
2N2784	55
2N2904★	22
2N2905A★	20
2N2906★	18
2N2907★	20
2N2907A★	22
2N2926G	10
2N3011★	24
2N3053★	20
2N3054★	49
2N3055★	55
2N3108	39
2N3442★	131
2N3563	20
2N3614★	169
2N3615★	135
2N3663★	24
2N3702	10
2N3703	11
2N3704	10
2N3705	11
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	18
2N3711	10
2N3771★	275
2N3772★	170
2N3773★	288
2N3819	22
2N3820	32
2N3823★	65
2N3824★	70
2N3866★	90
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037★	52
2N4041★	80
2N4058★	17
2N4061	17
2N4062	13
2N4064★	120
2N4069	45
2N4236	145
2N4286	20
2N4289	20
2N4859	65
2N4922★	55
2N5135	42
2N5136	42
2N5138	20
2N5172	24
2N5179★	60
2N5180★	60
2N5191★	65
2N5305★	24
2N5457	32
2N5458	32
2N5459	32
2N5485	32
2N5777★	45
2N6027	40
2N6109	45
2SD234★	50
3N128★	85
3N140★	85

Matched Pair 10p extra

LINEAR ICs

702	75
709C 8 pin	35
710★	67
723★ 14 pin	45
733★	99
741★ 8 pin	22
747C★ 14 pin	70
748C★ 8 pin	36
753 8 pin	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	180
AY-1-5051	145
AY-1-6721/6	195
AY-3-8500★	390
AY-5-1224A★	260
AY-5-1230★	450
AY-5-1315	560
AY-5-1317A	630
AY-5-3500★	510
AY-5-3507★	415
AY-5-4007	650
AY-5-8100★	735
CA3011★	82
CA3012★	150
CA3014★	137
CA3018★	68
CA3020	170
CA3023	170
CA3028A★	80
CA3035	240
CA3036	110
CA3043	190
CA3045	140
CA3046	71
CA3048	200
CA3075	175
CA3080E★	70
CA3081	190
CA3089E	210
CA3090AQ	375
CA3123E	200
CA3130★	85
CA3140★	70
F944DC	60
ICL7106★	795
ICL7107★	975
ICL8038CC★	335
ICM7205★	1150
ICM7215★	1025
ICM7217★	775
[illegible]130★	452

LF356★	98
LM300H★	170
LM301AP★	30
LM308T	110
LM311★	120
LM318H★	205
LM319S★	195
LM324A	68
LM327★	125
LM339★	60
LM348★	90
LM349★	00
LM379★	375
LM380	90
LM381N	145
LM382	122
LM1458★	50
LM3900★	60
LM3909N★	70
LM3911★	100
M252AA★	750
M253AA★	795
MC663	275
MC724★	175
MC1303	88
MC1304P	260
MC1310P	149
MC1312PQ	195
MC1488★	85
MC1489★	90
MC14433L	1250
MC1495★	350
MC1496L	92
MC1710CG	79
MC3340P★	120
MC3360P	120
MC3401	70
MC3403★	135
MEM780	205
MFC4000B	85
MFC6040★	97
MK50253★	650
MK50362★	650
MK50398★	635
MM307AA★	00
MM5303★	635
MM57160★	620
NE515	80
NE543K	210
NE544★	185
NE555★	29
NE556DD★	60
NE560★	325
NE561★	395
NE562B★	410

NE564★	425
NE565A★	120
NE566★	160
NE567V★	170
NE570★	375
NE571★	420
RAM2102-2★	150
RC4136D	120
SAD1024A★	1450
SG3402★	295
SL437A	560
SN76003N	170
SN76013	140
SN76018★	148
SN76023	140
SN76033N	175
SN76115N	215
SN76131★	110
SN76227N	115
SN76477★	225
TAA550	50
TAA621AX1	228
TAA661A	155
TAA700	353
TAA960	320
TAD100	159
TBA120S	70
TBA540	215
TBA540Q	220
TBA550Q	330
TBA641 A12 BX or BX11	250
TBA651	180
TBA800	90
TBA810	95
TBA820	70
TBA920Q	260
TBA990Q	395
TCA270Q	220
TDA1004★	290
TDA1008★	310
TDA1022★	575
TDA2020	320
TL061CP★	76
TL062CP★	125
TL064CN★	199
TL071CP★	60
TL072CP★	125
TL074CN★	199
TL081CP★	52
TL082CP★	96
TL084CN★	130
UAA170	198
ZN414	90
ZN424E★	130

TTL 74★ (TEXAS)

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	38
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
7426	36
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	82
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25
7473	32
7474	27
7475	38
7476	36
7480	48
7481	86

7482	69
7483	72
7484	95
7485	106
7486	31
7489	210
7490	33
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74104	62
74105	62
74107	29
74109	54
74110	54
74111	68
74116	198
74118	83
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74141	56
74142	209
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74159	210
74160	82
74161	92
74163	92
74164	105
74165	105
74166	140
74167	198
74172	625
74173	120
74174	87

74175	87
74176	75
74177	78
74180	85
74181	165
74182	88
74184	135
74185	135
74188	275
74190	95
74192	98
74193	98
74194	98
74195	98
74196	93
74197	80
74198	150
74279	119
74283	173
74365	128
74366	118
74367	115
74368	124
74393	184
75150	120
75450	84
75491	00
75492	00

74LS★

00	13
01	13
02	14
03	14
04	14
05	23
08	22
09	22
10	20
11	22
12	23
13	38
14	75
15	30
20	20
21	22
26	48
27	28
28	48
30	22
32	27
33	39
37	39
38	39
40	28

42	98
47	63
48	120
49	120
51	24
54	28
55	30
63	150
73	46
74	41
75	48
76	40
[illegible]	40
83	115
85	118
86	43
90	38
91	104
92	89
93	89
95	116
96	116
107	44
109	55
112	55
113	50
114	50
122	70
123	70
124	180
125	60
126	60
132	95
136	55
138	85
139	85
145	108
147	170
148	173
151	96
153	76
155	96
156	96
157	76
158	95
160	128
161	98
162	138
163	102
164	114
165	75
166	226
170	288
173	105
174	106

175	110
181	398
183	298
190	140
191	140
192	130
193	130
194	166
195	136
196	100
197	140
221	96
240	236
241	232
242	232
243	232
245	270
247	190
248	190
249	190
251	134
253	142
257	110
258	110
259	160
261	450
266	52
273	244
275	250
279	66
283	192
290	128
293	128
295	185
298	168
324	240
325	290
326	294
327	286
347	148
348	186
352	228
353	228
365	65
366	65
367	65
368	66
373	180
374	180
375	160
377	212
378	184
379	215
384	86
390	230

........news digest.......

LOST AND FOUND AT SEA DEPARTMENT

An interesting variation on the programmable calculator has sailed into our offices, Texas Instruments have introduced a TI58, complete with brass handled, mahogany case and adaptor/charger. Software includes a 30 programme navigational package. It will tell you just about everything from where you are, to how fast you'll be going somewhere else. Want to know more, then contact: Texas Instruments Limited, European Consumer Division, Manton Lane, Bedford MK41 7PA.

ELECTRONIC SUMMER SCHOOL

The Department of Electrical Engineering Science at the University of Essex will be holding its annual electronics summer school for teachers during the week 9th-13th July, 1979. This year, as well as courses in linear circuit design and digital circuit design, a third course in electronic systems is also available which is closely related to the A.E.B. electronics systems A-level. Further information on the Summer School may be obtained from The Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

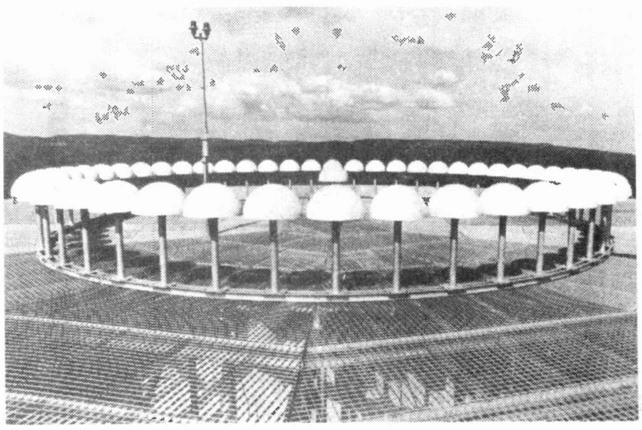
ORIENTAL TELETEXT

Sony are to launch a Teletext equipped receiver with infra red remote control. This is the first eastern set in a virtually all-European market. Costing about £800, it is likely to give the home TV industry some added headaches. The sets are to be built at the Bridgend factory.

CATALOGUE CORNER

This month's releases include the 1979 Marshalls catalogue, usual comprehensive assortment of components and hardware. Interesting to see they deal in KIM and PET, all in all not bad for value for your 40p.

........news digest.......



This is apparently same sort of aircraft navigation aid, but secret sources indicate it is in fact the British Home Stores Lampshade farm.

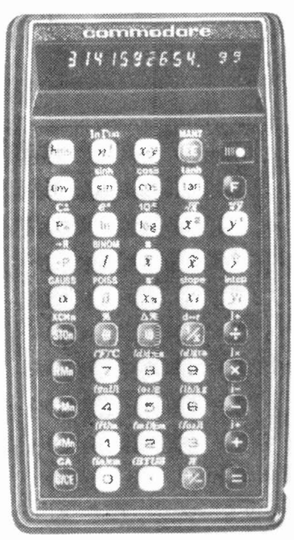
LCD POCKET TV

Matsushita have developed a pocket TV with better resolution than any previous LCD type. 57,600 elements are arranged in a 240x240 matrix which measures 2.4 inches (presumably diagonally). But even though CMOS circuits are used the TV consumes 1.5 W.

BBC TV TRANSMITTER OPENS AT LOCH NESS

We couldn't resist this one, the transmitter is sited at Wester Erchlite, opposite Urquhart Bay. We hear the installation is O.K. so far, but they have had a few teething troubles with programmes like 'All Creatures Great and Small,' something to do with frequency loch.

LANDLUBBER'S CALCULATOR



For those of us who are land-based, and taking O/A or degree level studies, Commodore have introduced an updated version of their successful 419OR, designated the SR919OR. It has nine memories with over 100 scientific functions at only £30. It has all the usual features, 10 + 2 LED display, rechargeable batteries and a 1 year guarantee. Your local calc. shop should be able to show you it in action.

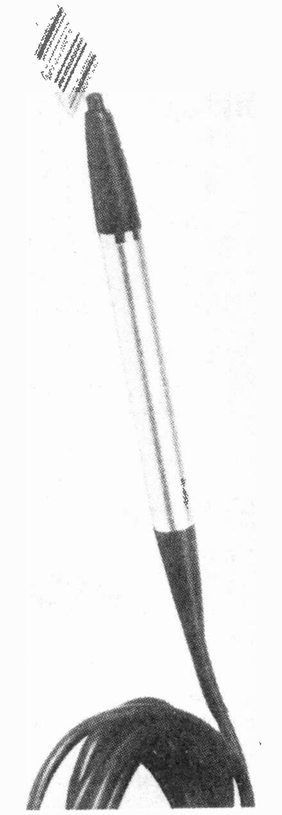
NEW CASES FROM VERO

New Eurocard-sized cardframes have just been announced by Vero. The frames, called the KM6, are available from Vero Electronics Ltd, Industrial Estate, Chandlers End, Eastleigh, Hampshire SO5 3ZR.

........news digest.......

FIBRE OPTIC LIGHT PEN

Light pens have never figured very greatly in the amateur market, but this device from Optronic Fort Ltd hopes to change that, particularly with the tremendous interest in mini-computers. It is TTL compatible and uses a pin-photodiode, weighs only 35 grammes and can be yours for only £175. Call them at Cambridge Science Park, Milton Road, Cambridge CB4 5BH.



VIDEO DISC 2

Further to the Philips video disc launch, news has just arrived about the RCA 'Selecta Vision' video disc system, pioneered in the USA. The RCA system uses a grooved disc, with diamond stylus. The disc rotates at 450 rpm, and has one hour's playing time per side. Again only drawback is you can't record your own material, but just think, you will be able to buy your own copy of Star Wars or even Emmanuel, if your that way inclined, and you can see the good bits over and over again, Cor.

BREADBOARD '79

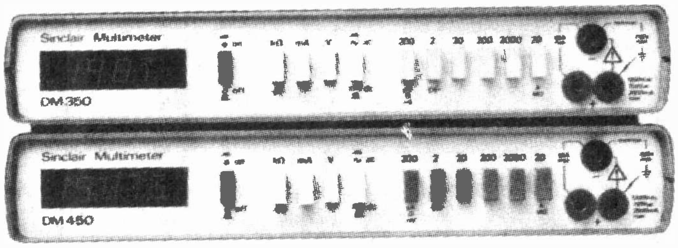
What! already. Well this year there are two dates to put into your Letts Electronic diaries. The Midlands show will be at Bingley Hall, Birmingham, on May 23rd-26th, and the London show is at the Royal Horticultural Hall, Westminster, December 4th-8th. Figures show over 10 000 people attended the first show, and that's a fantastic response for the first ever home electronics exhibition, indeed the Birmingham show is due entirely to response from contributors and visitors, we'll see you there.

MEMORIAL FUND

Following the tragic death of John Miller Kirkpatrik a memorial fund has been established for the benefit of his family. Those wishing to make a donation should send this to: John Miller Kirkpatrik Memorial, Lloyds Bank Ltd, 39 Threadneedle Street, London EC2.

SINCLAIR AGAIN

Two new laboratory quality multimeters are promised for 1979. As usual you can expect the Sinclair innovations in cost and features. These instruments which rejoice under the titles of DM450 (4½ digit 5 function) and DM350 (3½ digit, 34! ranges). They both have good technical specifications and accessories. See the Microvision article for Sinclair's address.



DIGITAL TO ANALOGUE TECHNIQUES

Digital to Analogue conversion (DAC) is a fast growing section of electronics. Tim Orr explains some of the more practical applications.

ELECTRONICS HAS CHANGED enormously in the past ten years, having swung away from valves, germanium transistors, even from descrete devices themselves. The trend is towards more and more complex integrated circuits, complete systems in a chip, large scale integration (LSI). Also the trend has swung heavily towards digitally based systems rather than analogue ones, partly because the IC manufacturers can get a greater success rate from making digital devices and partly because there are very many applications which can only be contemplated with a digital device. Such examples as pocket calculators and microprocessors spring immediately to mind. However there are several areas where analogue techniques present the only realistic solution (at this moment in time), such as tone controls in an audio amplifier. In fact, good cases can be made out for both analogue and digital systems and there are many examples where both are needed. In these it will be necessary to change from the analogue to the digital world or vice versa and to do this, some sort of conversion process has to be practised.

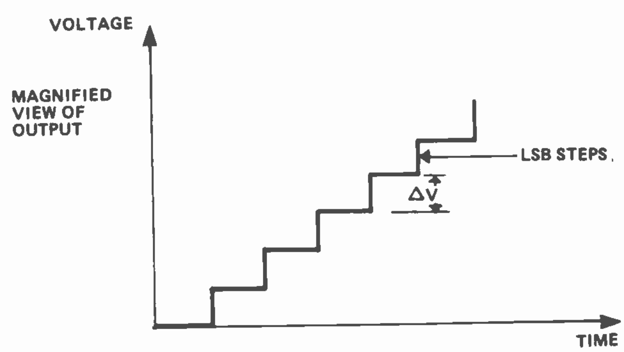
Digital to Analogue Conversion.

The job of a digital to analogue converter (DAC) is to convert a binary code (a digital data word) into an analogue voltage. The data word is a digital representation of that analogue voltage. Thus if we presented the DAC with a digital word that was linearly increasing in magnitude, the output would be a linearly increasing analogue voltage. This digital word would be the output of a binary counter driven by a constant clock frequency. The analogue output is a linear ramp, or rather a linear staircase where the step size is controlled by the "size" of the DAC. If the DAC is an 8 bit device, ie it can accept data words 8 bits wide, then it can generate a possible 2^8 descrete output level. Now 2^8 is 256, so therefore an 8 bit DAC could generate a staircase with 256 steps in it. The resolution of the DAC is thus 1 part in 256, or rather a change of one LSB (least significant bit) in the data word will make the output voltage change by 1/256th of the full scale output.

To get really fine resolution then a high performance DAC is needed. DAC prices seem to be almost linearly proportional to their resolution. I have got several DAC's amongst my collection of bits. There is an 8 bit DAC costing about £4, a 12 bit DAC costing about £35 and a 16 bit DAC costing just over £200. It is now possible to buy a monolithic (a single I C) DAC with a bit size of 6, 8, 10 and 12, but above this the devices are usually modular.

Size And Resolve

Fig 2 shows the relationship between DAC size and resolution. Notice that a 16 bit DAC with a 10 V full scale output is made up of a staggering 65,536 descrete



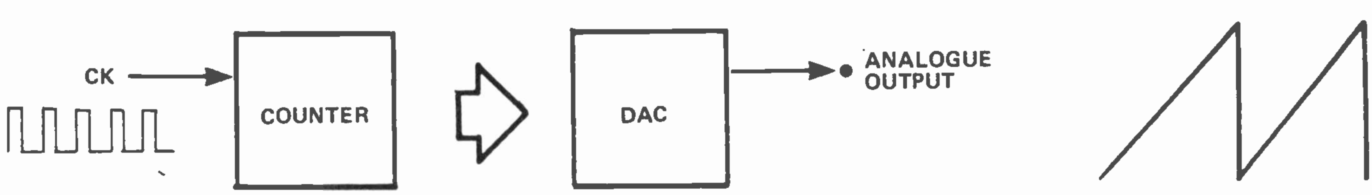


Fig 1. Converting binary code to analogue voltage.

WORDLENGTH n	RESOLUTION 1 PART IN 2n	MAXIMUM THEORETICAL DYNAMIC RANGE	BIT SIZE ASSUMING FULL SCALE = 10V
1	2	6dB	5.0V
2	4	12dB	2.5V
3	8	18dB	1.25V
4	16	24dB	0.625V
5	32	30dB	0.312V
6	64	36dB	0.156V
7	128	42dB	78.1mV
8	256	48dB	39.1mV
9	512	54dB	19.5mV
10	1024	60dB	9.7mV
11	2048	66dB	4.8mV
12	4096	72dB	2.4mV
13	8192	78dB	1.2mV
14	16384	84dB	610uV
15	32768	90dB	305uV
16	65536	96dB	152uV

Fig 2. Relationship between size and resolution.

levels each 152 μV in size. (There is also available an 18 bit device, costing a small fortune. The larger the bit size of the DAC, the larger is the dynamic range (best signal to noise ratio) of its output. This increases by 6 dB per bit. Thus a 10 bit DAC can give a best range of 60 dB.

The human anatomy has developed over the last few million years to respond to its environment. This has resulted in the following performance figures. The sensitivity of the eye to colour is not that good. Colour television transmission doesn't give much of its bandwidth to the colour part of the signal. Have a look at a TV and see how well defined the colour is; it is usually just "sort of smeared around" the subject. Thus it is possible to get quite good digital video using only 4 bits for the colour. The eye sensitivity to resolution is somewhat better, but even so an 8 bit oscilloscope memory will look fairly continuous, giving little indication that it is made up of descrete steps.

Ear Lead

However the ear can still outperform present day technology. Using a 16 bit high quality audio system a trained ear can still detect the difference between the digitally processed sound and the original. Thus, when using DAC's in professional audio equipment great care has to be taken to eliminate all types of abberations in the system. These digital abberations don't just worsen the signal to noise ratio (as an analogue system might), but they produce discordant harmonic distortion, sidebands like those obtained from ring modulation and other little funnies.

Figure 3 shows a DAC system in operation. The output of the DAC is meant to produce nice clean square wave steps, but the leading edges of these steps always have small spikes (glitches), caused by the switching times associated with the DAC's internal workings. These glitches are not regular in nature and so filtering cannot eliminate them. The glitches give the sound a "dirty" quality, or, if the system is an oscilloscope display it produces fuzzy pictures.

The glitches can be removed with a little module called a DEGLITCHER, fig 4. This is a logic controlled sample and hold which holds during the glitch period, but otherwise tracks the signal from the DAC. Thus the glitches are ignored. The output from the deglitcher then passes through a low pass filter and this removes the "stepped" quality of the signal and produces a smooth analogue output. The cut off frequency of this filter is very important and is related to the data rate of the DAC, The rule of thumb is that the filter cut off frequency should always be less than half of the data rate frequency.

Buying And Building

DAC's can be bought fairly cheaply as complete IC's or they can be constructed out of generally available parts, fig 5. This circuit uses precision buffers (a CD4041 will do), E24 resistors and a FET op amp. The buffers are run from a +10 V supply and their purpose is to provide high (+10 V) and low (0 V) output with low source resistance. They are driven by a 6 bit data word, the MSB (most significant bit) thus drives the 7k5 resistor, the LSB (least significant bit) the 240k resistor. So, when the MSB changes, the output of the op amp will move by a large amount (5 V), but when the LSB changes the output will only change a little (0V156). Going from the MSB down to the LSB, each bit has only half the effect of its predecessor. This is obtained by doubling the resistor values (7k5, 15k, 30k, 60k, 120k, 240k).

A 6 bit DAC can produce 2^6 descrete output levels. Now 2^6 is 64 and so the overall resistor tolerance should be ± 1 part in 2 x 64, which comes out at ± 0.8%. This type of DAC is known as a resistance ladder DAC, but in its presented form it is rather limited. For instance, a 10 bit device would require a resistor range of 1024 to 1 and a tolerance of 0.05%.

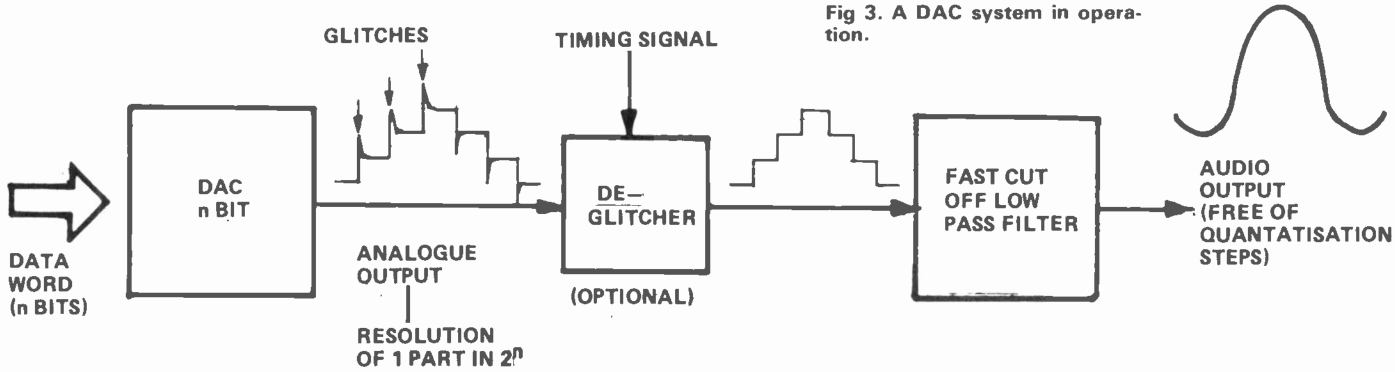


Fig 3. A DAC system in operation.

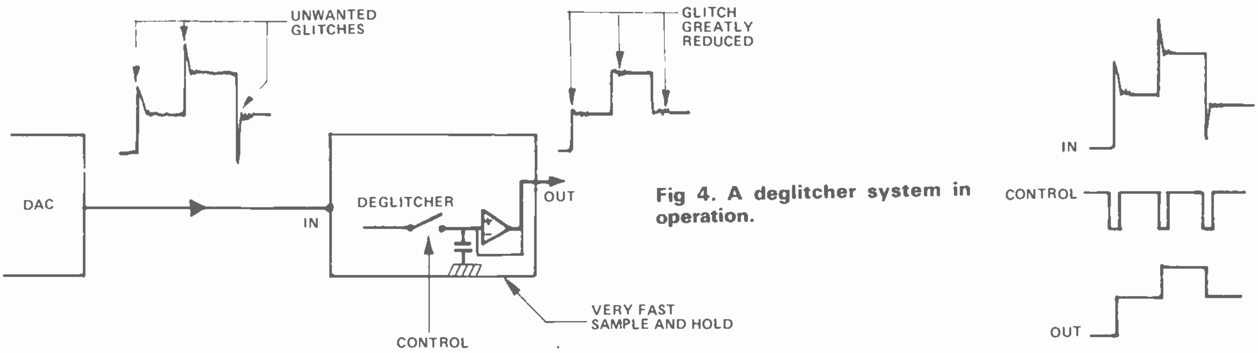


Fig 4. A deglitcher system in operation.

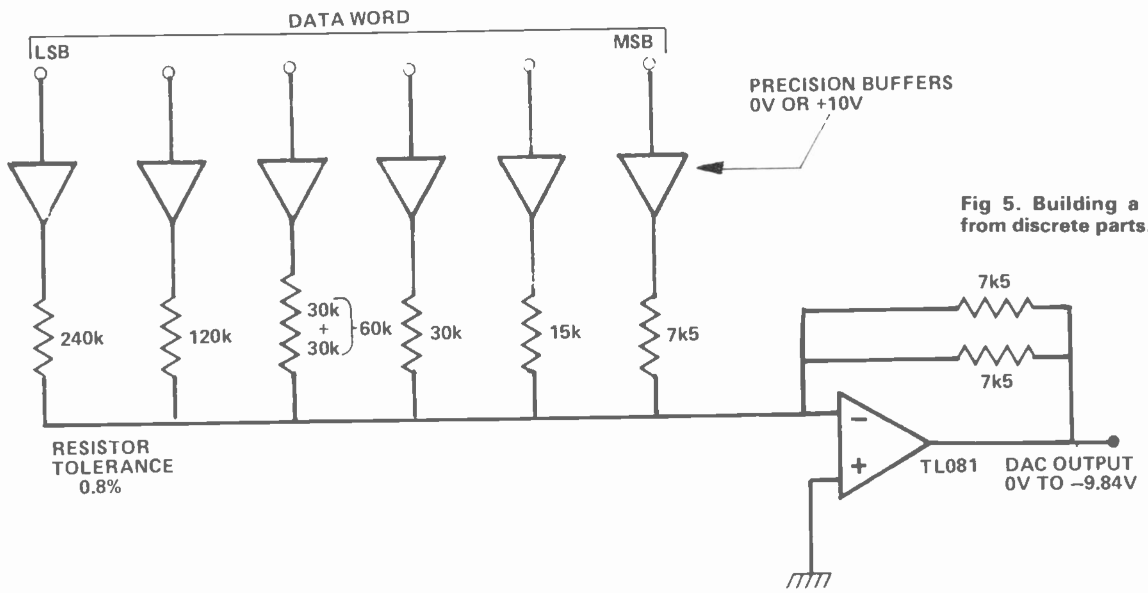


Fig 5. Building a DAC circuit from discrete parts.

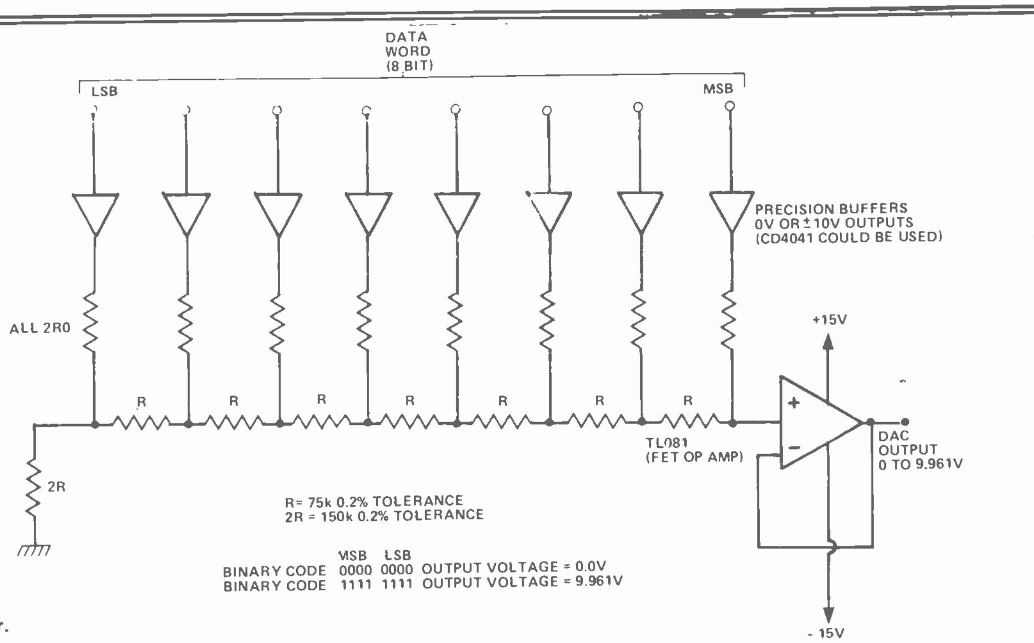


Fig 6. An R-2R ladder.

Multiple Choice

The DAC shown in Fig 6 overcomes the problem of multiplicity of resistor values; only two are needed. The resistor tolerance still applies. Also the ratio between the resistor value and the buffer ON/OFF resistance is important. The 2R resistors connected to the buffers should ideally be 2R — (the buffer output resistance).

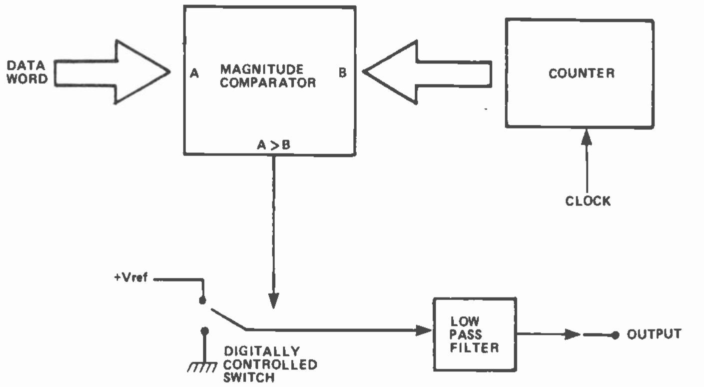
Counting On This

A "counting" type ADC is composed of a fast comparator, a gate, a counter and a DAC. This is why ADC's always cost more than DAC's, the ADC uses a DAC to do the conversion. Assuming that the analog input is positive, and the DAC produces a positive output, the conversion operation is as follows:

1) The signal "start conversion" is generated. This resets the counter to all zero's, the DAC output goes to zero, the comparator output goes high and so the clock is allowed to enter the counter. Thus the count proceeds and the DAC generates a positive going staircase.

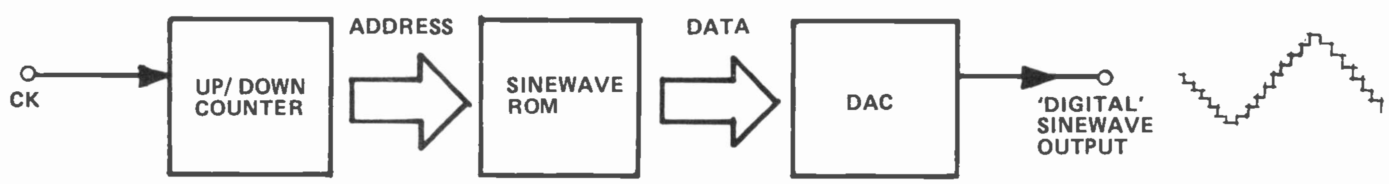
2) When the DAC output exceeds the level of the analog input the comparator output goes low, the counter stops. This is the end of the conversion, and the data that is held on the counters output is the data output. It would then be transferred to some latches, and held there until the next conversion is finished.

This data word describes as precisely as is possible the magnitude of the analogue input. Although simple to operate, this method has a major disadvantage, it is slow. Imagine that the ADC is a 10 bit device and the clock frequency is 500KHz,

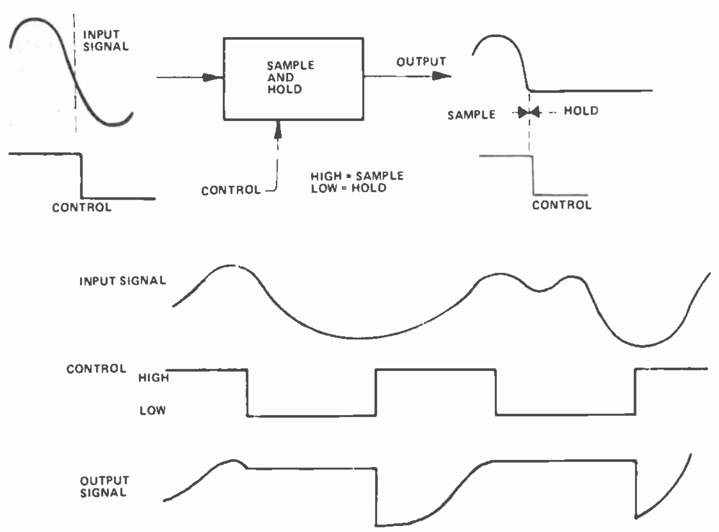


then the longest conversion time will be 1024 counts at 2μSec per count which is 2.048mSec, this means that the conversion rate will be less than 500 per second.

Memory Planning



The data that drives DAC's can come from several sources. It could be generated by computation or read from a programmed memory as shown. In this example a ROM (read only memory), has been programmed with the data necessary to produce a sinewave. An updown counter provides the address for the ROM and the data is converted into an analog output by the DAC. The clock frequency divided by the size of the counter determines the sinewave frequency.

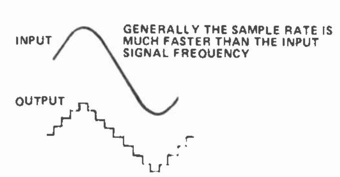


Data Lining

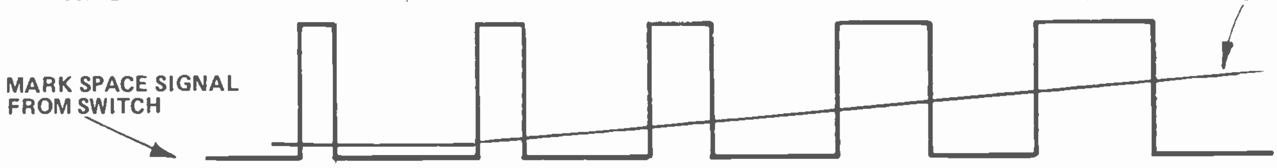
Another method of generating data is to convert analogue information into digital words. The signal must first be passed through a low pass filter, the cut off frequency of which must be less than half of the conversion frequency. The signal is then "held" in a sample and hold unit so that the ADC can do its conversion on a static signal. Control logic sends commands to the ADC giving it various instructions. The sequence of events is:

1) Tell sample and hold to HOLD.
2) Tell ADC to start conversion (SC).
3) Conversion finished, generate end of conversion signal (EOC).
4) Tell sample and hold to SAMPLE.

The process then repeats itself. The sample and hold mechanism is shown below. Generally, in one period and the input signal several ADC conversions will be done. The data generated is then stored, processed or transmitted.

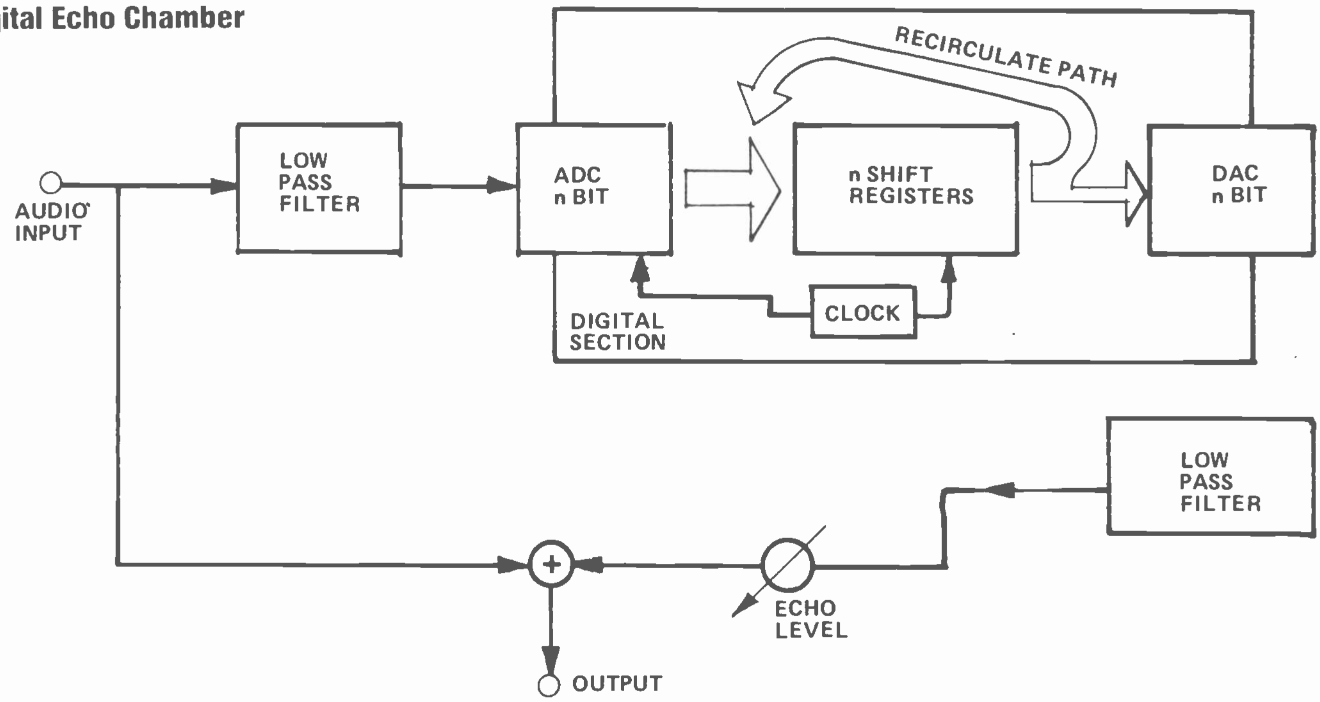


Mark Time



Yet another type of DAC, a mark space modulation DAC is shown above. The data word is presented to one side of a magnitude comparator, the output from a fast running counter to the other. When the counter is greater than the data word the A>B output goes low. The output is a mark space waveform the ratio of which is linearly proportional to the magnitude of the data word. The mark space signal operates a precision switch, the output of which is lowpass filtered, providing a smoothed DC output. This type of DAC requires a fast running counter, but gives a relatively low bandwidth output signal. It is a good solution for a system where lots of slow moving outputs are required, because the counter can be common to all the DAC's.

Digital Echo Chamber



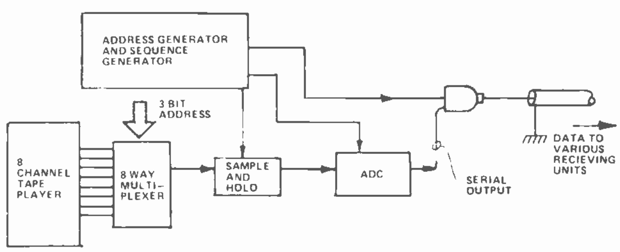
There are several professional echo chambers that are all digital. The audio input is converted into a digital word and then put into a parallel set of shift registers. A 10 bit system would use 10 sets of registers. The clock that starts the ADC conversion also shifts the data along the shift registers. The data coming out of the shift registers is then converted back into an analogue voltage by the DAC. It is then filtered and mixed with the original signal.

The echo can be made to repeat indefinitely by using the digital recirculate path around the shift registers. The amount of digital storage required is rather large. Let us assume that we want a good quality echo. This would be a 10kHz bandwidth, 60 dB dynamic range which implies a clockrate of about 25kHz and a 10 bit system. Thus to store 1 second of sound (to give one second delay), we would need 10 × 25,000 bits of memory, 0.25 Mbits!

The usual solution to this dilemma is to get longer delays at the expense of bandwidth. Thus a 1 second delay would be 1kHz bandwidth, a 0.1 second delay would be 10 kHz bandwidth. This would only require 25K of memory.

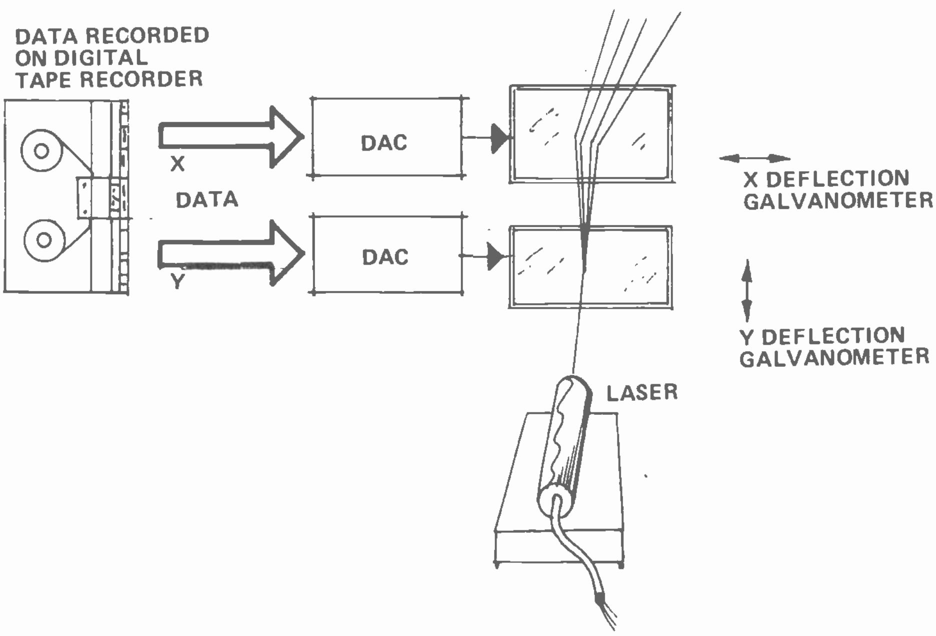
Multiplexed Sound System

Next time you are on an aircraft with a multichannel music system, it is quite possible that the sound you are hearing via your stethoscope is digitally generated. The sounds are usually stored on a multichannel tape player and each channel is connected to a multiplexer. This is a digitally controlled rotary switch and it is continually scanning all the audio channels. The output of the multiplexer is then fed to the ADC. Thus each channel is converted to a digital code. This digital code is then transmitted in serial mode and mixed with a sync pulse. The transmitted information is a series of serial data words, each representing a small piece of the eight music channels, plus some synchronisation data which passes down a two wire system to each receiving unit. This saves wire weight, there is less crosstalk and low pickup due to the high noise immunity of digital systems.



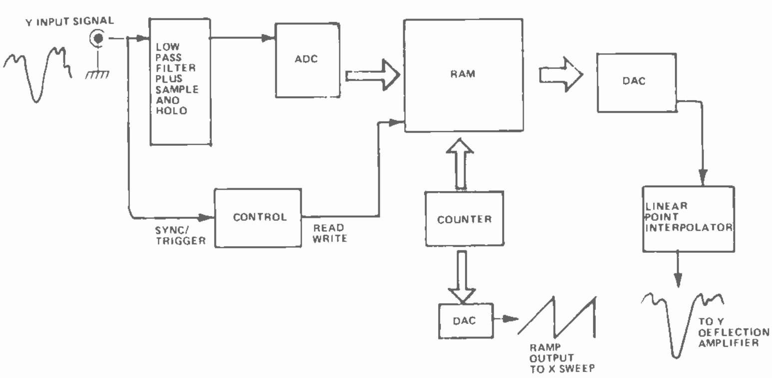
Laser Light Show.

One of the recent laser light shows in London used a digital tape recorder to store the data for the show. Two outputs were produced which were converted into control voltages by DAC's. These voltages were then used to manipulate the X and Y Co-ordinates of the laser. Thus it was possible to draw pictures and cartoon characters with a moving laser beam.



Digital Memory for an Oscilloscope.

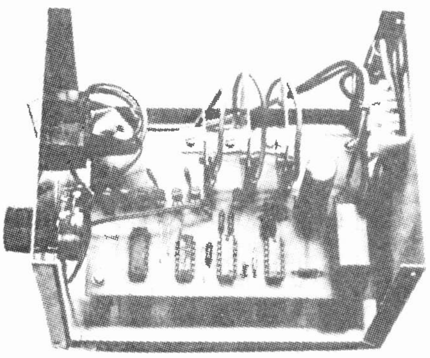
There are several products on the market that enable an ordinary oscilloscope to store waveform information. This is particularly useful if you are trying to capture non-repeating events. The system is very similar to the digital echo unit, there is an ADC, a memory and a DAC. Also there is a trigger circuit so that one shot events can be captured and a ramp generator to produce the Xsweep. The output of the DAC is rather interesting, because it is not low pass filtered, but it uses a linear point interpolation device. Basically, what this does is to join up the dots, so that a waveform that is represented by only a few points, can be made to look like the original signal. The visual results of interpolation are very good indeed.



Next Month

Hobby Electronics

Light Chaser



A light chaser is a mechanical or electronic gadget which controls three or more lights arranged in a chain; these are flashed on, one at a time, in sequence to create an illusion of movement. They are used at fairgrounds, in advertising, in shop windows and in discos. Our project to build one is both simple and easy to build.

Decibels

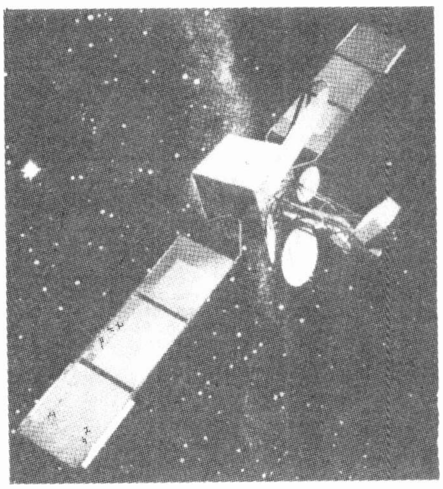
dB

Not surprisingly those who are new to electronics are confused by the apparently crazy use of decibels to describe gain or attenuation. Why not use easily understood numbers? We tell you and hope to convert you.

Photographic Timer

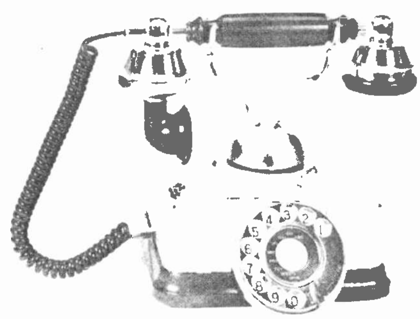
A project for those of you who do more than click the shutter Our unit is in the mains lead to your enlarger (although battery operated) and allows you to set exposure times between 0.9 and 100 seconds in two infinitely variable ranges.

Communications Satellites



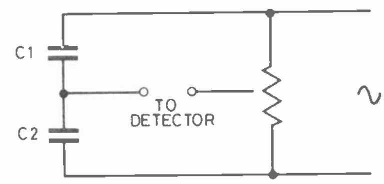
Speak to someone on the 'phone outside Europe and the chances are that your voice will spring out into space for thousands of miles on the way. The commercial ends of the space programme are described

Telephones



Do you know how the 'phone, one of the most widespread pieces of electronics, works? Lots of exciting things are happening on this front; we pull back the curtain and take a peep next month

Crossing your Bridges



The Wheatstone Bridge is one of the commonest circuit configurations in electronics. Next month K. T. Wilson examines the theory of this and describes the variations that we now use.

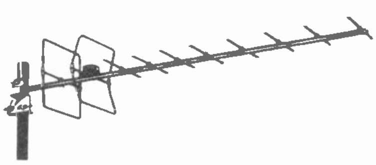
Experimenters Power Supply

Second in our series of test gear projects is a 0-20V, 1A bench power supply, stabilised of course as well as short circuit protected.

Workshop Test Gear

The HE project team have prepared a feature giving their views about what you need in the way of test gear in your workshop. It's a thoroughly practical approach and continually bears in mind the limitations of finance.

How TV Signals are Propogated

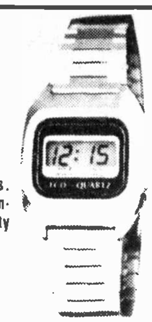


Put up an aerial in most areas of Britain and you'll have no trouble in getting a good signal but that's only because the broadcast engineers have taken into account a multitude of factors. We take a look at this subject in the March issue.

The March issue will be on sale February 9th

The items mentioned here are those planned for the next issue but circumstances may affect the actual content.

SAME AS ETI OFFER



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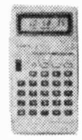

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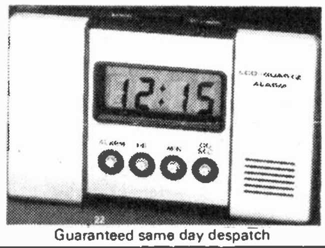

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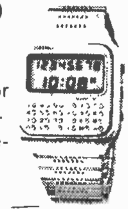

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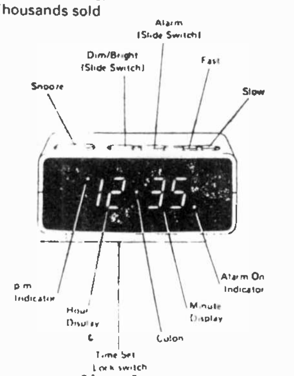

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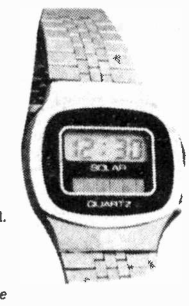

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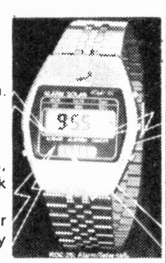

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HEADLIGHT DELAY

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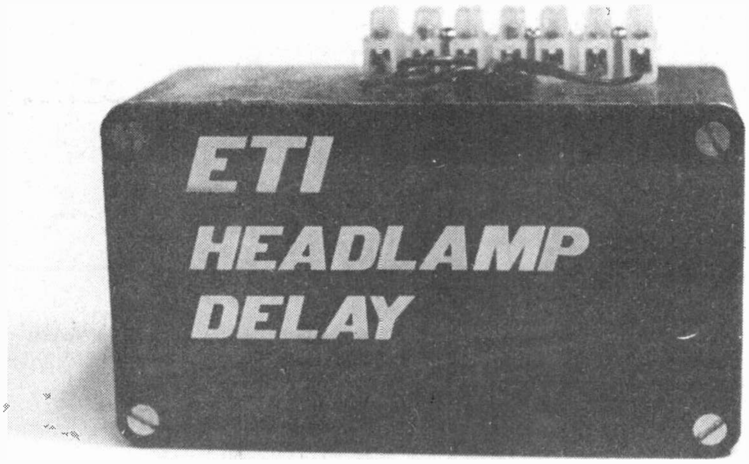


THIS SIMPLE LITTLE UNIT lets you use your car head or spot lights to illuminate your pathway for a pre-set period of about 50 seconds after you have parked the vehicle. At the end of this period the unit turns the lights off automatically

The unit thus enables you to avoid walking into dustbins or tripping over junk that may be obstructing your private driveway, and helps you avoid stepping into various nasty bits that may be laying on the public sidewalk. The unit is easy to install in the vehicle.

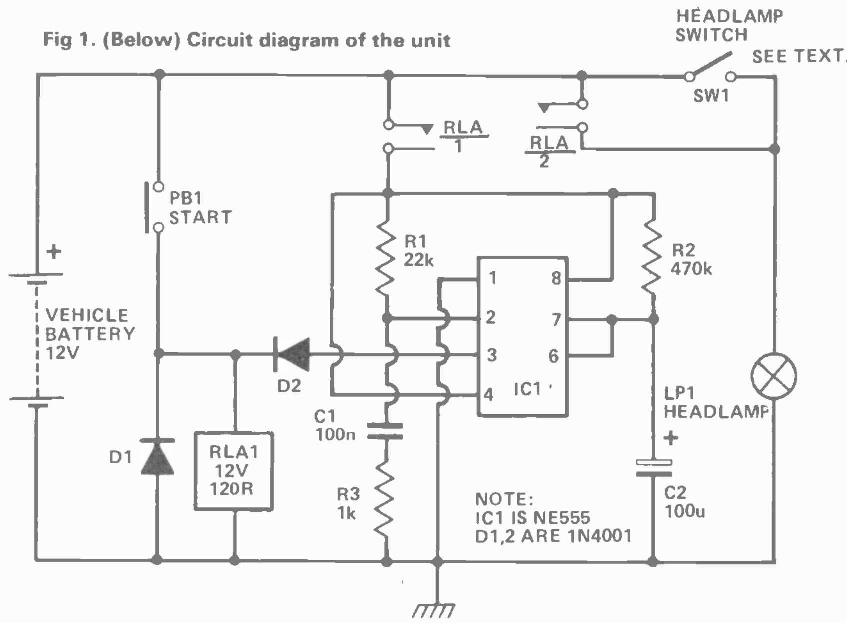
Construction and Use

Construction of the unit should present no problems at all. The relay can be any 12V type with a coil resistance of 120ohms or greater, and with two or more sets of N.O. contacts that are rated at 3 amps or greater.

When it comes to installing the unit, note that two methods of correction to the vehicle are possible. On some vehicles the headlight switch is connected directly to he battery so that the headlights operate even when the ignition is turned off (see Fig 2a). In this case take connection 4 of the 5-day terminal block directly to the live side of headamp switch SW1, and connection 5 to the headlamp side of SW1.

The alternative connection is shown in Fig 2b. Here, the headlight switch is wired in series with the vehicles ignition switch, so that the headlights only operate when the ignition is turned on. If your vehicle uses this type of connection, take connection 4 of the 5-way terminal block to the live side of the ignition switch, and take connection 5 to the headlamp side of SW1. ▶

Fig 1. (Below) Circuit diagram of the unit



HOW IT WORKS

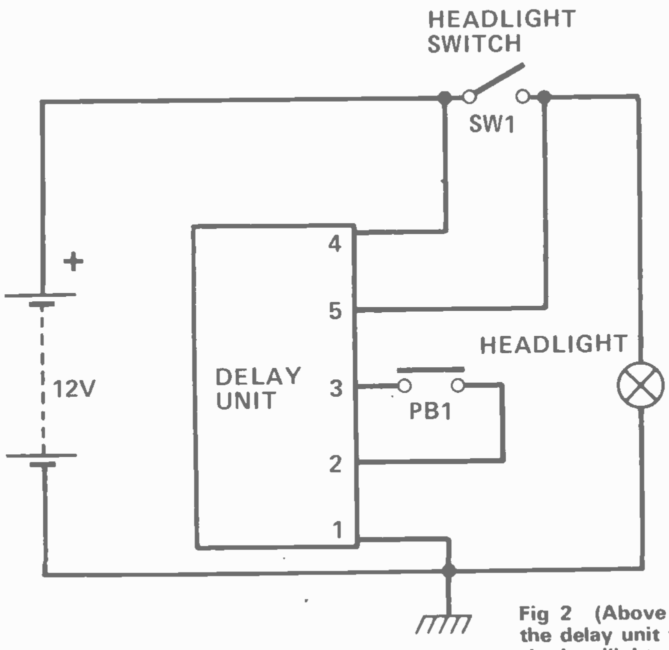
The unit is designed around a type-555 timer i.e., with a relay output. The relay has two sets of normally-open contacts. Normally, START switch PB1 and the relay contacts are open, so zero power is fed to the timer circuit and (assuming that HEADLIGHT switch SW1 is open) the headlights are off. Circuit Action is initiated by briefly closing push-button switch PB1.

When PB1 is momentarily closed power is fed directly to the relay coil, and the relay turns on. As the relay turns on contacts RLA/2 close and apply power to the headlights and contacts RLA/1 close and apply power to the timer circuit, but pin 2 of the IC is briefly tied to ground via C1 and R3 at this moment, so a negative trigger pulse is immediately fed to pin 2 of the IC and a timing cycle is initiated. Consequently, pin 3 of the IC switches high at the moment that the relay contacts close, and tbus locks the relay on irrespective of the subsequent state of switch PB1.

The 555 is wired as a one-shot timer or monostable with a timing period of about 50 seconds (determined by R2 and C2). Thus, the relay and headlights are held on for the duration of this 50 second timing period. At the end of the timing period pin 3 of the IC switches to the low state, so the relay turns off and contacts RLA/1 and RLA/2 open, removing power from the timing circuit and the headlights. The operating sequence is then complete.

BUYLINES

With the small number of components involved, it would be surprising if there were any problems in obtaining them.



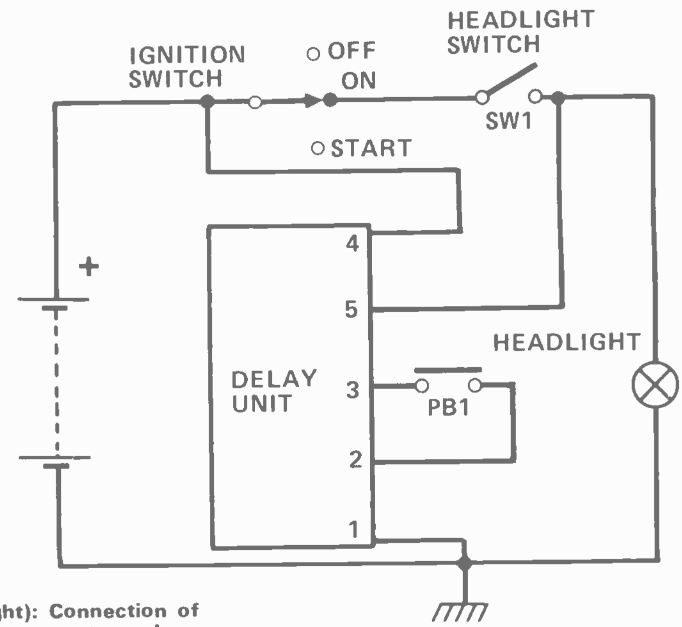


Fig 2 (Above right): Connection of the delay unit to a car system where the headlights are independent of the ignition switch.

(Above Left): Connection to all other systems!

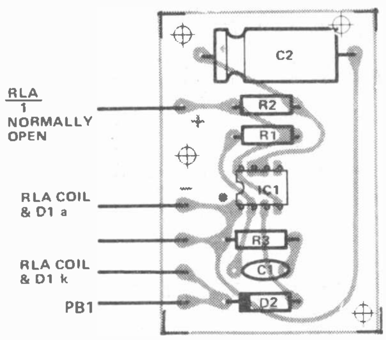
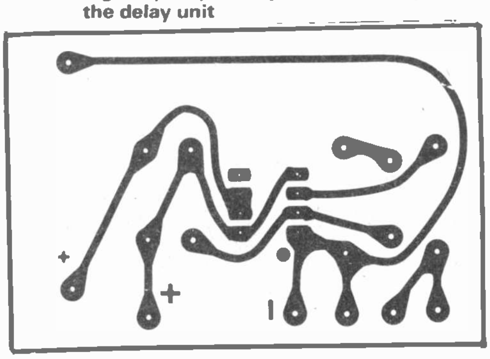


Fig 3. (Left): Component overlay for the delay unit



PARTS LIST

RESISTORS
R1, 22k
R2, 470k
R3, 1k

CAPACITORS
C1 100n polyester
C2, 100u elect.

SEMICONDUCTORS
IC1 NE555
D1, 2 IN4001

MISCELLANEOUS
Relay rated at 3A 2 pole c/o Coil 7120 SPST push button 5 way terminal. Block rated at 5A Die-cast case.

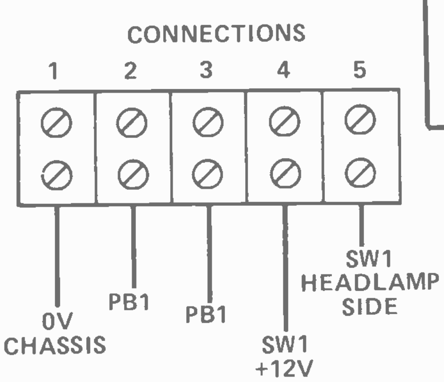
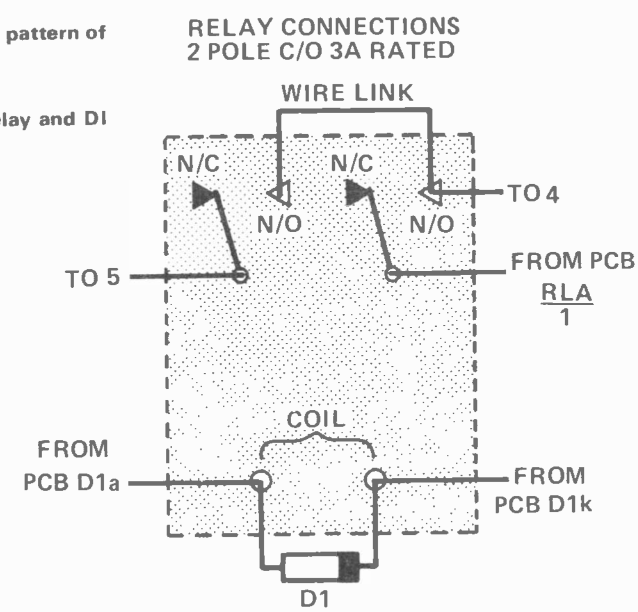
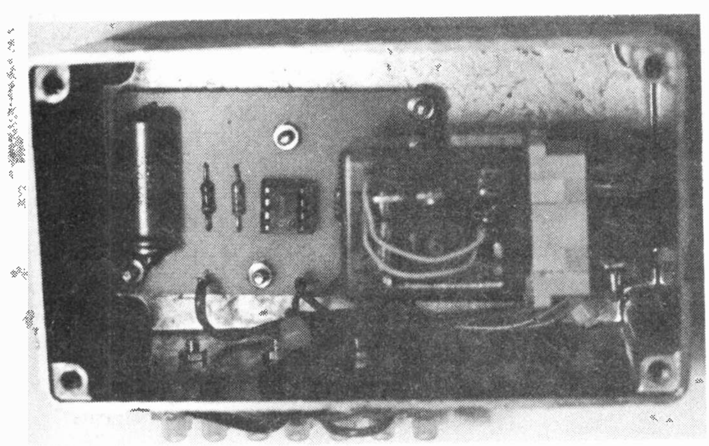


Fig 4. (Left): Wiring of the delay unit to a 5 terminal connection block

Fig 5. (Above): Full size foil pattern of the headlight delay PCB.

Fig 6. (Below right): The relay and DI wiring.





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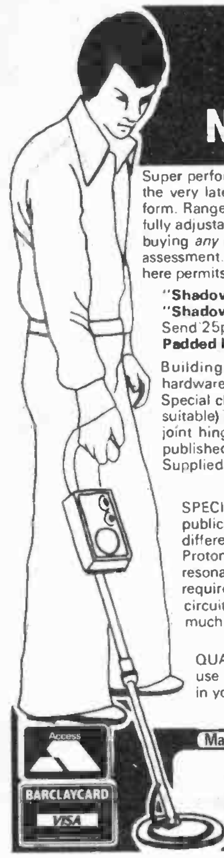

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Sept. 78	Cross Hatch Generator	T021	1 40	12.64	BEGHL
	Stac Timer	T022	2.30	23.26	BEJL
	Wheel of Fortune	T023	1 35	8 36	BEHL
Oct. 78	Complex Sound Generator	T024	2.95	21.88	BEH
	R.F. Power Meter	T025	1 20	12.94	BEHL
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Oct. 78	Proximity Switch	T028	1 95	13 11	BEGH
Feb. 78	Ultra Sonic Receiver	T029	70	9.03	BEH
Feb. 78	Ultra Sonic Transmitter	T030	55	4.57	BEH
Nov. 78	Cuts Cassette Interface	T031	2.25	12 76	BEH
	Audio Oscillator (2 pcbs)	T032	2 90	33 74	BEHL
Dec. 78	Car Alarm (2 pcbs)	T033	1 80	5.52	BEJ
	Wine Temperature Meter	T034	1 10	5.79	BEHL
	Curve Tracer	T035	1 00	9 31	BEHL
	Eprom Programmer	T036	2 25	20 21	BEH
	Eprom Programmer P.S U.	T037	1 30	5.09	BE
Jan. 78	Car Tachometer	T038	1 75	10.00	BF
	Digital Module A & B (2 pcbs)	T039	1.80	18.77	BE
	Digital Dial (Excl T039)	T040	1.25	7 60	BE
	Log Converter	T041	3.50	23.66	BE
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Dec.	544 Heart Rate Monitor	1 10
	447 Audio Phaser	1 60
	446 Audio Limiter	1.35
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Jan	570 Reaction Tester	1.60
	~~549 Metal Locator I~~	95
	Patch Detector	60
	~~Heads or Tails~~	.60
Feb.	448A Headphone Amp	60
	449 Balanced Pre-Amp	75
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	Door Bell	75
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	Drill Controller	70
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	Bongas	.75
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COMP COMPUTER COMPONENTS

CELLULAR LOGIC IMAGE PROCESSING

At University College, London, there is a research group working on a method of image processing which could prove to be the link between the human eye and the TV camera. Computing Today's Phil Cohen talked to Dr. Michael Duff about Cellular Logic Image Processing.

CELLULAR LOGIC IMAGE PROCESSING was first proposed in 1958 by S. Ungar in the States. It was suggested that the cells of the human eye do a lot of the processing *before* what we see is fed up the optic nerve to the brain.

What exactly do we mean by image processing?

Generally, it means processes like perimeter-finding — producing the outline of an object, or skeletonising — finding a set of lines which are unbroken and follow the object's shape.

This sort of process can be used in such diverse applications as fingerprinting, character recognition (OCR) or even intruder detection (spotting movement on a TV picture) but perhaps the two most useful areas will be biomedical scanning — chromosome counting or looking for abnormalities on X-ray plates — and production line quality control.

Parallel Processing

The model of the human eye previous to 1958 was of a simple camera — the point-by-point information was fed to the brain, which did all the clever processing.

However, it was pointed out that for processes such as edge-finding it was much more efficient to use a parallel processing system.

The essential difference between serial and parallel processing schemes is that in a serial scheme the data is processed bit by bit in a central unit (CPU) and the intermediate results are stored in memory. In parallel processing the data is fed in as an array and the processing takes place all at the same time — *there is one processor for each data element*. The intermediate results are passed from processor to processor as the calculations continue.

In the human eye, then, the question is: could a number of cells just behind the light-detecting ones be the parallel processors, responding to commands from the brain to find the edges of objects, or detect movement? Certainly it is known that the edges of the field of vision are extraordinarily good at spotting movement — could this be because the structure of the eye is different there?

The Processors

Going back to the CLIP machine, in this sort of application the type of processor we are talking about is in no way as complex as a modern MPU. The sort of data it receives are single-bit inputs from the image sensor ▶

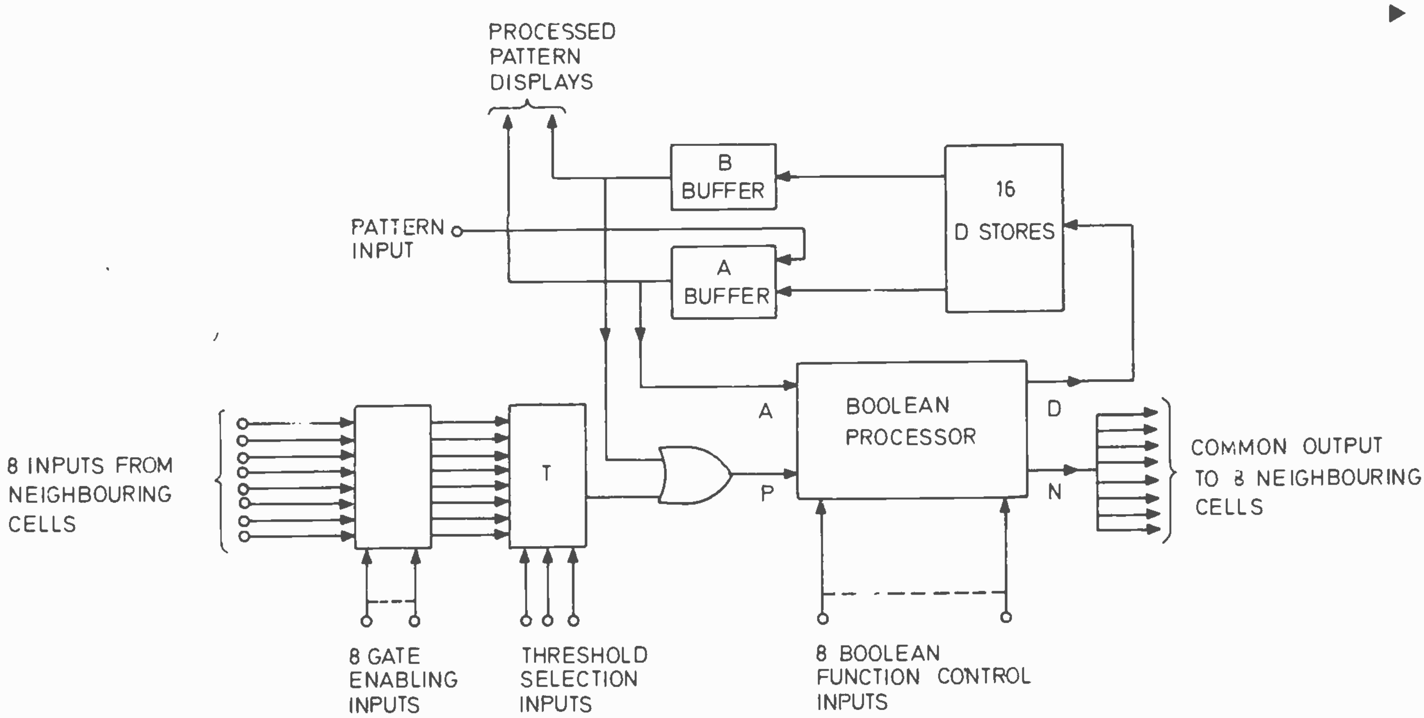


Fig. 1: The block diagram of one of the processors.

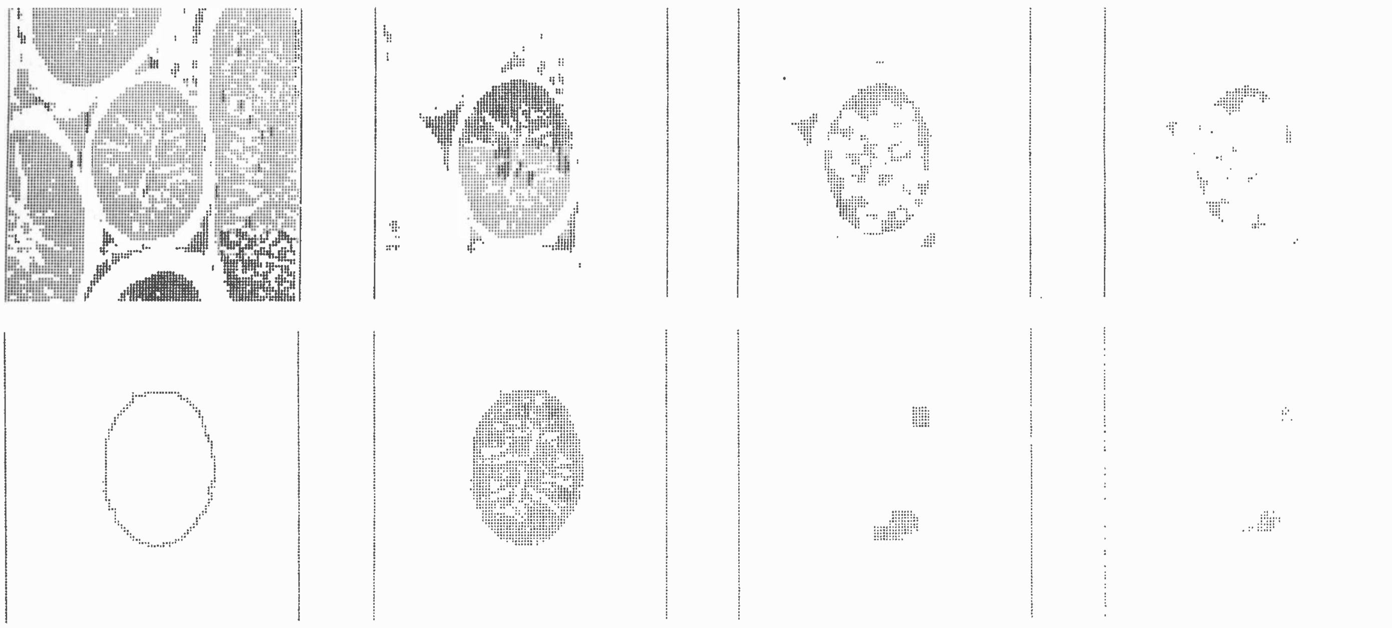


Fig. 2: Stages in the processing of a microscope picture of part of a rat's anatomy.

associated with it and one bit each from the eight nearest processors' outputs.

Why eight? Well, this provides an optimum "connectivity" — too few and the processing becomes slow, too many and the cost of connecting the processors together becomes enormous.

The sort of operation the processor would have to perform would be to give an output if any of its neighbours gave an output *and* the image bit fed to it was a "0".

The program example (in PET BASIC) given shows the usefulness of this sort of process. Of course, we cannot perform parallel processing directly in BASIC — the program has to scan the image bit by bit, simulating the action of each processor in turn.

The important thing about using this sort of scheme for image processing is that the outputs of the units will change in "waves", travelling at speeds dependant on the propogation delay of the devices involved. This means that, by having four "edge registers" which are not connected to the image input, we can do things like finding the outer edge of an object by starting a signal from the edge registers and programming the processors to stop propogating it at the edge of the object. The program example carries out this sort of process.

Structure

In the CLIP machine, the processors each have the structure shown in Fig 1. Each is connected to its eight neighbours and its output fans out to the same neighbours. There is also a "pattern input" for connection to the picture signal (which is derived from a TV camera and multiplexed to provide each processor with a 1-bit signal from one point of the camera's image).

The gate enabling threshold selection and function control inputs are from a programming bus common to all processors.

The gate enabling inputs allow instructions like "If the output from the processor to the left is '1' . . . "The threshold selection inputs allow "If more than three inputs are '1' . . ."

Combining the two allows very comprehensive processing of the inputs — "If any two of the processors to the left give and output . . ." for example.

There are also various buffers for more complex instruction types.

The boolean processor itself can be programmed via the function controls to "look" like any combination of memory-less logic gates.

Implementation

The processors come in custom-built ICs, each chip containing eight units. The CLIP 4 machine contains an array of 96 x 96 processors.

CLIP 4 is the product of ten years of research at University College. It's a commercially viable product — it fits into one 7-foot instrumentation rack, including power supplies and controller. The cost? In the region of £30-40 thousand.

The processors themselves are based on NMOS technology and the control circuitry (the part that acts as a "conductor" — in the musical sense — directing all of the processors) is implemented in hardware — an MPU would be too slow!

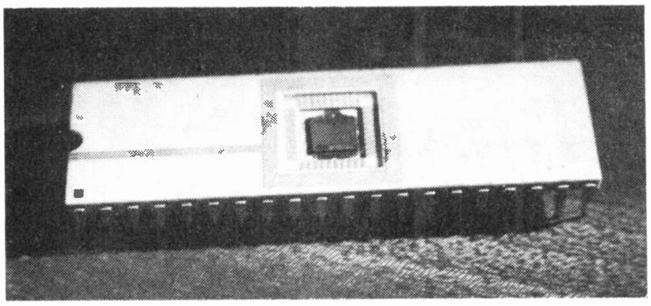
The input signal is from a TV camera (only part of the picture is used — 96 lines x 96 points). This is encoded either as a black and white picture with no grey or as a grey-scale image. CLIP can handle grey-scale pictures, performing processes such as smoothing.

The output from the system would be to a video monitor or, in some applications, just a few bits of data to another peripheral, such as a warning indicator in the case of intruder detection.

Software

The software for the system consists of a series of inputs for the function-definition bus of the processors and a loop structure which is linked to the processor outputs.

Looking at Fig. 2, the machine is trying to find the outline of the largest isolated mass of black in the input pattern.



One of the chips in the CLIP — each contains eight processors.

The original input is shown in the top left. The first instruction propagates white from the edge registers through all connected black. This leaves the pattern second from the left on the top line. The program then "erodes" the image by removing all black dots not surrounded by black and then removing their neighbour black dots as well.

It repeats this erosion until one more step would cause all black to vanish completely. This leaves the image as it is at the end of the top line.

The program then surrounds each black by eight blacks. It does this twice. It then recalls from the original input pattern the part which is "connected" to the current pattern. The last step finds its outline.

Naturally, this sort of software cannot be written in a conventional language — the group have developed what is effectively an assembler for the system and all the groups working on image processing worldwide are due to meet this spring to discuss a suitable high-level language.

Applications

One very interesting application mentioned earlier is production line control. CLIP can tell the difference between an object which has been correctly punched out of metal and one with the wrong surface area or the wrong number of holes, etc.

The amazing thing is that it can do this fifty times a second! In fact, the machine can perform 1500 parallel processes per TV frame period.

The machine could be fitted to the "reject" solenoid on a production line so that badly produced pieces could be pushed off the line.

Another area in which the machine could be useful is in microscopic counting. There are systems available already which will count the number of items in a picture, or even the number between certain size limits, but the inherent flexibility of CLIP make it invaluable for complex tasks such as red blood cell deformity checking and other applications where previously a human operator was the only alternative.

One slightly more frightening possibility is the use of such a system in facial recognition — enabling authorities to keep track of every individual automatically.

When the system was first proposed about ten years ago, the device which was envisaged was a pair of super-binoculars, with photo-diodes at one end and LEDs at the other, modifying images so that only moving objects, or even more selectively, only enemy tanks would be seen! This is some way from the present state of the art but in a few years . . . who knows?

We would like to thank Dr Michael Duff and University College in general for their help. ETI

CLIP SIMULATION PROGRAM

The following program simulates the action of the CLIP machine by pretending to be each processor in turn in a 10 x 10 array. It's very slow to run (several minutes) and this shows the advantage which a parallel processing system has over a serial one.

```
10 S=10
```

S is the dimension of the 2-dimensional square processor array.

```
20 DIM A(S, S), B(S, S)
```

A is the image input to the system. B represents the processor outputs. Load the image into the system:

```
30 FOR I=2 TO S — 1
40 FOR J = 2 TO S — 1
50 READ A(S, S)
60 NEXT J
70 NEXT I
```

The outer layer of processors represent the edge register, in which we can initialise processing 'ripples' (see text).

```
80 DATA 0,0,0,0,0,0,0,0
90 DATA 0,1,1,1,1,1,1,0
100 DATA 0,1,0,0,1,0,0,0
110 DATA 0,1,1,0,1,1,0,0
120 DATA 0,1,1,0,1,1,1,0
130 DATA 0,1,1,1,1,1,0,0
140 DATA 0,0,0,0,0,0,0,0
150 DATA 0,0,0,0,0,0,0,0
```

Now for the 'seed' which will propogate during processing. Note that it's in the edge register:

```
1010 B(S, S)=1
```

Now print the results so far:

```
1014 GOSUB 2000
1015 F=0
```

F is set to 1 if any changes are made.

```
1020 FOR I=2 TO S — 1
1030 FOR J=2 TO S — 1
```

. . . For each processor

```
1040 FOR K= —1 TO 1
1050 FOR L= —1 TO 1
```

. . . For each of the eight 'connected' processors

```
1055 IF L=0 AND K=0 THEN 1090
```

. . . Except the one we're simulating

```
1060 IF B(I+K, J+L)<>1 OR A(I, J) <>0 THEN 1090
```

skips the next bit unless the image is zero at this point *and* one of the neighbours outputs is one.

```
1070 IF B(I,J)=0 THEN F=1
```

B(I,J) is going to be set to 1. F is set to 1 if this represents a change.

```
1080 B(I,J)=1
1090 NEXT L:NEXT K:NEXT J:NEXT I
1130 IF F=1 THEN 1014
1140 STOP
```

repeats the process until the output is stable (ie there were no changes during this pass).

The following subroutine prints the results:

```
2000 REM PRINT
2010 PRINT " " : REM CLEAR SCREEN CHARACTER
2020 FOR I=1 TO S
2030 FOR J=1 TO S
2040 IF A(I,J) =1 THEN PRINT "A";:GOTO 2060
2050 PRINT " ";
2060 NEXT J
2070 PRINT " ";
2080 FOR J= 1 TO S
2090 IF B(I,J)=1 THEN PRINT "B";:GOTO 2110
2100 PRINT " ";
2110 NEXT J
2120 PRINT
2120 NEXT I
2140 RETURN
```

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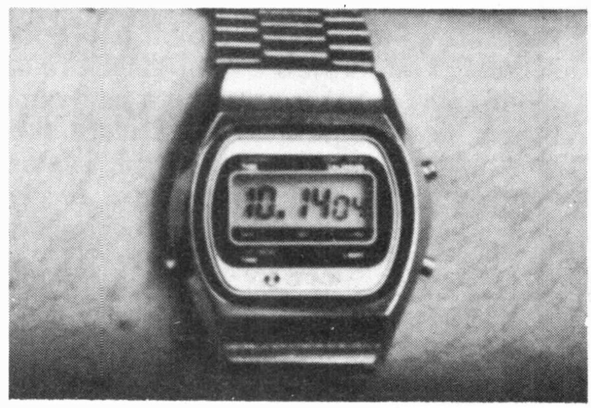

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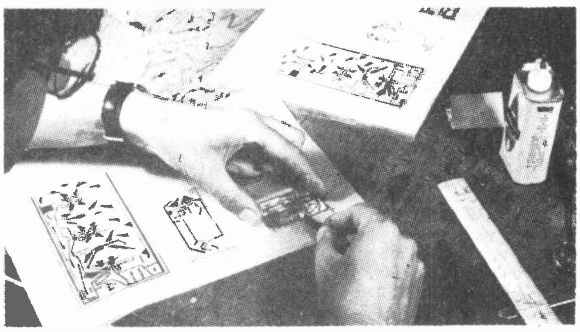

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004	Metal Locator Mk II	Feb 78
	Ultrasonic Tx/Rx	Feb 78
	5 Watt Stereo Amp (modified)	Jan 77
	Metronome	Feb 78
	Shutter Time	Feb 78
005	Op-Amp Supply Frequency Shifter LCD Panelmeter Light Dimmer (3 times)	Mar 78
006	CMOS Switched Preamp From Experimenters P.S.U. 555 Boards (twice	"Electronics Tomorrow"
007	Star Trek Radio	May 78
	CD Ignition	May 78
	CCD Phaser	May 78
	White Line Follower	April 78
008	Tank Battle Helping Hand	May 78
009	AM/FM Radio Bridge Oscillator CMOS Stars & Dots	June 78
010	Bench Amplifier Freezer Alarm Marker Generator LED Dice Watchdog (2 PCBs) Stars & Dots PSU	Project Book Six
011	Noise Generator General Preamp Flash Trigger Compander Active Crossover (2 PCBs)	Project Book Six
012	Disco Lightshow Stereo Simulator Digital Thermometer	Project Book Six
013	Amplifier Module Amplifier PSU Equaliser Equaliser PSU	Project Book Six
014	Skeet Game Sweep Oscillator Burglar Alarm GSR Monitor	Project Book Six
015	UFO Detector	July 78
	Torch Finder (twice)	July 78
	Etiwet (twice)	Aug 78
016	Stac Timer Xhatch Gen Wheel of Fortune	Sept 78
017	Complex Sound Gen Tele Bell Extender Power Bulge	Oct 78
018	RF Power Meter	Oct 78
	Proximity Switch	Oct 78
	Audio Oscillator (2)	Nov 78
019	Car Alarm (2)	Dec 78
	Wine Temp (2)	Dec 78
	Curve Tracer	Dec 78
020	Digital Tacho	Jan 79
	Module	Jan 79
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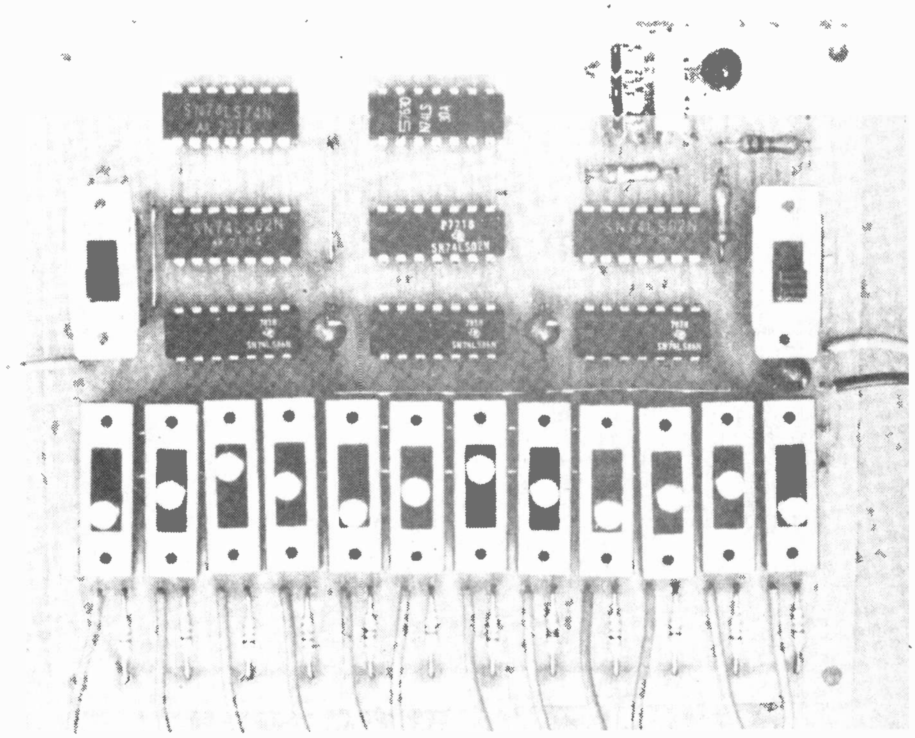
LOGIC TRIGGER

No need to be in the dark any more, see your pulses, doing their stuff before your very eyes.

WHEN USING AN oscilloscope to examine or fault find digital circuitry, it is often desirable to see what happens just before a pulse or edge occurs. An example of this is when measuring the propagation delay in a ripple counter. Here it is easy to trigger on the last output but the edge of the counter input which initiated the change in the output may have occurred over 100 ns earlier. Even with the delay line built into modern oscilloscopes the edge is too early to see.

Triggering on the input waveform allows this edge to be seen but if the output pulse occurs only once every thousand or so pulses it will not be seen. With this unit, the output of all the stages in the divider can be examined and a pulse can be generated anywhere in the cycle. By selecting a pulse very close to, but before, the edge in question and using it to trigger the oscilloscope (use ext trigger) both the clock waveform and output waveform can be see n.



SPECIFICATION

Modes	Asynchronous or synchronous
No. of inputs	12 address, 1 clock
Loading	
address	0.4 UL (TTL)
clock	0.4 UL (TTL)
Pulse extension mono	10 ms
Pulse indication	LED
Minimum pulse detectable	<40 ns
Propagation delay	<45 ns
Trigger (synchronous)	positive or negative edge of clock input
Set up time (synchronous) address to clock	<40 ns
Output	logical "1" when input agrees with switch setting and/or clock (synchronous only)
Power requriement	+5V @ 50 mA

With the advent of microprocessors it has become increasingly difficult to fault find as things happen (e.g. the CE input to a memory may go low) only when a particular address is given. As the address bus is always in motion it is almost impossible to trigger the scope on any one address. Again with this unit the address bus is interrogated along with the necessary write or read lines, and its output can be used to trigger the oscilloscope only when the correct sequencer is received.

Construction

We mounted all the components on the board including the switches. The only difficult (fiddly) bit is the writing of the three position slide switches which have to be preassembled before fitting to the pcb. The wiring is shown in fig. 3.

To aid this we have provided 12 holes in the pcb the size of the toggle of the switches; if the ▶

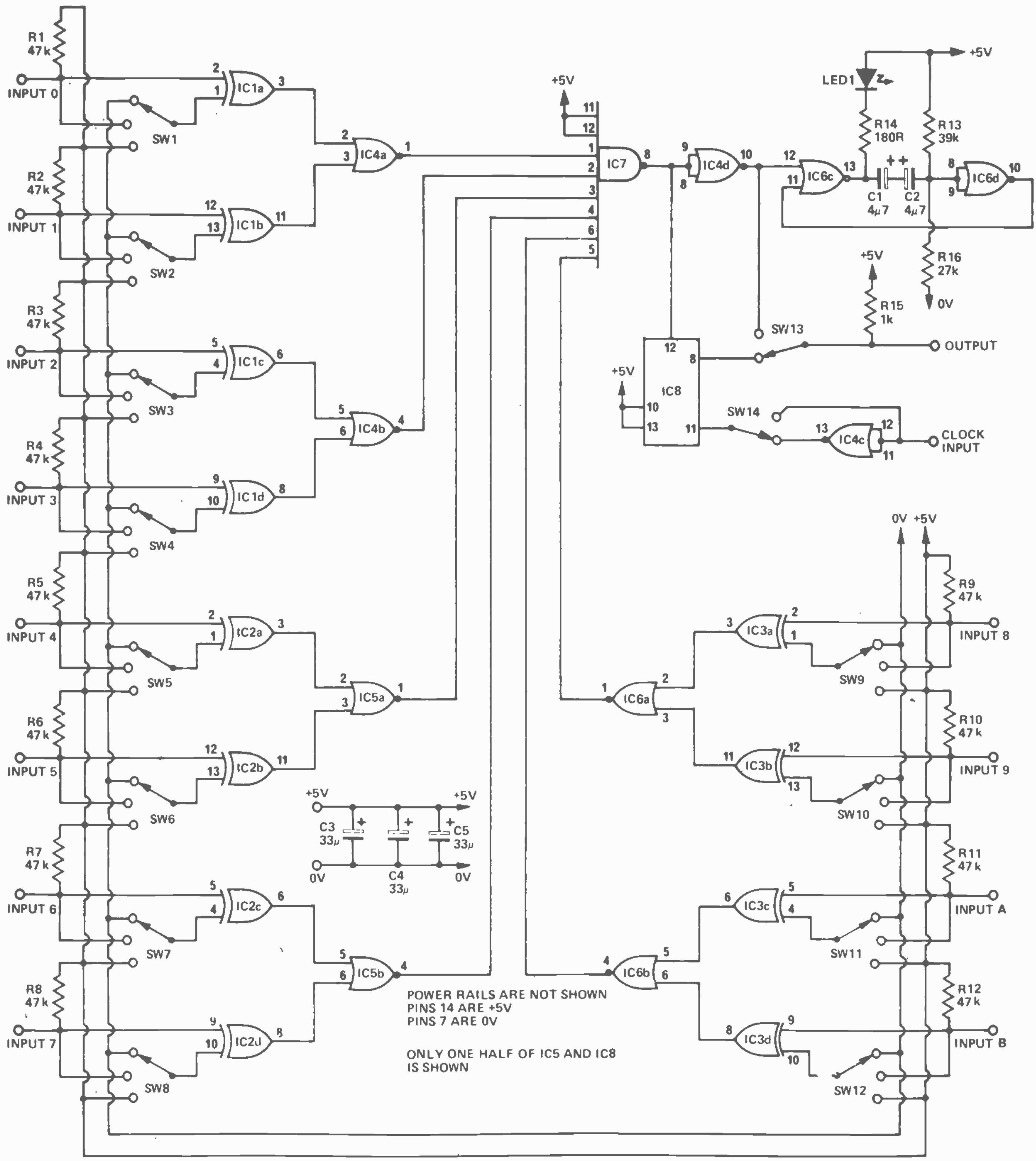


Fig 1. Full circuit diagram of the logic unit.

PARTS LIST

RESISTORS	all ½W, 5%
R1-R12	47k
R13	39k
R14	180R
R15	1k
R16	27k
CAPACITORS	
C1,2	4µ7 25V electro
C3-C5	33µ 16V tantalum
SEMICONDUCTORS	
IC1-IC3	74LS86
IC4-IC6	74LS02
IC7	74LS30
IC8	74LS74
LED1	Red LED
MISCELLANEOUS	
PC board ETI 141	
Twelve 3 position slide switches	
Two 2 position slide switches	
Front panel	
Box to suit	

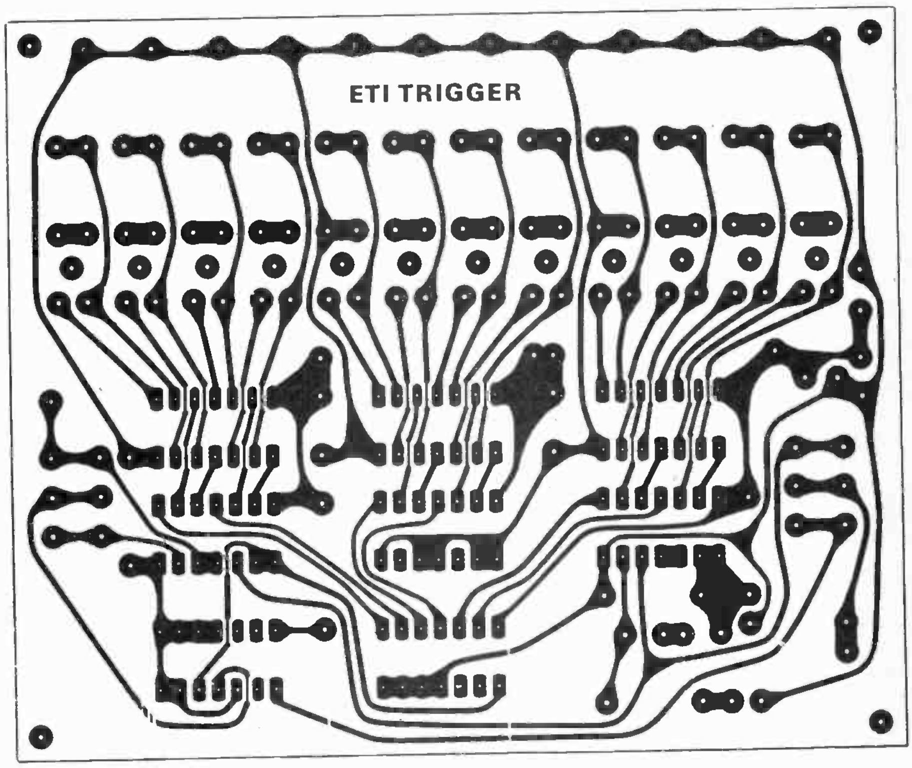


Fig 2 (right): Foil pattern shown full size.

HOW IT WORKS

The twelve inputs are compared to the levels set on the slide switches SW1-SW12 by the exclusive OR gates IC1-IC3. These ICs have a high output only if the two inputs differ. If they are the same, either both low or both high, the output will be low. If the two inputs are joined together, as when the switches are in the don't care position, the output will always be low.

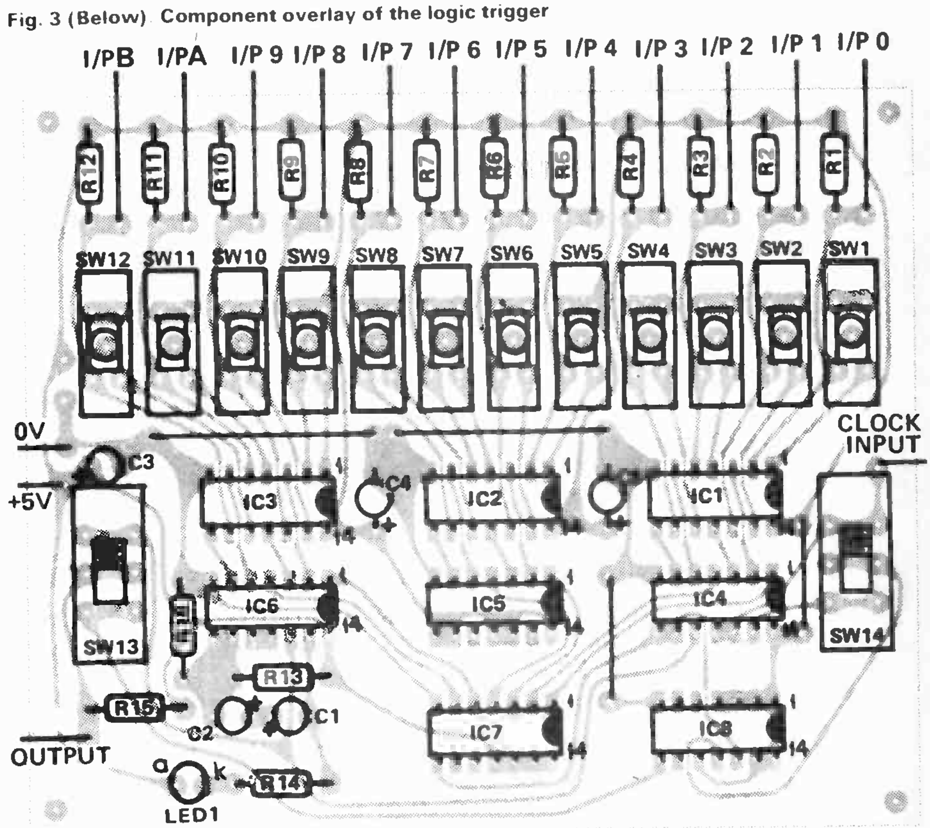
The outputs from the exclusive OR gates are combined in pairs by the NOR gates IC4-IC6. If the 12 input signals match the preset selection, the output of all 6 NOR gates will be high. If any one is not in agreement with the selection one or more of the NOR gates will have a low output.

These NOR gate outputs are combined by IC7 which is an eight input NAND gate. The output of this gate will low only if all 12 inputs match. The output of this IC is inverted by IC4/d to provide the asynchronous output.

This output also triggers the monostable formed by IC6/c and IC6/d. This gives a 10 ms long pulse of light the LED indicationg a pulse was received. If it is a steady state signal the LED will stay on.

The output of the NAND gate, IC7, also joins the data input of IC8 (D type flip flop). This IC is toggled on the positive edge of the clock waveform transferring the data to the output. This is the synchronous output. To allow for either positive or negative synchronization an inverter is used on the clock input and either polarity can be selected by SW13.

Fig. 3 (Below) Component overlay of the logic trigger



switches are initially placed upside down in these holes the board will act as a template to provide the correct spacing. We have also used two wires of the switch to provide mechanical support. While only a single pole switch is needed the only ones readily available are two pole.

The switches can now be mated to the PC board with the two longitudinal wires being terminated in the holes provided at the end of the switch bank. ETI

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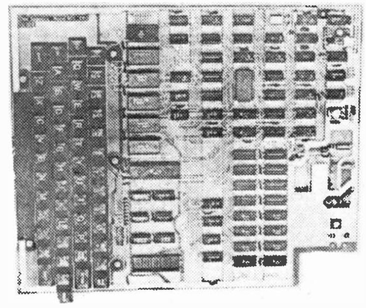

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to $2000. It is more powerful than computer systems which cost over $20,000 in the early 1970's.

This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the President of the United States to tutoring trigonometry all possible by its fast extended BASIC graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many of the other tasks via the broadest lines of expansion accessories in the microcomputer industry.

This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily instruct it or program it to do whatever you want, *but you don't have to.* You don't because it comes with a complete software library on cassette including programmes for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on ready-to-run cassettes. Program it yourself or just enjoy it, the choice is yours.

Standard Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
- Full feature BASIC runs faster than currently available personal computers and all 8080-based business computesr.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper-lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters, without overscan up to 30 x 30 characters.

Extras

- Available expander board features 24K static RAM (additional mini-floppy interface, port adapter for printer and modem and OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

Commands

CONT	LIST	NEW	NULL	RUN	

Statements

CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF...GOTO	IF...THEN	INPUT	LET
NEXT	ON...GOTO	ON...GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

Expressions
Operators
—, +, *, /, ↑, NOT, AND, OR, >, <, <>, >=, <=, =
RANGE 10^{-32} to 10^{+32}

Functions

ABS(X)	ATN(X)	COS(X)	EXP(X)	FRE(X)	INT(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)	SGN(X)	SIN(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)	USR(I)	

String Functions

ASC(X$)	CHR$(I)	FRE(X$)	LEFT$(X$,I)	LEN(X$)	MID$(X$,I,J)
RIGHT$(X$,I)			STR$(X)		VAL(X$)

Plus variables, arrays and good editing facilities.

Fully built and tested. Requires only +5V at 3 amps and a videomonitor or TV and RF converter to be up and running.

There is enormous interest in Superboard, so order early if you wish to avoid inevitably long delivery dates later this year.

FREE 15-DAY TRIAL
Lotus Sound have had so many enquiries with questions about various aspects of Superboard II that in order to save time and ensure your satisfaction we are offering to return the full price to anyone who returns their machine, in good order, within 15 days of delivery.

SOUND

4 MORGAN ST., LONDON E3 5AB

(Phone for appointment)

To: LOTUS SOUND
4 MORGAN ST., LONDON E3 5AB

Please send me ..... Ohio Scientific Superboard Computer(s)
I enclose cheque/PO for £ ....

Name ....

Address ....

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....

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ETI 3

TRANSISTORS

AC107	0.23	BC117	0.15	BC206	0.10	BC559B	0.11	BF184	0.20	BU205	1.30	2N1613	0.18
AC125	0.17	BC118	0.12	BC206B	0.11	BCY42	0.55	BF185	0.20	BU208	1.50	2N1671	1.10
AC126	0.17	BC119	0.25	BC207	0.10	BCY58	0.20	BF194	0.06	BU208-02	1.75	2N1671B	2.20
AC127	0.18	BC125	0.15	BC209B	0.09	BCY71	0.13	BF194A	0.07	BU406	3.60	2N1711	0.20
AC127K	0.23	BC125B	0.16	BC212A	0.10	BCY72	0.13	BF195	0.06	BUY69A	6.75	2N1893	0.25
AC128	0.14	BC126	0.15	BC213L	0.10	BD115	0.30	BF195C	0.07	BUY69B	2.00	2N1905	0.25
AC128K	0.25	BC136	0.15	BC214L	0.10	BD116	0.39	BF195G	0.07	BUY69C	7.00	2N1990	0.25
AC128/176	0.42	BC137	0.15	BC237	0.15	BD123	0.60	BF196	0.06	BUY70A	5.00	2N2060	1.00
AC142	0.18	BC138	0.30	BC237A	0.16	BD128	1.02	BF197	0.06	BUY71	4.50	2N2168	0.20
AC153	0.55	BC140	0.27	BC237C	0.21	BD131	0.35	BF198	0.06	MPS6517	0.48	2N2218A	0.22
AC156	0.50	BC141	0.29	BC238	0.15	BD133	0.40	BF224	0.18	MPS6523	0.27	2N2222	0.18
AC176	0.16	BC142	0.20	BC238B	0.16	BD135	0.30	BF253	0.18	MPSA06	0.90	2N2222A	0.20
AC187	0.50	BC147	0.06	BC238C	0.18	BD136	0.30	BF254	0.18	MV5053	0.72	2N2270	0.39
AC187K	0.55	BC147B	0.07	BC251A	0.15	BD137	0.30	BF255	0.18	NKT214	0.25	2N2368	0.10
AC188K	0.55	BC148	0.06	BC251B	0.17	BD138	0.30	BF257	0.16	NKT224	0.25	2N2484	0.18
ACY20	1.02	BC148A	0.07	BC252A	0.15	BD139	0.30	BF258	0.28	OC22	1.40	2N2904	0.18
ACY22	1.02	BC148B	0.07	BC252B	0.17	BD140	0.30	BF259	0.28	OC26	1.40	2N2906	0.18
AD142	0.87	BC149	0.06	BC252C	0.20	BD144	0.30	BF324	0.20	OC29	0.85	2N3053	0.15
AD143	0.87	BC157	0.06	BC258	0.20	BD168	0.50	BF335	0.25	OC36	1.00	2N3117	1.00
AD149	0.65	BC157A	0.07	BC261A	0.10	BD178	0.72	BF338	0.45	OC44	0.12	2N3440	0.70
AD161	0.35	BC158	0.07	BC262	0.20	BD181	1.32	BF457	0.60	OC45	0.12	2N3638	0.15
AD161/162	0.70	BC158A	0.08	BC267A	0.21	BD183	1.50	BF523	0.22	OC71	0.09	2N3638A	0.16
AD162	0.35	BC158VI	0.09	BC267B	0.22	BD232	0.60	BF594	0.10	OC74	0.10	2N3643	0.24
AD262	0.36	BC159	0.06	BC268	0.21	BD233	0.60	BFR91	5.00	OC75	0.10	2N3692	0.24
AD263	0.36	BC159A	0.07	BC304	0.25	BD234	0.60	BFT43	0.54	OC82	0.48	2N3705	0.06
ADY26	4.74	BC159B	0.07	BC307	0.15	BD235	0.40	BFX29	0.20	OC139	0.50	2N3706	0.06
ADZ11	4.05	BC161	0.25	BC307A	0.15	BD236	0.40	BFX34	0.70	OC203	2.50	2N3707	0.06
AF106	0.45	BC167	0.06	BC307B	0.15	BD237	0.40	BFX84	0.20	OC207	2.70	2N3711	0.06
AF109R	0.36	BC168	0.06	BC308	0.15	BD238	0.40	BFX85	0.20	OC1072	2.50	2N3819	0.20
AF124	0.25	BC169	0.06	BC309A	0.15	BD434	0.40	BFX88	0.20	OC1074	2.50	2N3899	3.00
AF125	0.25	BC170B	0.07	BC317B	0.15	BD507	0.50	BFY18	0.50	R2008B	2.10	2N3904	0.06
AF126	0.25	BC170C	0.07	BC322	0.10	BD508	0.50	BFY19	0.50	TIP30	0.35	2N3905	0.06
AF127	0.25	BC171	0.06	BC327	0.16	BD518	0.50	BFY33	0.50	TIP31	0.45	2N3906	0.06
AF139	0.32	BC171A	0.07	BC328	0.16	BD537	1.02	BFY34	0.50	TIP31A	0.45	2N4037	0.25
AF178	0.30	BC171B	0.07	BC337	0.16	BD587	1.40	BFY46	0.50	TIP32	0.45	2N4058	0.10
AF179	0.30	BC172	0.06	BC338	0.16	BDX32	1.90	BFY51	0.12	TIP33	0.60	2N4222A	0.65
AF200	0.36	BC172A	0.07	BC348A	0.15	BDY16	0.50	BFY52	0.12	TIP42	0.60	2N4348	2.00
AF201	0.39	BC172B	0.07	BC350A	0.17	BDY20	0.50	BFY81	4.00	TIP2955	0.65	2N4448	1.50
ASY73	0.30	BC172C	0.07	BC441	0.20	BF115	0.35	BNY39	0.35	TIS90	0.18	2N5172	0.25
ASZ15	0.80	BC173	0.06	BC461	0.24	BF121	0.20	BSX20	0.18	2N3448	0.30	2N5245	0.30
ASZ16	0.60	BC173B	0.07	BC546	0.10	BF123	0.20	BSX52	0.33	2N404	0.45	2N5296	0.40
ASZ17	0.60	BC174B	0.07	BC547	0.11	BF125	0.20	BSY20	0.21	2N524	0.45	2N5458	0.25
AU103	0.90	BC177A	0.12	BC547A	0.11	BF127	0.20	BSY25	0.30	2N526	0.48	2N5496	0.60
AU107	1.00	BC177B	0.12	BC547B	0.11	BF137	0.21	BSY26	0.30	2N527	0.48	2N5870	0.65
AU110	0.90	BC178B	0.12	BC547C	0.11	BF152	0.15	BSY27	0.30	2N685	3.50	2N5926	0.55
AU210	0.90	BC179	0.12	BC548A	0.11	BF154	0.15	BSY29	0.54	2N705	0.10	2N6123	0.85
BC107	0.06	BC182A	0.09	BC548B	0.11	BF157	0.37	BSY39	0.15	2N706	0.10	2S003	0.75
BC107A	0.07	BC182B	0.09	BC548C	0.11	BF158	0.15	BSY52	0.33	2N706A	0.11	2S302	0.90
BC107B	0.07	BC183A	0.09	BC549A	0.11	BF167	0.25	BSY54	0.39	2N708	0.12	2S303	0.90
BC108	0.06	BC183LA	0.09	BC549B	0.11	BF173	0.20	BSY56	0.36	2N1039	0.15	2S304	0.90
BC108A	0.07	BC183LB	0.09	BC550	0.11	BF174	0.20	BSY80	0.36	2N1059	0.15	2S305	0.90
BC108B	0.07	BC184	0.08	BC557	0.11	BF177	0.25	BSY84	0.30	2N1101	0.15	2S323	1.00
BC109	0.06	BC184L	0.09	BC557A	0.11	BF178	0.25	BU105	1.08	2N1102	0.15	2S732	1.00
BC109B	0.07	BC184LB	0.10	BC557B	0.11	BF179	0.25	BU105-04	1.08	2N1132	0.20		
BC109C	0.07	BC186	0.19	BC557C	0.11	BF180	0.20	BU108	1.80	2N1304	0.50		
BC113	0.12	BC187	0.19	BC558	0.11	BF181	0.20	BU126	1.00	2N1305	0.50		
BC114	0.15	BC204	0.08	BC558A	0.11	BF182	0.20	BU133	1.75	2N1307	0.50		
BC116	0.13	BC204B	0.09	BC558B	0.11	BF183	0.20	BU204	1.30	2N1309	0.50		

TTL

7400	.12	7426	.25	7470	.28	74107	.28	74148	1.20	74176	.90
7401	.12	7427	.25	7472	.22	74109	.45	74150	1.00	74177	.90
7402	.12	7428	.34	7473	.26	74110	.46	74151	.60	74178	1.20
7403	.12	7430	.13	7474	.20	74111	.70	74153	.60	74179	1.10
7404	.13	7432	.24	7475	.28	74116	1.60	74154	1.06	74180	.70
7405	.13	7433	.32	7476	.13	74118	.82	74155	.63	74181	1.95
7406	.29	7437	.24	7483	.75	74119	1.30	74156	.63	74182	.75
7407	.29	7438	.24	7484	.90	74120	.82	74157	.63	74184	1.20
7408	.14	7440	.13	7485	.90	74121	.26	74158	1.70	74185	1.20
7409	.14	7441	.52	7486	.26	74122	.40	74160	.80	74186	7.20
7410	.13	7442	.55	7489	2.00	74123	.55	74161	.80	74188	5.40
7411	.18	7444	.90	7490	.35	74125	.45	74163	.80	74190	1.10
7412	.21	7445	.70	7491	.65	74126	.46	74164	.90	74191	1.00
7413	.25	7446	.70	7492	.45	74128	.62	74165	.90	74192	1.00
7414	.54	7447	.66	7493	.36	74132	.70	74166	1.00	74193	1.10
7416	.27	7448	.60	7494	.80	74141	.58	74167	2.70	74194	.92
7417	.27	7450	.13	7495	.55	74142	2.02	74170	1.70	74195	.85
7420	.13	7451	.13	7496	.62	74143	2.02	74172	4.00	74196	.92
7421	.28	7452	.13	7497	2.40	74144	2.02	74173	1.20	74197	.92
7423	.25	7454	.13	74100	.95	74145	.65	74174	.90	74198	1.60
7425	.22	7460	.13	74105	.40	74147	1.35	74175	.70	74199	1.50

CMOS

4000	.15	4014	.85	4025	.20	4043	.85	4069	.20	4508	2.30
4001	.15	4015	.80	4026	1.35	4044	.85	4070	.20	4510	1.10
4002	.20	4016	.45	4027	.35	4049	.28	4072	.20	4511	.70
3006	.95	4017	.55	4028	.70	4050	.45	4073	.20	4512	.95
4007	.20	4018	.90	4029	.90	4051	.88	4075	.20	4516	.70
4008	.94	4019	.45	4030	.50	4052	.88	4076	1.10	4518	.65
4009	.46	4020	.60	4033	1.40	4053	.88	4078	.20	4520	1.10
4010	.50	4021	.85	4035	1.10	4055	1.00	4081	.20		
4011	.15	4022	.85	4040	.90	4060	1.00	4082	.20		
4012	.15	4023	.20	4041	.80	4066	.35	4502	.90		
4013	.35	4024	.68	4042	.75	4068	.20	4507	.52		

RESISTORS

¼W Values available in E12 series from 10R to 1M. Price 0.03 each.

½W Values available in E12 series from 1R0 to 10M. Price 0.03 each.

1W Values available in E12 series from 2R2 to 10M. Price 0.06 each.

2W Values available in E12 series from 10R to 10M. Prices 0.11 each.

5W Values available in E6 series from 1R0 to 6K8.
Prices 1R0 to 1Ko 0.19 each.
1K5 to 3K3 0.22 each.
4K7 to 6K8 0.24 each.

7W Values available in E12 series from R47 to 22K.
Prices R47 to R82 0.25 each.
1R0 to 1K0 0.26 each.
1K2 to 12K 0.27 each.
15K to 22K 0.28 each.

11W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 1K0 0.29 each.
1K5 to 12K 0.30 each.
15K to 22K 0.35 each.

17W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 4K7 0.39 each.
6K8 to 22K 0.41 each.

½W Single turn cermet potentiometer. Values available: 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K, 200K, 500K, 1M.
Price 0.97 each.

¾W Multiturn cermet potentiometer. Values available: 20R, 50R, 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 100K, 500K.
Price 1.40 each.

1W Potentiometer with 2" spindle. Values available: 10R, 25R, 50R, 100R, 250R, 500R, 1K0, 2K0, 5K0, 10K, 20K.
Prices 10R to 5K0 1.51 each.
10K & 20K 1.62 each.

1.5W Convergence preset potentiometer. Values available: 5R0, 7R0, 10R, 15R, 20R, 100R, 500R.
Price 0.50 each.

2W 10 Turn potentiometer. Values available: 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K.
Price 7.34 each.

DIODES

AA119	0.17	BA243	0.85	BY142	0.45	BY204-8	0.85	ITT827	2.35	OA86	0.20	1N5403	0.15
AA121	0.11	BAX13	0.06	BY164	0.50	BY204-10	0.75	ITT921	0.20	OA90	0.07	1N5404	0.16
AA129	0.08	BAX16	0.07	BY176	3.45	BY206	0.30	ITT923	0.35	OA91	0.06	1N5405	0.25
AA143	0.15	BAX17	0.18	BY179	0.90	BY210-400	0.45	ITT1075	0.25	OA95	0.06	1N5406	0.20
AA144	0.09	BB105B	0.35	BY182	1.85	BY210-600	0.50	ITT2001	0.25	OA202	0.07	1N5407	0.19
BA102	0.30	BB105G	0.35	BY184	0.70	BY210-800	0.55	ITT2002	0.20	ST2	0.14	1N5408	0.20
BA111	0.98	BB110G	0.45	BY187	1.30	BYX10	0.35	MR502	0.75	1N4001	0.04	1N5450A	6.75
BA115	0.25	BB142	1.25	BY198	0.75	BYX55-350	0.45	MR813	0.90	1N4002	0.05	1N5761	0.60
BA145	0.15	BR100	0.20	BY199	0.55	BYX55-600	0.55	MR854	1.80	1N4003	0.05		
BA148	0.12	BR101	0.30	BY201-2	0.48	BYX71-350	0.90	MR856	2.10	1N4004	0.06		
BA154	0.10	BY100	0.20	BY201-3	0.40	BYX71-600	1.15	MR992A	1.55	1N4005	0.06		
BA155	0.12	BY103	0.35	BY201-4	0.45	BZX61 series		MV2203	1.60	1N4006	0.07		
BA156	0.12	BY118	1.45	BY201-5	0.55		0.18	MV5460	0.65	1N4007	0.08		
BA157	0.45	BY126	0.15	BY201-6	0.55	BZX88 series		OA47	0.07	1N4148	0.04		
BA158	0.65	BY127	0.10	BY203-12	0.60		0.08	OA70	0.07	1N4150	0.45		
BA159	0.75	BY130	0.15	BY203-16	0.85	DK13	0.45	OA71	0.35	1N4448	0.25		
BA182	0.45	BY133	0.10	BY203-20	1.00	ITT44	0.10	OA81	0.12	1N5401	0.12		
BA201	0.15	BY134	0.45	BY204-4	0.45	ITT210	1.35	OA85	0.12	1N5402	0.15		

CAPACITORS

Tantalum Bead		
6 3V	47uF	0.32 each
	100uF	0.50 each
16V	10uF	0.24 each
	22uF	0.30 each
	47uF	0.50 each
25V	22uF	0.41 each
35V	0 1uF	0.22 each
	0 22uF	0.22 each
	0 47uF	0.22 each
	1 0uF	0.22 each
	2 2uF	0.22 each
	4 7uF	0.24 each
Disc Ceramic		
8kV	150pF	0.27 each
	180pF	0.27 each
	200pF	0.27 each
	220pF	0.27 each
	250pF	0.40 each
	270pF	0.40 each
	300pF	0.40 each
Mixed Dielectric		
600V	1uF	1.01 each
1kV	0 01uF	0.26 each
	0 033uF	0.32 each
	0 047uF	0.35 each
	0 1uF	0.39 each
	0 22uF	0.58 each
	0 47uF	0.89 each
1 25kV	0 1uF	0.50 each
1 5kV	0 001uF	0.24 each
	0 0022uF	0.24 each
	0 0047uF	0.24 each
	0.22uF	0.28 each
Single Ended Electrolytic		
16V	10uF	0.11 each
	22uF	0.11 each
	47uF	0.11 each
	100uF	0.11 each
	220uF	0.14 each
	470uF	0.28 each
	1000uF	0.32 each
63V	1uF	0.11 each
	2 2uF	0.11 each
	4 7uF	0.11 each
	10uF	0.13 each
	22uF	0.16 each
	47uF	0.22 each
	100uF	0.32 each
	220uF	0.46 each
Double Ended Electrolytic		
10V	22uF	0.14 each
	100uF	0.14 each
	220uF	0.17 each
	470uF	0.36 each
	1000uF	0.40 each
25V	10uF	0.14 each
	22uF	0.14 each
	47uF	0.17 each
	100uF	0.17 each
	220uF	0.36 each
	470uF	0.47 each
	1000uF	0.72 each
63V	1uF	0.14 each
	2 2uF	0.14 each
	4 7uF	0.14 each
	10uF	0.17 each
	22uF	0.17 each
	47uF	0.29 each
	100uF	0.40 each
	220uF	0.65 each
	470uF	0.66 each
	1000uF	1.01 each
	2200uF	1.44 each
100V	10uF	0.20 each
	22uF	0.25 each
	47uF	0.36 each
	100uF	0.61 each
	220uF	0.68 each
450V	1uF	0.27 each
	4 7uF	0.45 each
	10uF	0.53 each
	22uF	1.07 each
	33uF	1.22 each
Silvered Mica		
500V	3 3pF	0.18 each
	5pF	0.18 each
	10pF	0.18 each
	39pF	0.18 each
	100pF	0.18 each
	150pF	0.18 each
	180pF	0.18 each
	220pF	0.18 each
	330pF	0.36 each
	470pF	0.36 each
	680pF	0.36 each
	820pF	0.36 each
	1000pF	0.42 each
	2200pF	0.50 each
	8200pF	1.58 each
	10000pF	1.62 each
Multi-sectional Electrolytic		
30V	2500/2500uF	1.94 each
70V	2500/2500uF	2.70 each
300V	150/150/100uF	2.81 each
350V	200/300uF	2.46 each
	200/200/100/32uF	3.89 each
	150/100/100/100/150uF	4.75 each
	400/400uF	4.75 each
	300/300/150/100/50uF	5.18 each

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CA3046	0.80	SAA570	4.20	SN76033N	2.48	TAA621	8.95	TBA510	2.40	TBA700Q	2.25	TCA270B	3.80
CA3048	2.50	SAA7008	10.15	SN76110N	1.50	TAA630	0.55	TBA510Q	2.50	TBA720	5.10	TCA270Q	3.60
CA3065	1.50	SAS560	2.75	SN76131N	2.00	TAA630S	5.10	TBA520	2.50	TBA720A	5.10	TCA270S	2.25
CA3089E	7.88	SAS570	2.75	SN76226N	3.15	TAA661A	1.70	TBA520Q	2.50	TBA720AQ	2.10	TCA270SQ	3.40
CA3090Q	4.50	SBA750B	6.75	SN76226N0	3.15	TAA661B	1.80	TBA530	2.50	TBA750	2.40	TCA800	5.40
ETT6016	4.95	SC9503P	2.00	SN76227N	2.50	TAA700	3.50	TBA530Q	2.50	TBA750Q	2.50	TCA800Q	12.40
ETTR6016	4.95	SC9504P	2.00	SN76532N	3.15	TAA840	4.50	TBA540	2.50	TBA800	0.90	TCA830	3.10
MC1303L	1.50	SL414A	4.85	SN76533N	2.70	TAD100	1.35	TBA540Q	2.25	TBA800Q	2.85	TDA440	6.75
MC1304P	2.00	SL415A	6.30	SN76544N	1.80	TBA120A	3.05	TBA550	3.50	TBA810A	3.40	TDA1327	2.65
MC1305	5.15	SL901B	8.50	SN76550N	1.80	TBA120AS	1.50	TBA550Q	3.80	TBA810S	1.10	TDA1327B	2.85
MC1307P	2.85	SL917B	10.70	SN76660N	0.80	TBA120S	2.70	TBA560	6.45	TBA820	0.80	TDA1330	1.60
MC1310P	1.00	SL1310	5.65	SN76666N	1.60	TBA120SB	1.60	TBA560C	4.50	TBA915	7.35	741	0.25
MC1327P	2.75	SL1327	2.75	TAA300	3.75	TBA120SQ	1.60	TBA560Q	7.35	TBA920	3.00		
MC1327PQ	2.50	SL3046	2.60	TAA310	3.15	TBA281	4.70	TBA560CQ	3.80	TBA920Q	3.50		
MC1330P	1.25	SN76003N	2.50	TAA320	2.60	TBA350A	3.00	TBA570	2.00	TBA950-2	5.40		
MC1339P	3.95	SN76003N0	2.15	TAA350A	3.00	TBA396	1.80	TBA570Q	2.00	TBA950-2X	5.04		
MC1349	3.35	SN76013N	1.50	TAA435	3.40	TBA440	3.60	TBA641A12	6.20	TBA990	4.95		
MCx351P	1.25	SN76013N0	2.15	TAA550	0.50	TBA440B	3.95	TBA641B11	5.85	TBA990Q	3.75		
MC1352P	1.45	SN76023N	1.50	TAA550B	0.48	TBA480Q	2.50	TBA673	5.00	TCA160	5.10		

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1A	200V	B1/200	0.28
1A	400V	B1/400	0.30
1A	800V	B1/800	0.34
2A	50V	B2/50	0.40
2A	100V	B2/100	0.45
2A	200V	B2/200	0.55
2A	400V	B2/400	0.65
2A	800V	B2/800	0.70
3A	200V	B3/200	0.70
3A	600V	B3/600	0.80
4A	100V	B4/100	0.90
4A	400V	B4/400	0.95
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6A	400V	B6/400	1.20
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25A	200V	B25/200	4.20
25A	400V	B25/400	4.30

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CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
80mA	30V	TO18	S08/30	0.22
80mA	60V	TO18	S08/60	0.24
80mA	200V	TO18	S08/200	0.25
1A	50V	TO220	S1/50	0.25
1A	100V	TO220	S1/100	0.26
1A	200V	TO220	S1/200	0.28
1A	400V	TO220	S1/400	0.35
3A	50V	TO220	S3/50	0.25
3A	100V	TO220	S3/100	0.26
3A	200V	TO220	S3/200	0.30
3A	400V	TO220	S3/400	0.40
4A	50V	TO220	S4/50	0.35
4A	100V	TO220	S4/100	0.40
4A	200V	TO220	S4/200	0.50
4A	400V	TO220	S4/400	0.55
5A	400V	TO220	S5/400	0.55
7A	50V	TO220	S7/50	0.45
7A	100V	TO220	S7/100	0.50
7A	200V	TO220	S7/200	0.55
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22	D22	0.35
24	D24	0.40
28	D28	0.45
40	D40	0.60

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CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
3A	100V	TO220	T3/100	0.75
3A	200V	TO220	T3/200	0.80
3A	400V	TO220	T3/400	0.85
6A	200V	TO220	T6/200	1.00
6A	400V	TO220	T6/400	1.05
8A	400V	TO220	T8/400	1.35
10A	400V	TO220	T10/400	1.40
15A	400V	TO220	T15/400	2.00

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WHO NEEDS ELECTRONICS?

K.T. Wilson explores the all too frequently ignored and misunderstood field of Magnetic Amplifiers.

THINK OF AMPLIFICATION, and you automatically think of transistors. Perhaps if you're a bit longer in the tooth you remember valves. Have you ever thought of large amounts of power gain being obtained without using either transistors or valves? It's power gain we're talking about, too, not just voltage gain. A transformer will give voltage gain, up to 100 times, but at the expense of current, so that the power out is never quite as much as the power in. There's no *power* gain there, but a device called the magnetic amplifier, which looks very like a transformer, can give very large values of power gain, can control AC power into a load very smoothly, and is used in the sort of applications where thyristors would be a natural choice for many.

The magnetic amplifier has been used in industrial control for decades, yet has never really caused any stir of interest anywhere else. Perhaps it's because it's always a ready-made item, but then so is an IC amplifier, and everyone seems to make use of those. Perhaps it's just because so very few people outside the ranks of professional engineers know just what a magnetic amplifier is. Let's remedy that!

Induced Knowledge

To start with, we need a pretty clear idea of what happens inside an inductor. A simple inductor has a winding which consists of insulated wire wound round a core of a soft magnetic material. Soft doesn't mean that you can spread it on your bread, but that the material magnetises easily, and *de*magnetises just as easily. Take a piece of this material, hold a magnet near it, and it's magnetised. Take a magnet away and it's demagnetised. This material we use for the cores of inductors, transformers, electric motors, relays etc.

An inductor makes use of this 'soft' magnetism. The winding has an alternating current flowing in it. This alternating current (changing smoothly from a peak in one direction to a peak in the opposite direction and back) causes the core of the inductor to magnetise. The magnetism isn't steady like a bar magnet, but alternating, which is the point of using soft magnetic material. a graph of the magnetism (called flux density) of the core plotted against time would, ideally, have exactly the same shape as that of the waveform of the AC applied.

So far so good — it's an alternating magnet. But we've known for about 150 years (or someone has) that

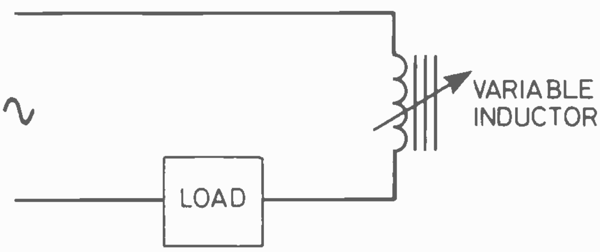

Fig. 1. Control of a load using a variable inductor, this configuration has very little power lost as heat, unlike a resistive controller.

wherever there's an alternating magnetic field, any piece of wire or other metal will have an alternating voltage induced.

Stick a piece of wire near your alternating magnet and you'll find an alternating voltage across the ends of the wire. The voltage is small if you use just a few centimetres of straight wire, but if you wrap several metres or wire round the core, so that all the magnetism of the core is at the centre of the coil of wire, then you find quite a respectable amount of AC. Recognise it?, a transformer.

Laying Down the Laws

The laws of Electricity are very consistent, though, *Any* coil of wire around a core that has an alternating magnetic field will have an AC voltage induced. That means that if we have only one coil, and we send AC through to generate the magnetism, it will *also* have an AC voltage induced in it. This voltage which the text books call a "back EMF", opposes the current which causes the magnetism which causes the voltage.

Result?

It's a darn sight more difficult to pass AC through an inductor than it is to pass DC!.

When we use an inductor in a DC circuit, then apart from some effects at the moments of switch-on and switch-off the thing behaves like a resistance, good old Ohm's Law and all the rest, and a fairly low value of resistance at that.

Now you might think that it should pass the same amount of current for AC as for DC, but it doesn't.

Imagine that the resistance is 2R, so that 10 V DC passes 5 A. Apply 10 V AC and the current's nothing like 5 A. It's not because Ohm's law stops working, it's because of the induced voltage. We're trying to push AC ▶

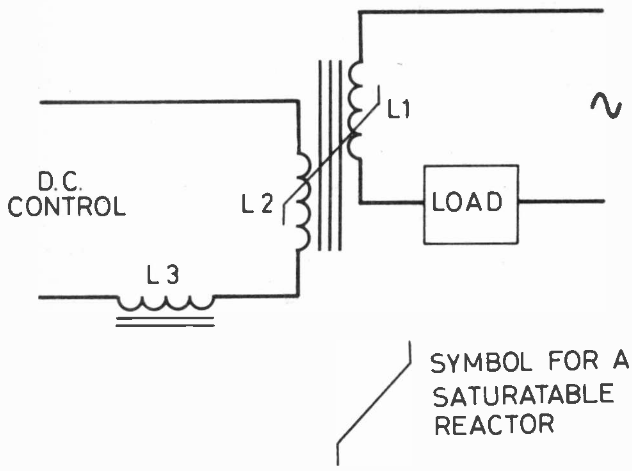

Fig. 2. Simple magnetic amplifier circuit, showing DC control winding.

through with one voltage, and the induced voltage is opposing our efforts. It's only the difference between the two voltages that has any effect at all.

Impedance Impediment

Suppose for example, that with 10 V AC applied, the induced voltage is 9V9. This makes the difference equal to 0V1, and the current is

$$\frac{0.1}{2} = 0.05 \text{ A, (by Ohm's Law)}$$

Now these are calculations we seldom bother to make. Instead we measure a quantity called the self-inductance, L, of the coil and use this quantity and the resistance value to calculate impedance, which is the ratio

$$\frac{\text{AC voltage}}{\text{AC current}}$$

for the coil. In our example, 10 V causes 0.05 A to flow, making the impedence 10/.05=200 R, not a particularly large impedance, but much greater than the *resistance* of 2 R.

The useful thing about an impedance is that there's practically no loss of power in it. Pass a current through a 200 R resistor, and you lose energy in the form of heat the amount of heat lost per second is 200×(current)^2 joules for a 200 R resistor. The same current through the inductor in our example doesn't look anything like this — only its resistance loses heat, and that's only 2×(current)^2 joules, because the resistance is only 2 R.

We can therefore use an inductor to control the flow of AC in a circuit (see Fig. 1) with none of the power loss that a resistor would cause. Now if we could just have a variable inductor, we could be very neatly control the flow of current in that circuit. Of course, we could use an inductor with tapped turns and slide contacts, built like a potentiometer, and we make use of just such a device, the familiar Variac. It's possible though, to control the inductance of a winding with no mechanical movement at all, and what makes it possible is the effect called saturation.

Control-A-Coil!

When we send a current, AC or DC, through a coil of wire which is wound round a magnetic core, we can't pass as much current as we like and expect the magnetism to keep pace. At some stage in the game the core saturates, which means that it's as magnetised as it's ever going to be, no matter *how* much current is used. Now when a core is saturated like this, a change of current doesn't cause a change in the magnetism, so there's no more induced voltage. In other words, the inductance is no more and the impedance is practically zero.

Let the AC flow to it's load through an inductor whose core we can cause to saturate. How? By passing DC through another winding, by making the core of material which saturates easily, and the making the core continuous with no air gap.

That's our recipe for a magnetic amplifier.

Amps For Amps

Figure 2 shows a simple magnetic amplifier circuit. The inductor L1 has a large inductance when the core is not saturated, because of that, its impedance is very large, enough to make the current in the circuit very small. Now let DC flow through the second winding L2, and the core saturates.

If we can keep the core saturated for the whole of the AC cycle, then the inductance of L1 is almost zero, and the full amount of AC current flows through the load.

We don't of course, have to switch between saturation and no-saturation. We can adjust the control current so that the core saturates only on half of the AC cycle, or in peaks so that the average current through the lead is controlled.

Self Satisfied

Even such a simple magnetic amplifier has a lot of advantages, such as low power dissipation and high power gain, but better results are possible by using what is called a self-saturating design. Self-saturation is a form of positive feedback, using some of the signal current to assist the DC control current. Fig 3 shows a half-wave self-saturating circuit. The rectifier D1 ensures that only one direction of current flows through the coil L1 and the rated load current will cause the core to be close to saturation. The DC control current in winding L2 need only be quite small to cause the core to saturate on peaks, so that less power is needed to control the load current, and power gain is much higher.

Only half cycles are passing into the load, however, so that a full wave version is more desirable.

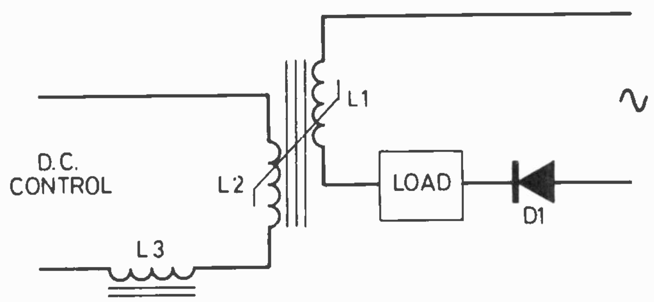

Fig. 3. Half-wave control using self-saturation.

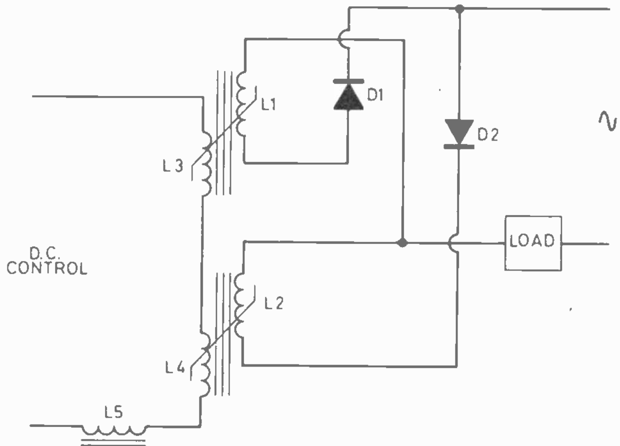

Fig. 4. Full-wave amplification with self saturation, by positive feedback.

A full-wave self-saturating magnetic amplifier is shown in Fig 4. Two sets of windings are used, each handling half of the wave, with rectifiers ensuring that the AC wave is split into its two halves.

In all these circuits, an additional inductor is used in the DC control line to prevent AC appearing in the control circuit because of transformer action.

Going Straight

DC amplification? Simple enough, just rectify the output of the magnetic amplifier — the self-saturating full wave type already has two rectifiers included in the circuit and only two more are needed. More sensitivity? Add another winding to pass DC bias current, and the sensitivity increases because the bias can be set so that the core is very close to saturation.

Nothing could be *that* perfect, there has to be a snag somewhere, and response time is it for magnetic amplifiers. Being slow beasts a sudden change of control signal may not cause much change in the output current until several cycles of AC have passed through. Nevertheless for stabilising AC supplies, for control of large AC loads and for high power gains magnetic amplifiers are not so easily displaced by electronics .There's not much to go wrong, they can be built to order, and they can be repaired.

Ever tried to put a new junction into a thyristor? ETI

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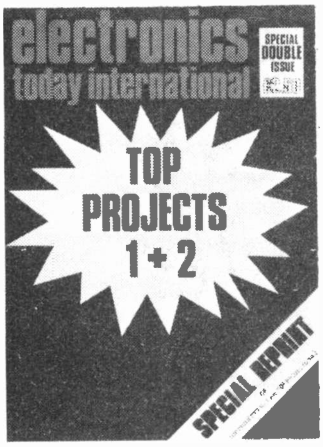

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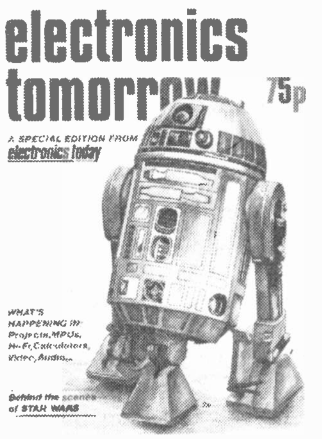

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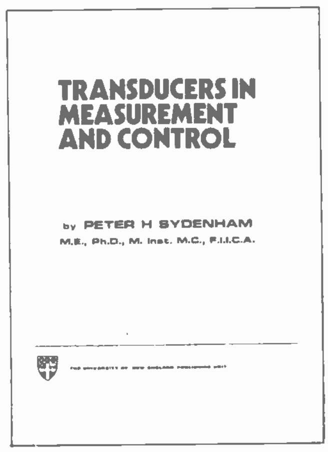

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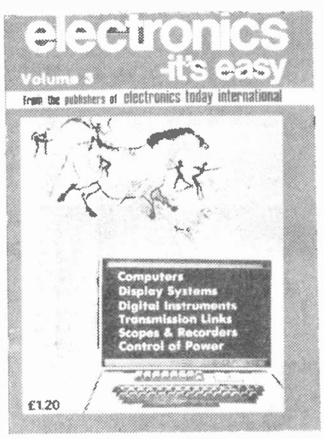

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The first types of dimmer used, of which there are still some examples in older theatres, was a variable resistance type which used either a variable or switched power resistor in series with the load. With small loads a wire wound resistor or a carbon pile was used while larger loads used a tank of saline solution with a central electrode which was raised or lowered in the liquid, effect vely changing the resistance. This type of dimming, while reasonably effective, dissipated a lot of power which made life uncomfortably hot for the operator, since to minimise mechanical linkages the dimmers themselves were often in the control room.


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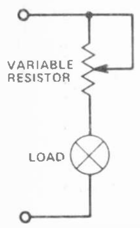
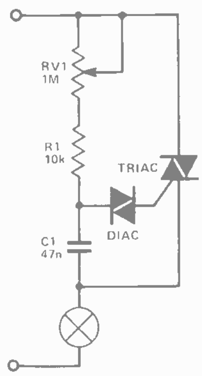
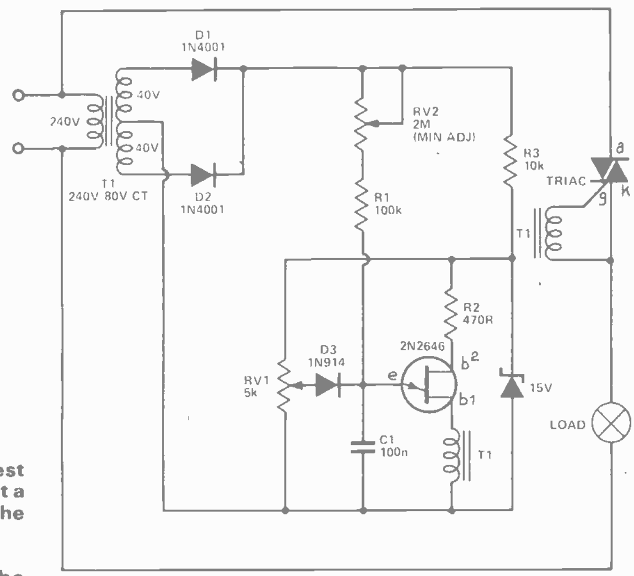






Electronics

With the advent of electronics, life was a little bit easier. The use of phase controlled dimming using thyratrons and later SCRs and Triacs reduced the heat dissipation dramatically (if you'll excuse the pun) and also allows the control to be physically separate from the dimmer. Besides being easier for the operator performances were greatly enhanced by the much better control available.

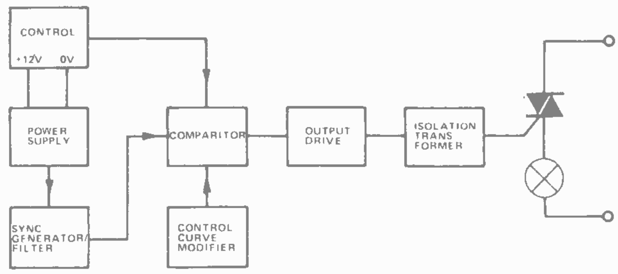
Today the use of phase control is almost universal as it is simple, reliable and cheap. Another method in use today is by magnetics; this type has the advantage of generating no RFI but unfortunately is expensive.

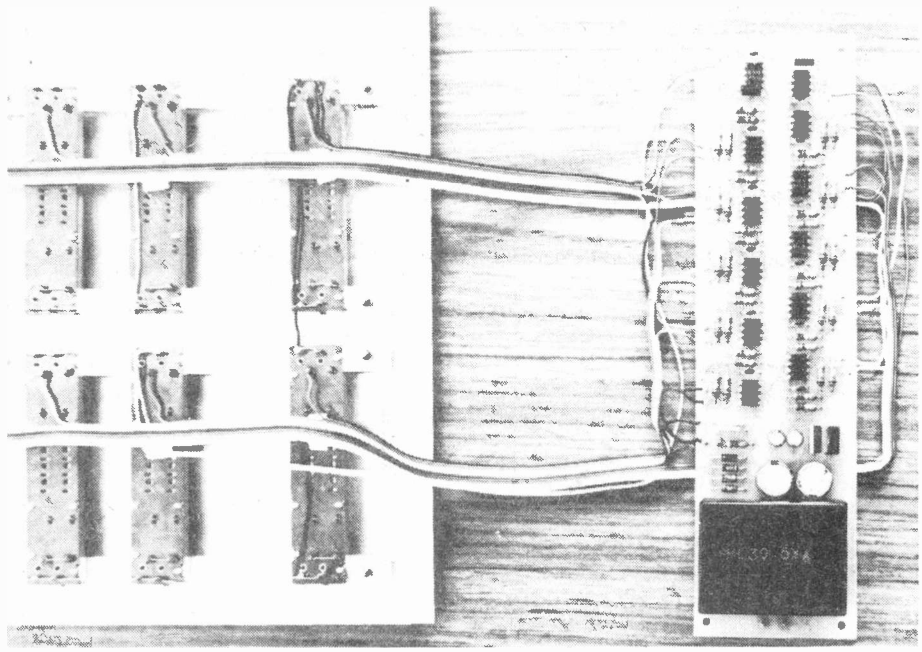
The problem of RFI is common to all phase control circuits, but can usually be reduced to acceptable levels by the use of a choke and several capacitors. For RFI the choke need not be very large, but one other effect of phase control is the audible rattling of the lamp filament (especially with the larger globes) which is due to the sudden application of power, and the magnetic field so produced, each half cycle. This can be cured by reducing the rate of the rise of current by using a larger choke.

Fig 1. (Far left). The earliest type of dimmer employing just a variable resistor controlling the load.

Fig 2. (Left). Common! The most usual kind of light dimmer in use today.

Fig 3. (Right). A more refined realisation of the art, which at least has the control isolated!





Type Casting

We have given some schematic diagrams of types of dimmers which have been used previously. Fig. 1 is the oldest type comprising simply a variable resistor in series with the load. The second (Fig. 2), probably the most common type in use today (mainly in homes) is very simple but lacks the versatility needed for theatrical work.

The third type (Fig. 3) is in common use and while still very simple does have many good features. These include having the control potentiometer isolated from the mains voltage and also a modified control curve to give a better input-output voltage relationship. Synchronization is referred to the zero crossing of the mains voltage, making the unit more suitable for driving inductive (fluorescent) loads; this also eliminates hysteresis which occurs with the simple dimmers.

The dimmer to be described here is more complex than most but a great deal of effort has been taken to ensure that *all* problems have been solved. A low pass filter, with phase ▶

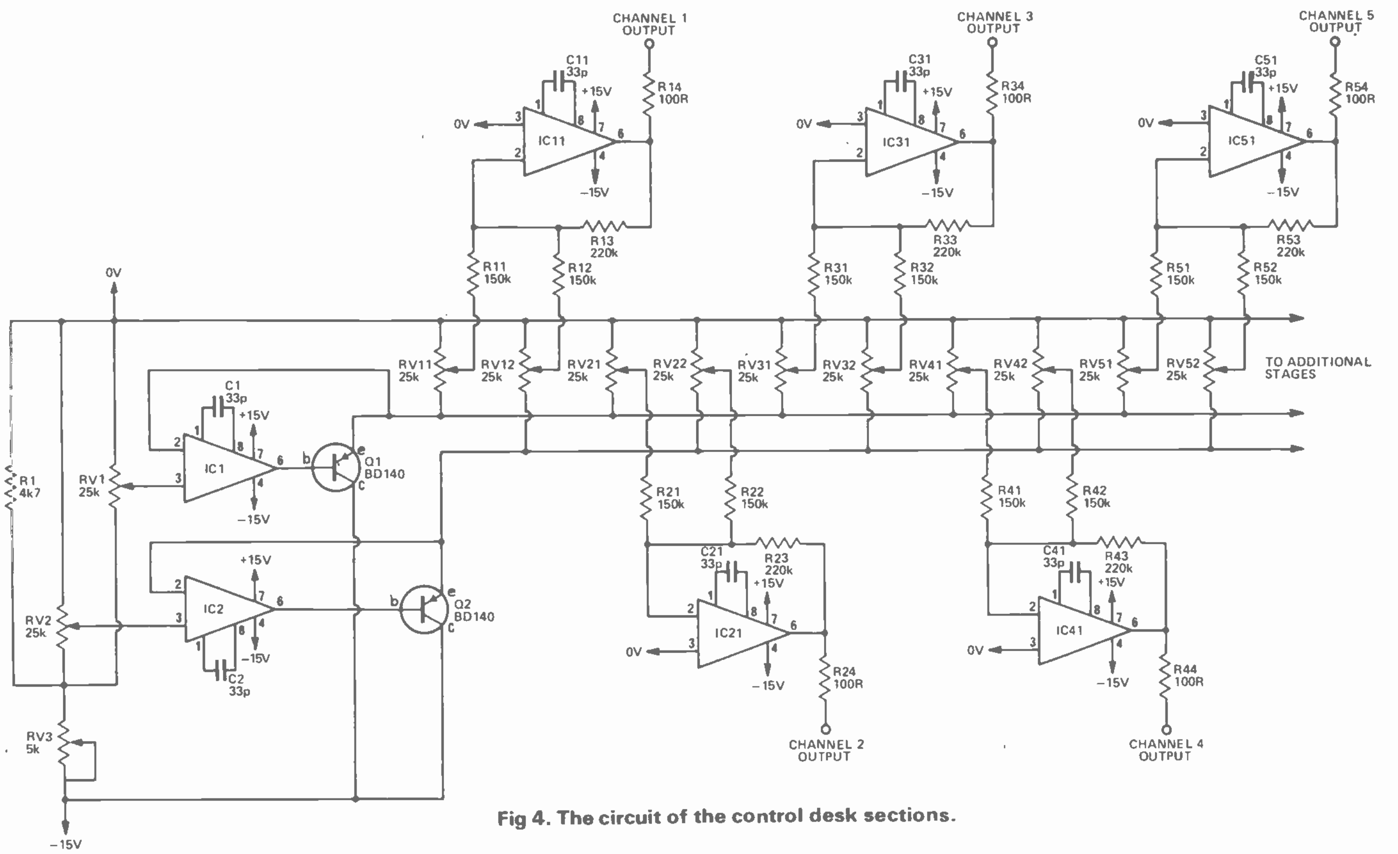


Fig 4. The circuit of the control desk sections.

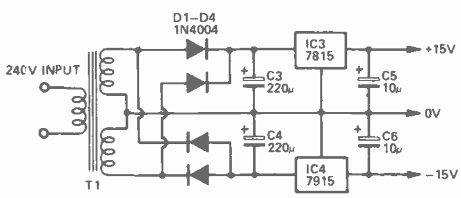


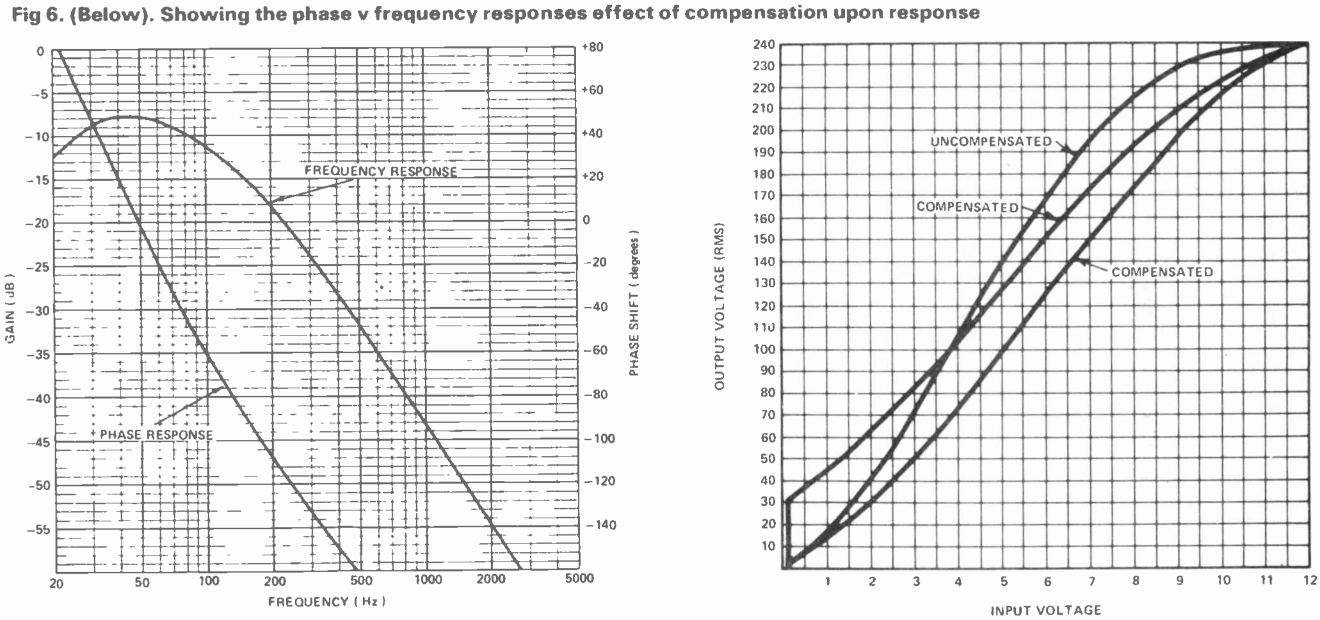
Fig 5. Power supply circuit

HOW IT WORKS - CONTROLLER

There are two controls for each dimmer along with two master controls. The master controls vary the voltage on the individual level control potentiometers from 0 V (no light) to —8 volts (full light). Normally one master will be at maximum and the second at zero. The outputs of the two controls for each dimmer are added by an operational amplifier, referred to 0 V. As one set of potentiometers has 0 V on both of its ends it can be varied without changing the output allowing it to be set for the next scene. By varying the master controls together, but in opposite directions, the complete lighting set up can be smoothly varied from one scene to the next.

As we need + 12V out to drive the dimmers the supply voltage of the control desk is ± 15 volts.

Fig 6. (Below). Showing the phase v frequency responses effect of compensation upon response



PARTS LIST

Resistors all ½W 5%	
R1	4k7
R11,12,21,22,31 32,41,42,51,52, 61,62,71,72 81,82,91,92,101,102	150k
R13,23,33,43,53 63,73,83,93,103	220k
R14,24,34,44,54, 64,74,84,94,104	100R
POTENTIOMETERS	
22 off	25k 1in. 60mm slide
RV3	5k trimmer
CAPACITORS	
C1,2	33p ceramic
C3,4	220u 50V
C5,6	10u 25V
C11,21,31,41	33p ceramic
C51,61,71,81	33p ceramic
C91,101	33p ceramic
SEMICONDUCTORS	
IC1,2	301A
IC3	7815
IC4	7915
IC11,21,31,41 51,61,71,81 91,101	301A
Q1,2	BD140
D1-D4	1N4001
MISCELLANEOUS	
Transformer	30V
Box and front panel	5W
Knobs to suit	

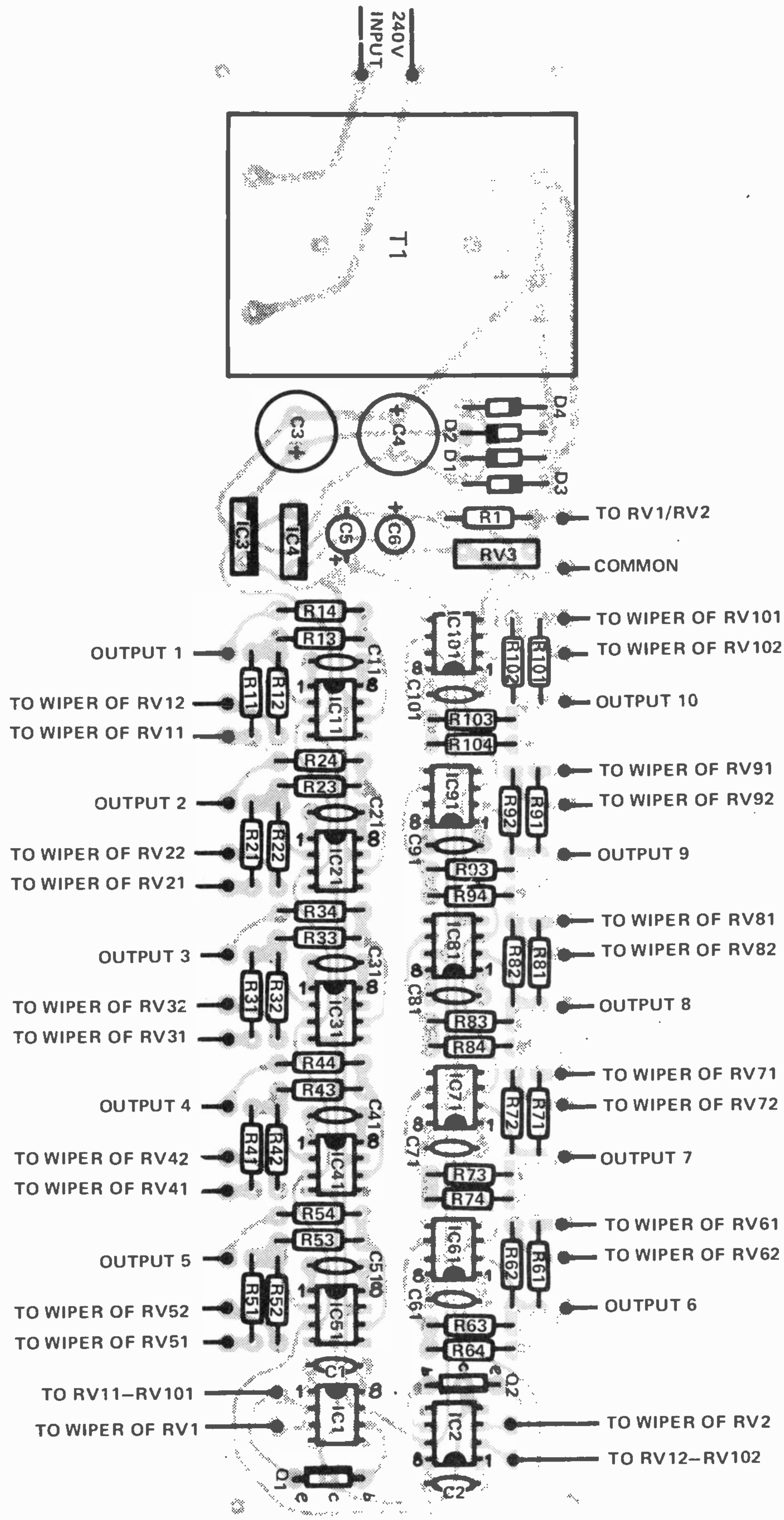


Fig 7. (Right): Component Overlay for the Controller Module.

BUYLINES

Apart from the pulse transformer T1 — for details of which see Table One — none of the components in this (admittedly huge) project should tax your local supplier overmuch. If you send us an SAE we will send you the foil patterns for the PCBs used here, as they were simply too big to print full size.

Any 400V ten or twenty amp triac will probably serve if you can't find the specified type easily.

correction, is used to ensure accurate synchronization. The control curve is also modified to give a subjectively more linear response and it has the ability to drive a fluorescent load without requiring a ballast resistor. Both the maximum and minimum light levels are adjustable without interaction giving reliable and predictable output. This is especially necessary if a dimmer fails for some reason and is replaced by a spare unit.

The Protection racket

The protection of SCRs and Triacs, especially Triacs, is usually difficult as they tend to fuse faster than the fuse purportedly protecting them. The use of a cheap Triac which requires an expensive fuse to protect it is false economy. We have used a large rugged Triac (40 A device for the 20 A dimmer) which allows economical fuses to be used, especially for the 10 A version.

On the control side we will be describing a panel with two sets of long sliders per dimmer with two master controls which allow the next scene to be set up then faded in when required. A digital memory which can 'prerecord' scenes and recall them on demand may be published later.

Dimmer Module — Construction

Assemble the boards with the aid of the overlay. The heatsink should be drilled and tapped for the triac to allow easy replacement if ever necessary. Note that the mounting of the fuse is different for the 10 and 20 A dimmers.

The choke is bolted onto the PCB using the long clamping bolts, preferably using rubber grommets in the holes in the board (they may have to be drilled out to do this). The leads from the choke should be bent such that they go into the holes provided without going near the mounting bolts which are at earth potential. The leads can now be soldered (both sides on the 20 A unit).

The pulse transformer can now be added according to Table 1 Be careful when winding this transformer not to damage the insulation on the wire as there is 240 V between windings. We also recommend some epoxy between the transformer and the board.

The printed circuit boards for the two versions of the dimmer board are identical in layout and differ only in that the connector end of the 20 A board is double sided to present a greater area of contact with the connectors.

Controller-Construction?

The component numbering system used on the controller drawings is designed to indicate which channel a particular component is part of. The printed circuit board drawing for the dimmer board is too large to publish in the magazine at full size; however, the pattern is available from our offices for the cost of an SAE — a large SAE!

If the dimmer modules are not required to be connected through sockets, the total cost can be reduced by connecting directly to the modules and mounting them in a box. In the 20 A unit the heavy wires should be bolted on to the appropriate pads to ensure contact to both sides of the board.

One more modification to the control desk is the addition of a black-out switch which allows all lights to be blacked out without moving the master control. This is simply done by switching the supply voltage on the master potentiometers from the 8 V supply as set by RV3 to 0V. RV3 should be adjusted such that with one master at maximum, the second at minimum and one individual control at maximum that its output voltage should be +10 volts.

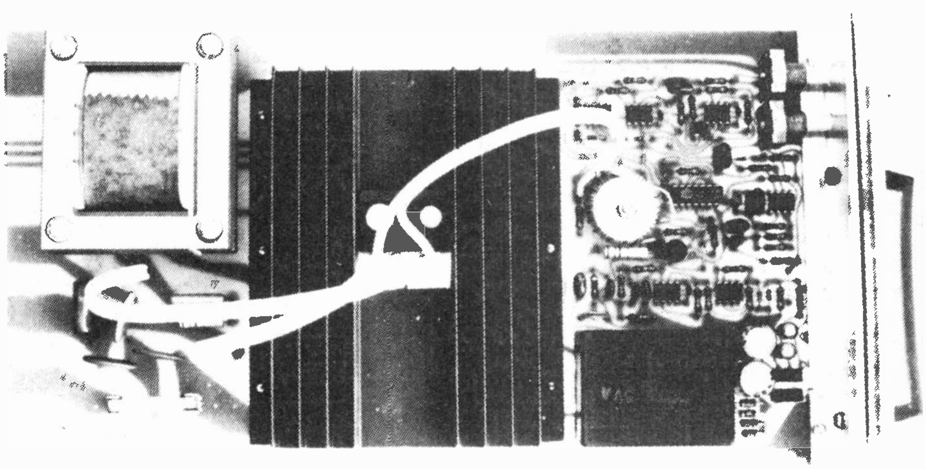
Setting up

With the dimmer module the trim potentiometer has to be adjusted so that the output pulse from IC7 occurs at the very end of each half cycle. This is easiest set using an oscilloscope although an approximate setting can be made without one.

If the dimmer is connected up to a reasonably heavy load and adjusted for about 1/3 level it will probably be found that with RV3 at one end the light level is not stable and tends to flash. This is caused by the sync pulse occurring after the end of the half cycle and the trigger pulses from the previous half cycle triggering the next. The trim potentiometer RV3 should be turned back about ¼ turn from the position at which this effect stops.

Max and Min

When adjusting the maximum and minimum levels the minimum should be adjusted first. Note that the control potentiometer must be slightly up off zero to get any light and minimum should be adjusted at this point. The maximum should be adjusted with both the master and individual control at maximum and set to the point where the light level is just starting to drop. ▶



Shown above is a completed dimmer module

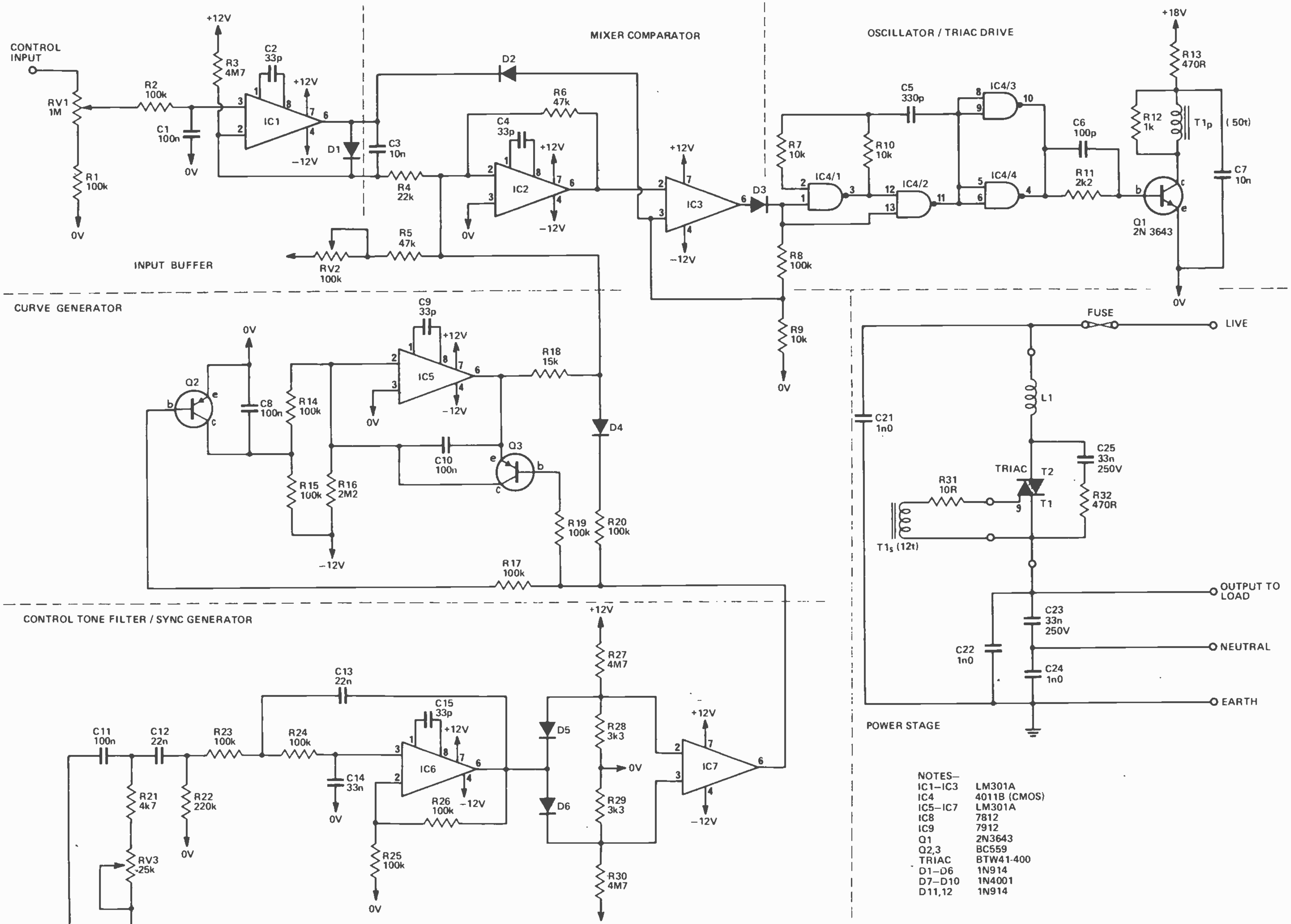
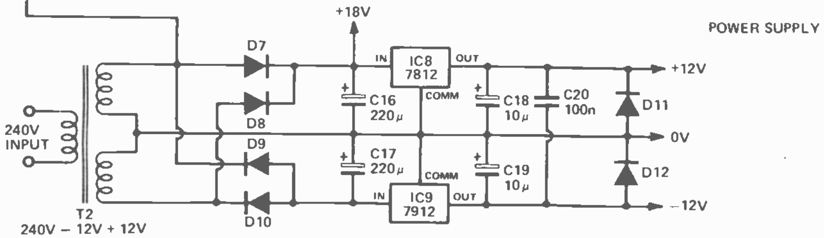


Fig 8. Circuit diagram of the light dimmer module and its power supply (below).



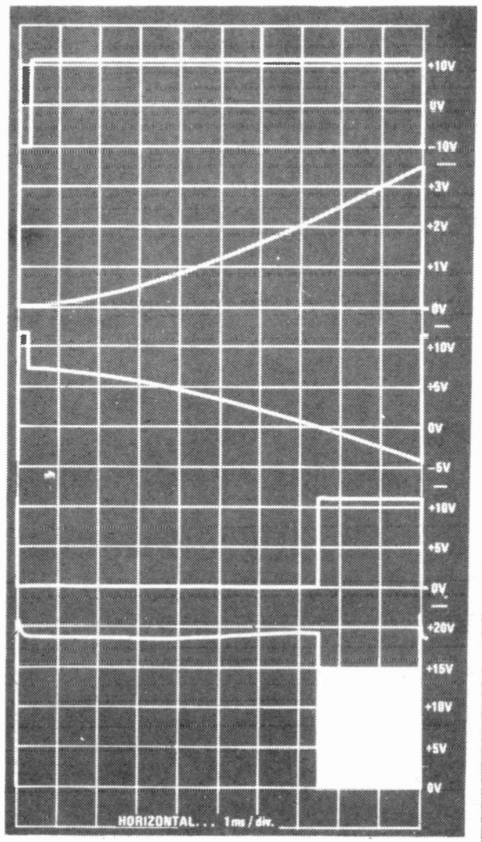


Fig 9. Waveforms shown are: Sync pulse (output IC7), curve generator (output IC5), mixer output (output IC2), oscillator output (IC4), transformer drive (Q1).

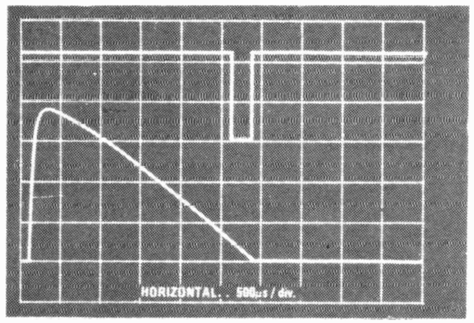


Fig 10. Relationship between the end of half cycle and the sync pulse.

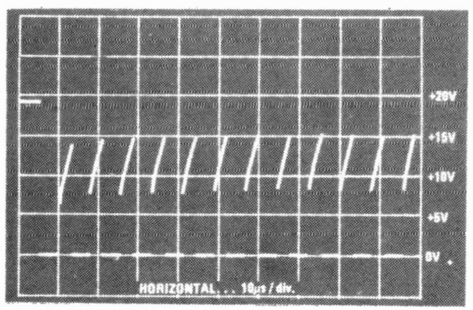


Fig 11. An expanded view of the drive waveform showing Q1 collector voltage.

HOW IT WORKS -DIMMER MODULE

To help explain the operation the circuit can be broken into seven sections.

1. Power supply
This is a simple full wave rectifier which gives about ± 18 V after being filtered by C16 and C17. Using 3 terminal regulators this is reduced to ± 12 volts which is needed for the circuitry.

2. Control tone filter and sync generator
As the name implies this removes the control tones that the supply authority superimposes on the mains voltage. These are normally about 1050 Hz and can cause problems by upsetting synchronization of dimmers. The filter is a low pass type comprising IC6 and associated components. As filters always alter the phase relationship this is corrected using phase shift networks. C11/R21 and C12/R22. Potentiometer RV3 is used to ensure the phase shift is zero (at 50 Hz) with normal component variations. If the output of IC6 is between +0.6 volts and −0.6 volts, neither D5 nor D6 will be forward biased sufficiently to change the input voltages to IC7 so its output will be −10 volts. As the output voltage of IC6 is a 'clean' 50 Hz sine wave of about 6 volts amplitude this will only occur at a small region about the zero crossing point. At all other times the output of IC7 will be + 10 volts. The result is a negative pulse, about 250 μs wide at the zero crossing point of the 50 Hz.

3. Curve generator
This produces the output shown in Fig. 6. When the sync pulse occurs, transistors Q2 and Q3 discharge capacitors C8 and C10. Immediately on release of the sync pulse the output of IC5 begins to ramp up slowly due to R16 charging C10. However, while initially the voltage across R14 is zero and therefore does not affect the charging of C10, as C8 begins to charge due to R15 its effect becomes more and more dramatic. A curve is necessary as it gives a better input/output voltage relationship but the curve must be reproduceable hence the circuit used.

4. Input buffer
This serves two purposes; firstly, it allows a megohm input impedance and secondly it detects when the input voltage falls below 0.1 volt and turns the dimmer output completely off. This allows the minimum light control to be turned up to give a better control range, ie with the filaments just glowing, yet have them off if the control voltage is reduced to zero.

If the voltage is above 0.1 volt, the diode D1 will lift the voltage on pins of IC1 to equal that of the input on pin 3. However if the voltage falls below this level, the voltage on pin 2 will remain at about 0.1 volt due to R3 and the output of IC1 will go to about −10 volts.

5. Mixer-comparator
IC2 mixes the input voltage, the output of the curve generator the sync pulse and the minimum adjustment potentiometers. This gives the waveform shown in Fig. 2 with the input voltage and the minimum adjustment only moving the curve up and down without altering the shape. When the output of IC2 falls below zero volts the output of IC3 goes from −10 V to +10 volt with D3 and R8/9 providing about 1 volt of positive feedback. The voltage has to rise to above 1 V to force the output back to −10 volts. The diode is necessary to ensure that the voltage at the input of the oscillator IC4 remains within the supply voltage of the IC (+12 V, 0 V).

6. Oscillator/triac drive
A CMOS oscillator IC4 is used to drive Q1 which supplies the energy for the pulse transformer T1. The oscillator will only operate when the control inputs (pins 1 and 13) are +10 V. The frequency is controlled by C5 and is set at about 150 kHz. Resistor R13 provides current limiting for the pulse transformer while R12 prevents the reverse voltage damaging Q1 if the load on the secondary load (the triac) becomes disconnected.

7. Power stage
This is simply a triac with a choke in series to prevent both RFI and 'filament rattle' and a fuse to protect against short circuits. Capacitors are also used as bypasses to help prevent RFI.

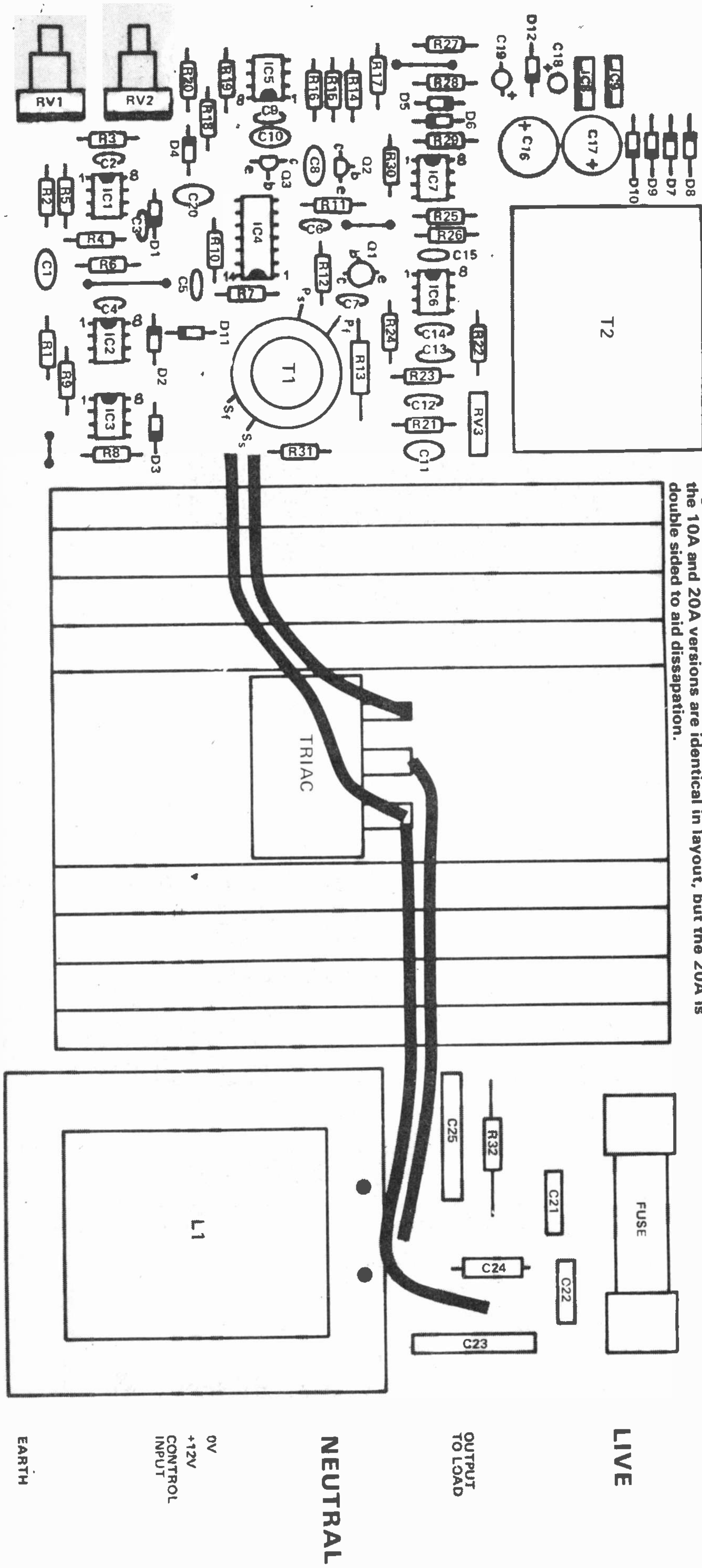


Fig 12. Component Overlay for the dimmer module board. Both the 10A and 20A versions are identical in layout, but the 20A is double sided to aid dissapation.

PARTS LIST

RESISTORS all ¼W 5%	
R1,2,8,14,15, 17,19, 20,23-26, R3,27,30	100k
	4M7
R4	22k
R5,6	47k
R7,9,10	10k
R11	2k2
R12	1k
R13	470R IW
R16	2M2
R18	15k
R21	4k7
R22	220k
R28,29	3k3
R31	10R
R32	47R 1W
POTENTIOMETERS	
RV1	1M linear
RV2	100k linear
RV3	25k trimmer
CAPACITORS	
C1,8,10,11,20	100n polyester
C2,4,9,15	33p ceramic
C3,7	10n polyester
C5	330p ceramic
C6	100p ceramic
C12,13	22n polyester
C14	33n polyester
C16,17	220u 25V
C18,19	10u 25V
C21,22,24	1n polyester
C23,25	33n 250V AC
SEMICONDUCTORS	
IC1-3,5,6,7	LM 301A
IC4	4011B
IC8	7812
IC9	7912
Q1	2N3643
Q2,3	BC 559
TRIAC	BTW41/400
D1-D6,11,12	1N 914
D7-D10	1N 4001
MISCELLANEOUS	

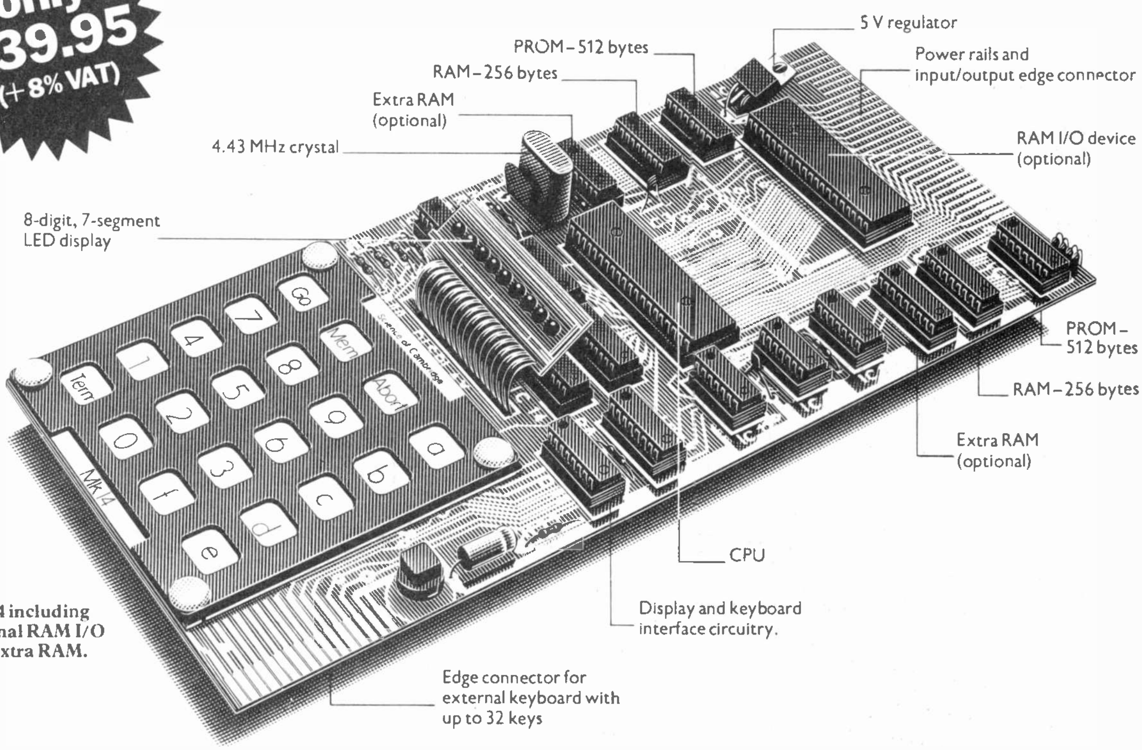
TI see text, T2 24V, 5VA, heatsink and choke and fuse 10A or 20A to suit, fuse holders.

TABLE ONE

The pulse transformer T1 is the most difficult component in the project to find or produce. Tandy market a 4:1 device and this must be first choice. If this, and all other, commercial units prove elusive — try winding it yourself onto an ferrite ring of about 2in outside diameter, using 50 turns and 12 turns for the windings to obtain the required ratio. Some experimentation may be needed here in order to get the triac to fire properly, and we do not recommend you try this unless you have wound coils previously.

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only £39.95 (+8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

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Optional extras include:

1. Extra RAM – 256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB) giving further 128 bytes of RAM.
3. Low-cost cassette interface module – which means you can use ordinary tape cassettes/recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

•Hexadecimal keyboard • 8-digit, 7-segment LED display • 8 x 512 PROM, containing monitor program and interface instructions •256 bytes of RAM • 4 MHz crystal • 5 V regulator • Single 8 V power supply • Space available for extra 256-byte RAM and 16 port I/O • Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

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Allow 21 days for delivery

Science of Cambridge

electronics today international

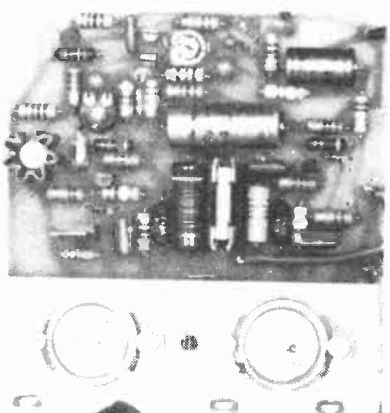
What to look for in the April issue: On sale March 2nd

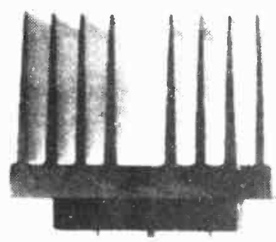
Amp Survey

Build-it-yourself hi-fi continues to flourish, and new designs appear almost daily. Power amplifiers are a favourite in the field, and their numbers, by now, are legion.

Unfortunately there is no way for the home constructor to 'listen in' to a module before he builds it, and thus he is left to fall back on the spec. sheets. Fine if you like it, rotten if you don't.

Next month we're surveying the field, giving full details of all the models we can find, and putting the market leaders against top quality commercial equipment to find out how they sound.





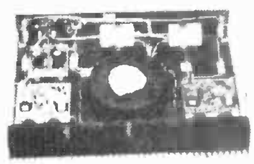
MAINS SEEKER

So you are about to drill the living room wall to hang up those shelves you promised the wife 7 years ago. Black & Decker in hand you advance to the plaster. Wait a minute there a mains socket right beneath.

Doubt sets in — to drill or not to drill — that is the question. Which way do the wires run? Will you black out the entire Universe if you try it? How can you find those wires?

Simple really — just read ETI next month when we have a neat little project to show you exactly where the mains wires lie!

OCTAVE SHIFTER

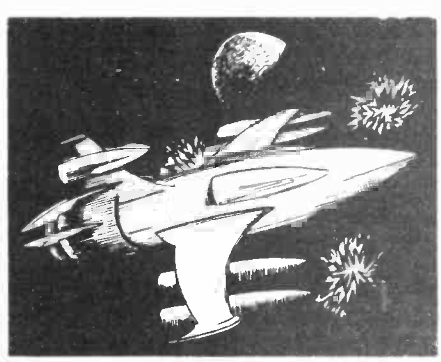


A superb little circuit to add that instant 'jump' to guitar playing. Operated by a footswitch the effect has a unique sound all its own — not to be missed — no strings attached to this one.

3080

Well ten of them anyway The 3080 is a much under-rated device, and next month's IETs circuit man Tim Orr hopes to put that right with ten ways to use device, all comprehensively explained to help you design the other 3070 circuits yourself.

AMBUSH



Your starship crashes through the void — running between the lines of enemy dreadnoughts to deliver medical supplies to the seiged plant of Tora. In order to preserve energy your ship has no weapons, only its shields and its speed.

Missiles can appear from any direction, and to destroy them you must actuate your shields at the precise moment of impact, thereby conserving power and allowing the engines to keep you moving at Warp Factor 20.

Can you make it through the Ambush and make Capt. Kirk look a cissy?

microfile

ALTHOUGH out of the first flush of youth I still consider myself to be young at heart so the young computing funfair seemed just the thing for me. Organised by the British Computer Society (BCS) the fair filled the Bloomsbury Centre Hotel early in January with the younger members of the ever growing group of people with an interest in computers.

Following on from the 'Living with Computers' conference, again organised by the BCS and held in the Institute of Education near the Bloomsbury Centre, the event provided a fitting climax to a very stimulating few days.

The funfair included exhibits ranging from mini-computers, computers being used for choreography in ballet, computer controlled games, DIY computer kits, a micro-computer controlled railway and many stands showing how the computer is in use in our everday life. Among this last group of exhibits were the Abbey National Building Society (they got the computing habit, they have) and the police, showing that big brother was alive and well at the funfair.

The NASCOM stand was a great attraction for many people, demonstrating as it did the latest add ons to that popular DIY computer kit, the NASCOM 1. The buffer board, mother board and expansion RAM cards allowed the NASCOM's on display to run the 2K BASIC interpreter NASCOM are now producing. The BASIC includes all the facilities common to basics of this size, interger arithmetic, 26 variables (Designated A-Z), single dimension array plus assorted commands, operators and functions. In addition a machine code call greatly extends the power of the interpreter. NASCOM's super tiny BASIC makes use of this machine code call to provide amongst other commands, an edit function which allows the insertion/deletion of individual characters within a line, a renumber command and a facility for string inputs — something sadly lacking in the basic BASICS.

Undoubtedly though the exhibits that caused the greatest interest amongst the younger generation that made up the majority of the visitors to the fair were the rows of amusement machines. Everything from cowboys at the OK coral to star wars in space quadrant 0040. 7689. Microprocessors have revolutionised the arcade industry, both in bringing arcade type games into the home and in dramatically increasing the sophistication and supposedly, entertainment value of the machines in the public domain. Certainly the young audience were impressed.

Altergo ran a painting competition in conjunction with the funfair and Saturday saw the prize giving ceremony. The subject for the painting was "My Friendly Computer." The first prize was an Altergon robot, a beast that walks, talks, moves and flashes its eyes. Talking of beasts brings us onto beauty and Joanna Lumley — of the new Avengers — who presented the prize to the winner of the competition — 12 year old Fiona Mackay.

As well as the exhibition stands a concurrent series of lectures was presented in a hall adjacent to the main event. The lectures concentrated on introducing people to the various aspects of computing and the careers potential offered by the computing industry. These were well attended in spite of the attractions of the afforementioned amusement machines.

All in all a successful gathering that introduced the fascinating and diverse world of the computer to people who will form the systems engineers, computer operators, engineers etc. of tomorrow.

Any excuse to get a robot onto the pages of ETI is eagerly taken up. The fact that there are a couple of ladies in frame is incidental. The robot was first prize in the painting competition organised by Altergo. Fiona Mackay won the robot which was presented by Joanna Lumley.

Following on from my item last month concerning low cost keyboard designs Mr Charles Lacey has written to me with details of a project along these lines that is at the prototype stage. Designed as a touch keyboard with fifty keys including space bar, 2 shift keys, a delete key and two spare controls the system is more elegant than my attempt. Looking back at the circuit I proposed it does seem a bit clumsy.

With luck Mr Lacey should have a very nice project in a couple of months time. We'll keep in touch.

By the way if anybody else has had ideas along these lines please let me know.

Finally may I add my own tribute to John Miller-Kirkpatrick who died last December. I'd known John just on two years and it was the System 68 project that brought us together. John handled the design and construction of the system while I dealt with the production from the magazine's end. System 68 had many teething problems but it was the first such project tackled in this country, way ahead of its time, and John remained enthusiastic throughout the problems and put in vast amounts of time to get things sorted out.

The last time I saw John was at the Breadboard exhibition. He took a keen interest in all of the stands and no doubt had a few ideas of his own for things to tackle in the future. ETI

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AUDIO POWER METER

An accurate way to determine whats watt in your hi-fi system, with our true reading power meter

POWER IS PROBABLY the least understood and most misrepresented quantity in the electric measurement system. This is especially so in the area of audio amplifier and speaker specifications when terms like peak, peak to peak, music and RMS are related to power.

Power is simply the rate at which energy is being used. It is expressed in watts and the value may vary from femtowatts (10^{-12} W), as in the input power of a FET, to thousands of megawatts in the power generation field. The term thousand megawatts is generally used in preference to the more correct term, gigawatts.

Power can be calculated simply by multiplying voltage and current:

$$P = EI$$

In a DC circuit where both voltage and current remain constant no problem arises. However in an AC or a DC circuit where the voltage is not constant with time, this formula only holds for instantaneous power as the power varies with time. Power as we usually use the term is the time average of this. If the load is resistive, i.e. contains no inductance or capacitance, and we can measure the RMS value of the voltage, we can still use this simple formula. However measuring the RMS voltage is not easy as most voltmeters measure the peak or average rectified voltage with a suitable scaling factor built in to give a correct result when measuring a sine wave signal.

Reactive Reaction

If the load is reactive the current and voltage will no longer be in phase, i.e. the peaks do not occur at the same point in time. The difference can be expressed either by the phase angle in degrees or by the cosine of this angle (known as the power factor). The current waveform can either be ahead of the voltage (leading) or behind it (lagging). Capacitive circuits give rise to a leading power factor while inductive circuits lag.

If working with a sine wave, and if the power factor is known, the formula for power can be expressed as:

$$P = EI \cos \phi$$

where ϕ is the phase angle. In a DC circuit $\cos \phi$ is unity so the formula holds for this case as well. An example is a 40 W fluorescent light which takes 430 mA from the 240 V mains. At first sight, this implies a ▶

power consumption of over 100 W, until it is realised that its power factor is about 0.45 lagging. The formula above, using $\cos\phi = 0.45$, thus gives a power consumption of only 46.4 W. (The additional 6 odd watts is dissipated in the ballast.) The product of voltage and current is known as the VA rating and is used when calculating the currents in a circuit. If a capacitor is connected across a sine wave AC circuit the current taken can be calculated by dividing the voltage by the reactance of the capaitor. While this circuit draws current, it has a power factor of very near zero (90° phase lead) and therefore takes no power! By adding the correct amount of capacitance to an inductive circuit (i.e. the fluorescent light) the power factor can be altered, reducing the current drawn (but not the power).

Confused yet?

Ample Reason

Getting back to audio amplifiers and their ratings, the problem lies in the complex nature of the music waveform and how to specify the amplifier's rating. As the waveform is far from a constant sine wave with the peak power being anything up to 20 times the average, numerous methods such as peak power, peak to peak power, music power, etc. evolved. However, for a long time there was no set standard, and one amplifier advertised with a 50 W (music) rating was in fact a 5 W stereo amplifier. The situation got so out of hand that the US Government brought down legislation on how amplifiers were to be tested. This is with a continuous sine wave signal with level set so that the distortion is at a specified level and power calculated from the RMS output voltage: hence the term RMS power. Note however that the term RMS refers to the method of measurement, i.e. the use of RMS voltage, and it is not the RMS value of the power waveform. It is, in fact, the average of the power waveform.

Speakers are just as confusing. They are normally specified not in terms of the power they can dissipate, but the maximum power of amplifier they are suitable for. This is due to the fact that music is never (well, rarely) a continuous sine wave and the average power in the speaker may be only 10% of the RMS rating of the amplifier, even with the amplifier clipping.

To measure the power actually being delivered to the speaker under music conditions, a wattmeter must be used.

Design Features

To multiply current and voltage together we had the choice of analogue or digital techniques. Unfortunately while digital is the 'in' thing, offering versatility and accuracy, it is not fast enough to calculate the instantaneous power on high frequencies. We therefore chose the analogue method.

Looking around the ICs, the only ones with reasonable price and availability were the MC1494, 1495 and 1496. The 1496 (or 796) is the cheapest and most readily available, but has the disadvantage of not being able to multiply DC signals or AC signals with a DC offset. The 1494 and 1495 are about the same price, and of the two, the 1494 was more linear and easier to use.

We chose not to use any input buffer on the voltage input but had to pay the penalty of having a lower input impedance than normal with voltmeters.

Using the Power Meter

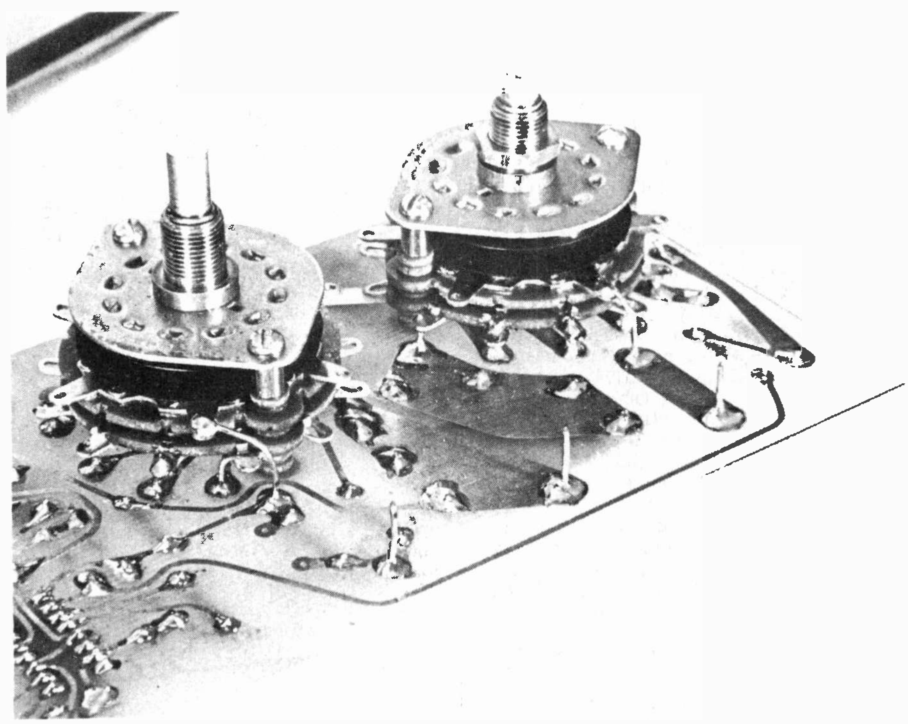
To use the meter we must measure both voltage and current. There must be a common point for these measurements. The current connection can be in either of two ways as shown in the drawings below. One measures the power out of the supply and the second the power into the load. The difference? The current shunt in the wattmeter drops one volt when working at the full range value and this may or may not affect the reading. At 10 A this accounts for 10 W which, if the power being measured is only 100 W, is a 10% error — although if the measured power is 2400 W the error is only 0.4%.

The range of the meter is the product of the individual ranges, i.e. on 30V and 1 A the fsd is 30 W, while 30 V and 3 A gives 100 W FSD. To help give a reading reasonably high on the scale, the voltage range can be overvoltaged by a factor of 2. Due to power dissipation problems this should not be attempted on the current ranges The peak voltage or current can be as high as three times the range value.

Construction

We mounted all the components associated with the meter and the switches on a single pc board and if the same or similar case is to be used this is recommended.

Except for the meter and the switches the components are mounted on the 'normal' side of the pc board. These should be mounted ▶



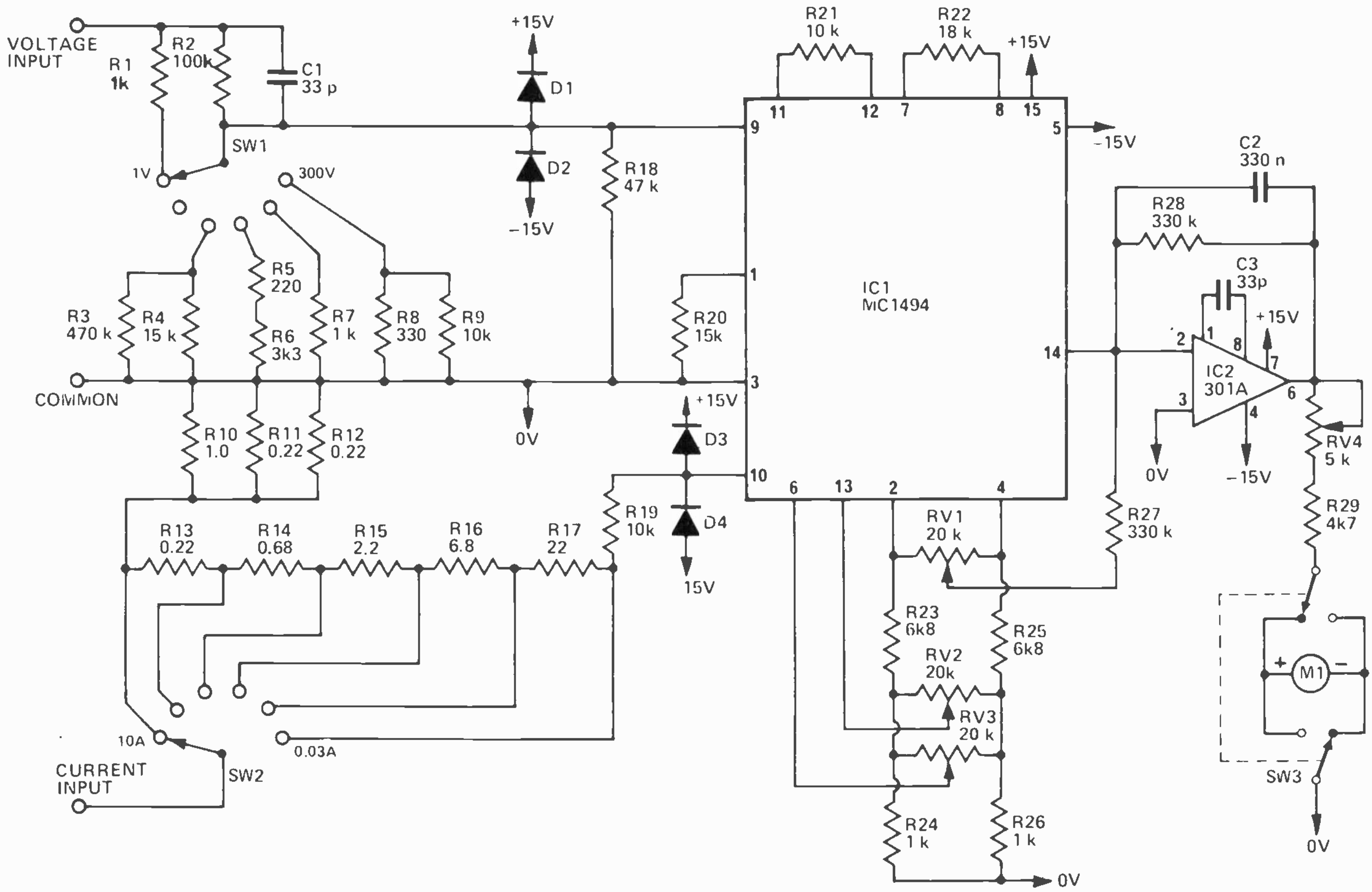


Fig. 1. The circuit diagram of the audio power meter.

HOW IT WORKS

Power is the product of current and voltage. This holds irrespective of the nature of the load, provided you are talking about instantaneous power. By multiplying current and voltage together and then taking the average of these instantaneous values we find the true power. Again this works irrespective of the load.

In this circuit the multiplying is done by IC1 (MC1494), the output of which is a current proportional to the product of the inputs. For more detailed notes on this IC, see the separate section. The current output of this IC is converted to a voltage by IC2 with C2 providing the averaging. The meter is then simply wired across the output of this IC with a meter reversing switch provided. This reversing switch is needed not to measure negative power, but to correct for reversed readings due to differing external connections.

The power supply is a full wave bridge with a centre tap giving about ∓20V DC which is then regulated to the ∓15 V required by IC1.

Adjustments for zeroing the voltage and current inputs are provided by RV2 and RV3 while RV1 compensates for offsets in the output. These are supplied by a stable ∓4 V reference in IC1. Range switching is done by SW1 and SW2. Protection against overvoltaging the IC is provided by D1 — D4.

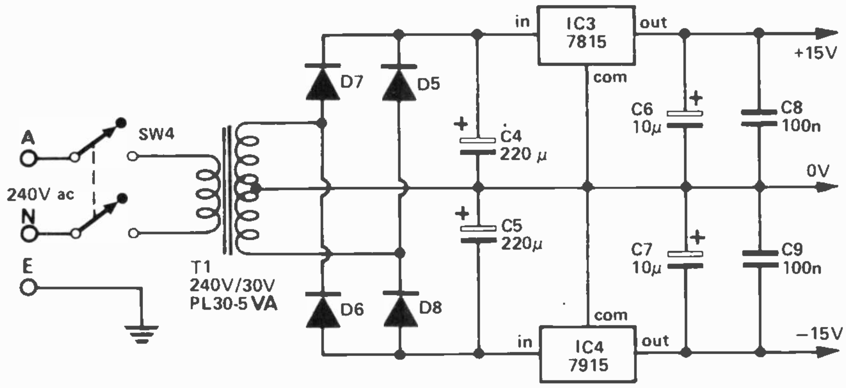
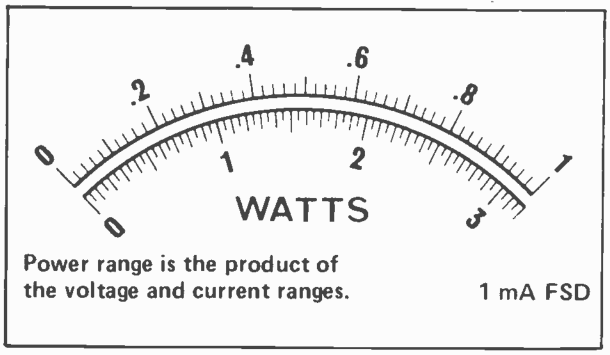


Fig. 2. Power Supply Circuit.

Right: meter scale designed for a 1mA FSD meter. These scales may need to be altered for differing meter units.



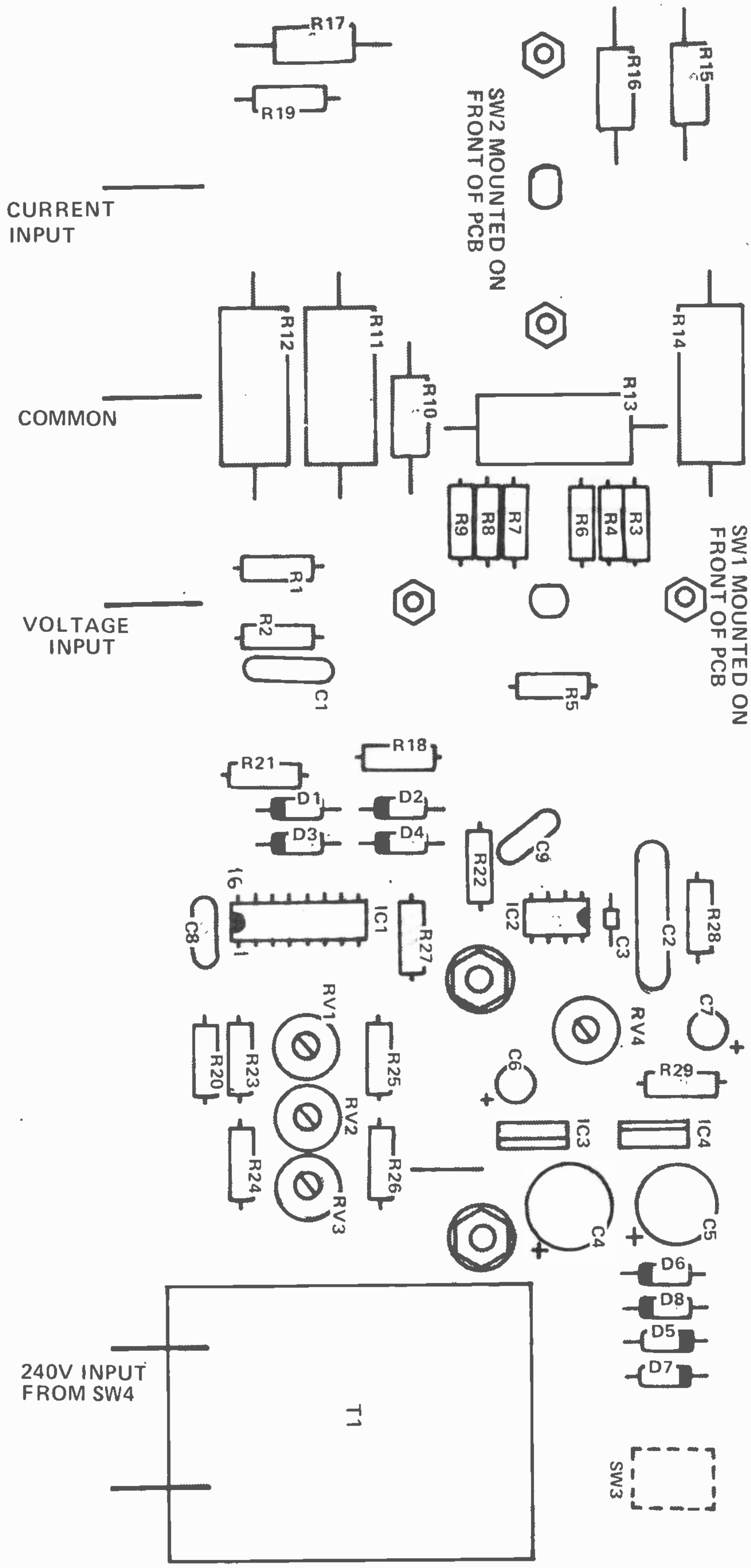


Fig. 3. Overlay for the Power Meter.

PARTS LIST

Resistors all 5% ½W unless stated

R1, 7, 24, 26	1k
R2	100k
R3	470k
R4, 20	15k
R5	220R
R6	3k3
R8	330R
R9, 19, 21	10k
R10	1R 1W
R11-13	0R22 5W
R14	0R68 5W
R15	2R2 1W
R16	6R8 1W
R17	22R
R18	47k
R22	18k
R23, 25	6k8
R27, 28	330k
R29	4k7

POTENTIOMETERS

RV1-3	20k trimmer
RV4	5k trimmer

CAPACITORS

C1	33p 500V ceramic
C2	330n polyester
C3	33p ceramic
C4, 5	220u 35V electrolytic
C6, 7	10u 25V electrolytic
C8, 9	100n polyester

SEMICONDUCTORS

IC1	MC1494
IC2	301A
IC3	7815
IC4	7915
D1—D4	1N914
D5—D8	1N4004

MISCELLANEOUS

PCB
SW1, 2 two pole 6 position 10A rotary Radiospares
SW3, 4 two pole toggle switches
Transformer 15-0-15, 5VA
Meter 1mA FSD
Three binding posts
Instrument case 255 x 100 x 205mm
Power cord and clamp
Two knobs
Front panel

BUYLINES

Most of the parts for this project are readily available. Two things which may cause trouble are the switch assemblies and the quadrant multiplier itself.

The switch is an RS unit and as such can be obtained from any of their stockists. As for the IC, Tamtronik — who advertise on page 32 of this issue — can supply this and by the time you read this they will be able to sell you all the rest as well!

first with the only critical part of the assembly in the area of the range switches. Here the high powered resistors should be spaced at least 5mm from the PCB as they run hot at maximum current. Also the leads of all the reistors in this area should be cut off close to the pc board after soldering. This is to give adequate clearance to the rotary switches. We used two self tapping screws into the plastic of the transformer case to help fix it onto the board. We have made ▶

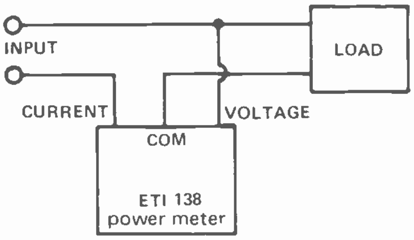


Fig. 4. This connection measures the power into the load.

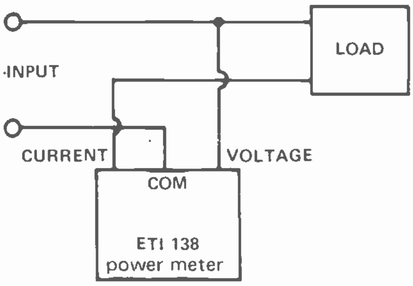


Fig. 5. This connection measures the power out of the supply.

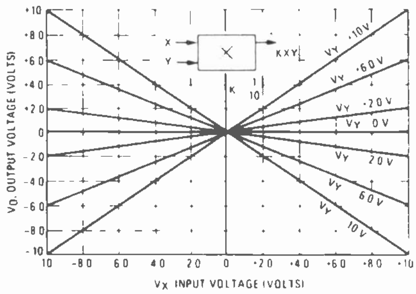


Fig. 6. Transfer characteristics of the IC.

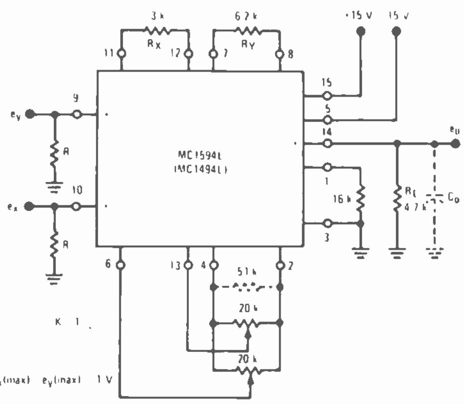


Fig. 7. Typical connections for a wide band multiplier or balanced modulator.

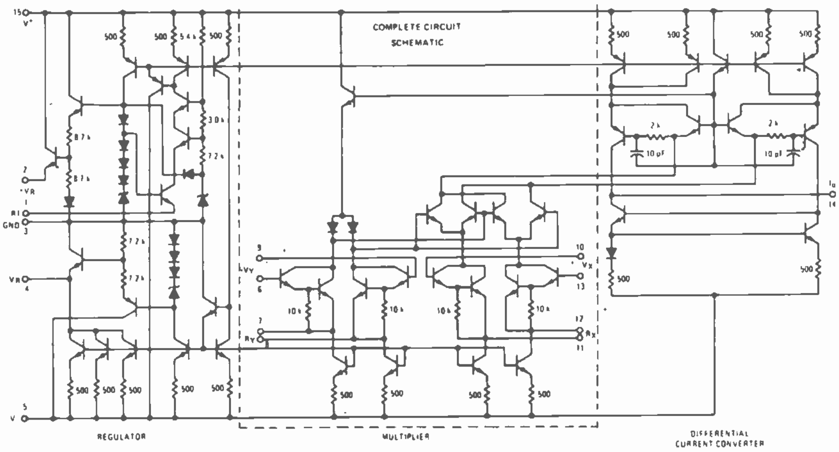


Fig. 8. The internal circuit diagram of the IC.

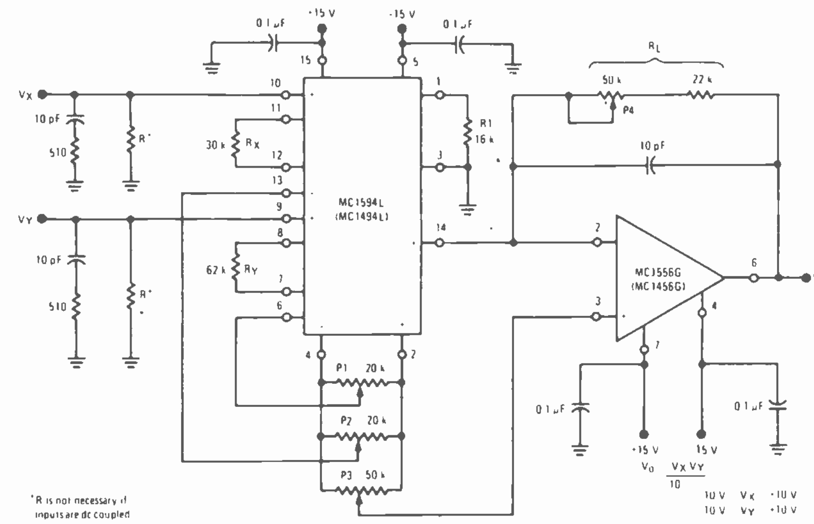


Fig. 9. Typical connection of a low frequency multiplier. For a squaring circuit simply parallel the two inputs. In this case pin 6 can be connected to OV and P1 deleted.

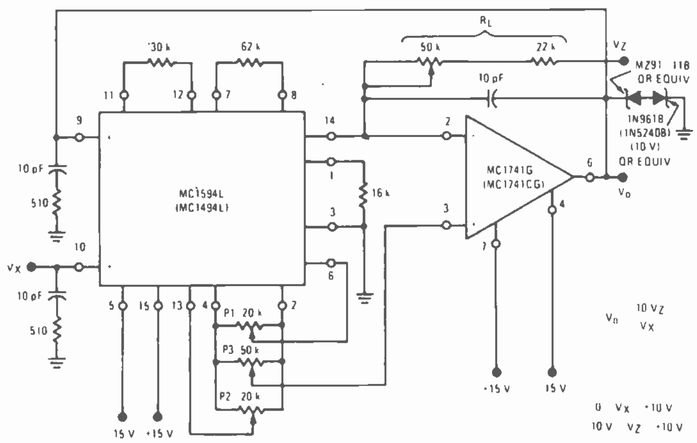
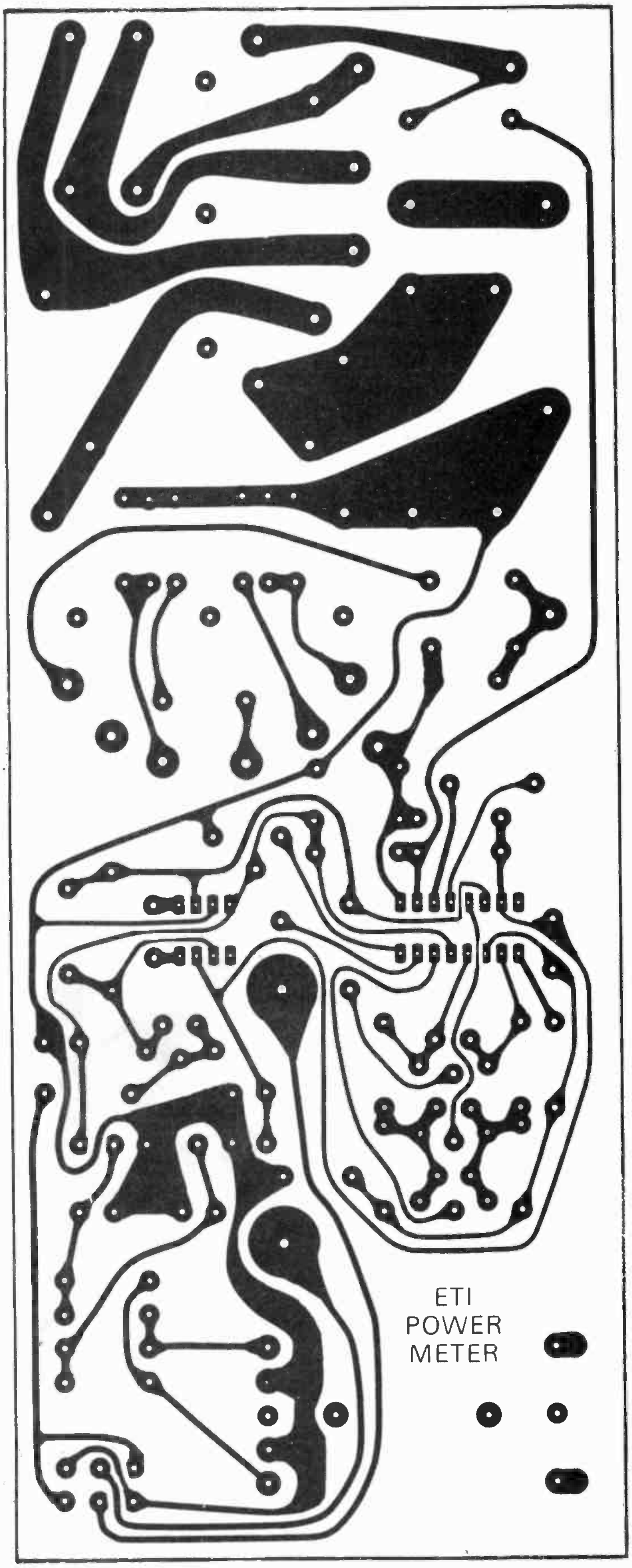


Fig. 10. Typical connection of a divide circuit. For the square root joins pin 9 and 10. Like the squaring circuits pin-6 can be connected to OV and P1 deleted.

Full size foil pattern for the power meter.



allowance for either the cermet (VTP) or the normal carbon trim pontentiometer.

Calibration

Four adjustments are required, which are performed as follows:

Select the 1 V and 0.03 A ranges and switch on. If the meter reads in reverse, toggle SW3. Don't worry about the reading unless it is off scale. If it is, adjust RV1 to bring it back towards zero. Now apply a voltage of about 1V DC to the voltage input and note the meter deflection. Adjust RV2* until there is no deflection when this voltage is applied. Now apply the voltage to the current input (it will take about 30 mA) and adjust RV3 until there is no deflection. Recheck the voltage input and readjust if necessary.

Now with no voltage applied adjust RV1 to give zero output. Apply exactly 1 V to both current and voltage inputs and adjust RV4 to make the meter read FSD.

This is all the calibration that should be necessary.

About the 1494

The 1494 is a variable transconductance multiplier with a bidirectional current source output. What this means is that it looks at the voltage on the two points and gives an output current potential to the product of the two. Typical applications include: multiply, divide, square, square root, phase detection, frequency doubling, balanced modulation/demodulation and electronic gain control. An internal circuit diagram is given for those interested.

Values and Limitations

1 For best temperature coefficient R1 (pin 1 to 0V) should be 16k (we used 15k as it is easier to obtain). This sets the value of all the current sources inside the IC ($I1 = 8/R1$)
2 The value of Rx (pin 11 to pin 12) should be $\geqslant$3x peak input voltage(X) expressed in k ohms.
3 The value of Ry (pin 7 to pin 8) should be $\geqslant$6x peak input voltage(Y) expressed in k ohms.
4 Choose the scaling factory required ie $Vout = K.Vx.Vy$.
5 Load resistance (pin 14 to 0V) can be calculated by $RL = (K.Rx.Ry.)I1)/2$
6 If RL is connected between pin 14 and 0V without an inverting amp. the frequency response is limited by the output capacitance of 10pF.
7 For best temperature coefficient the load between pins 2 and 4 should be 8.6k. ETI

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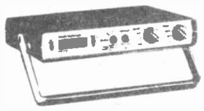
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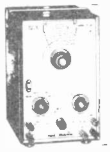
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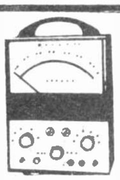
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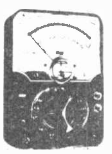
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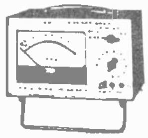
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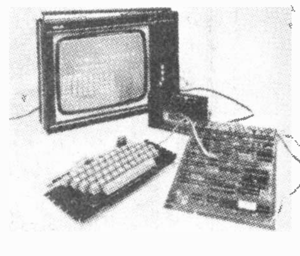

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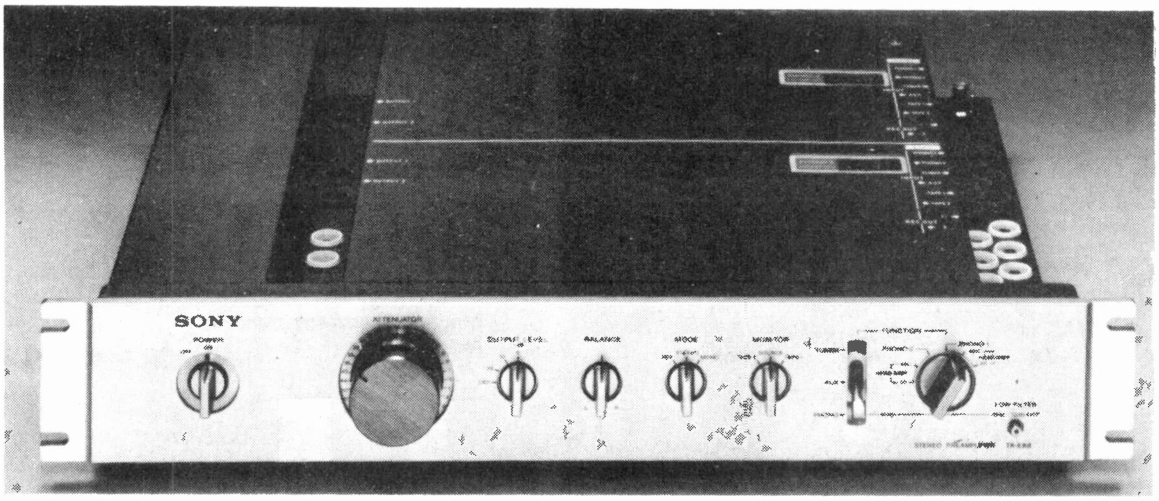


BY NOW I expect most of you have already heard of the TA-E88 pre-amp, the Sony flagship design. Costing a mere £699 it has been designed to match the TA-N88 VFET power amp, and uses FETS in the later stages of its circuitry. Overall the finish of the unit is probably up to a £700 standard. All sockets are gold plated, and a gold ended twin phono lead is supplied as standard. The controls are very nice to operate, and the volume and balance controls are very special indeed. Stepped attenuators are employed, but the operation is so smooth as to make you doubt it.

As you can see from the internal shot below, the signal path lies entirely along the PCB. There are no leads from the board carrying signal potentials, all switches and sockets are mounted in place, and extended to the front panel where need be.

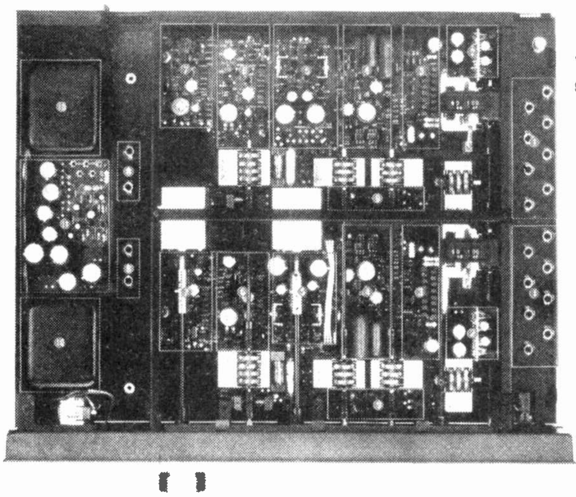
Shifting Load

There is even provision for switching about the resistance and capacitance associated with the magnetic phono inputs. Gold plated switches of course. Adjustment is variable between 10k-100pf and 100k-500pf. A useful provision this.

Completely separate channels — and PSUs — keep the right insensitive to the meanderings of the left and with the moving coil inputs especially this can be no bad thing.

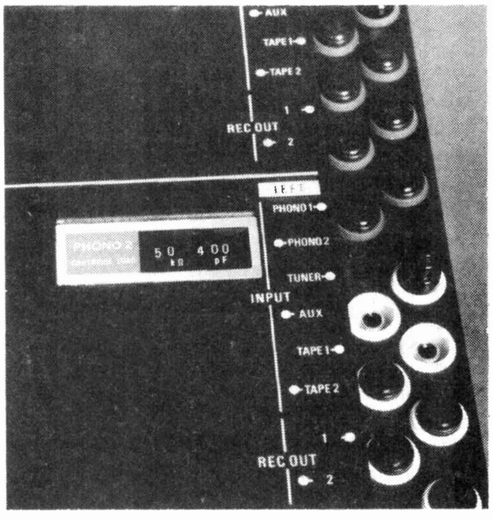
The head amp incorporated is a version of Sony marketed HA55, one of the best mains powered units on the market, and has two possible input impedances.

All this and no tone controls. It should be interesting to go through the circuit section by section, so I suppose the place to begin is the beginning. ▶



Right: an internal shot of the TAE88. The two channel construction can be clearly seen.

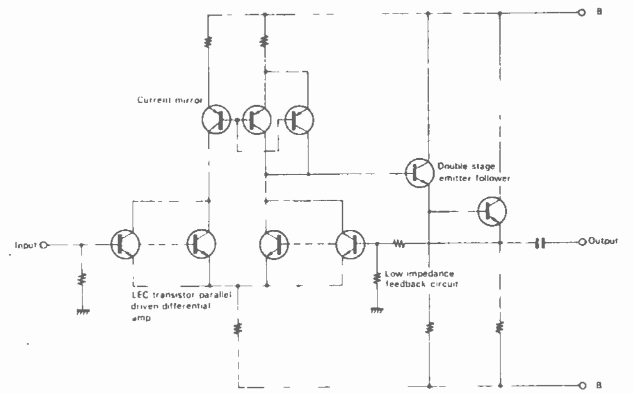
Left: a close up of the cartridge load switching and gold input sockets!

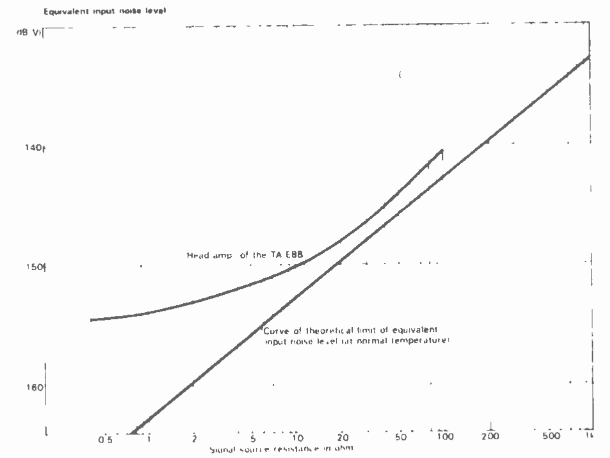


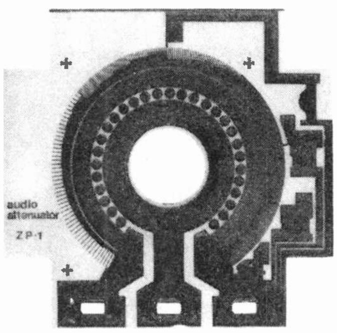
Head Start

As shown below, the moving coil amp consists of a differential pair with current minor driving an emitter follower output stage.

The differential circuit consists of cascade connected transistors to get the noise and gain figures required, and 44dB of negative feedback is applied to lower distortion as usual. Low impedance feedback paths like this are fine for some applications, but need careful design indeed to avoid becoming more of a hindrance than a help.







Above: moving coil input circuit and performance graph.

Left: the PCB from the balance control. Each 'step' is connected to a precision resistor!

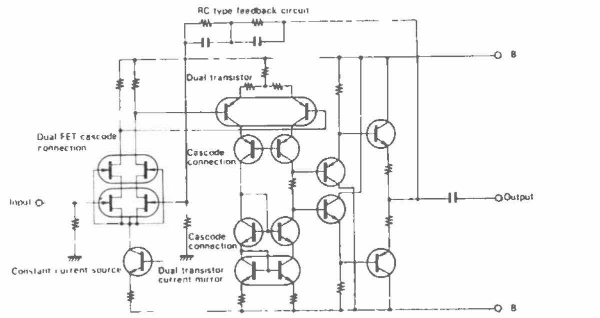
Magnetic Charm

For more normal pickups the TA88 employs dual FET inputs (in cascode mode) and more conventional RC feedback equalisation circitry. The FETs used were developed specially for the amplifier, when your 'Sony' of course you can get these things done.

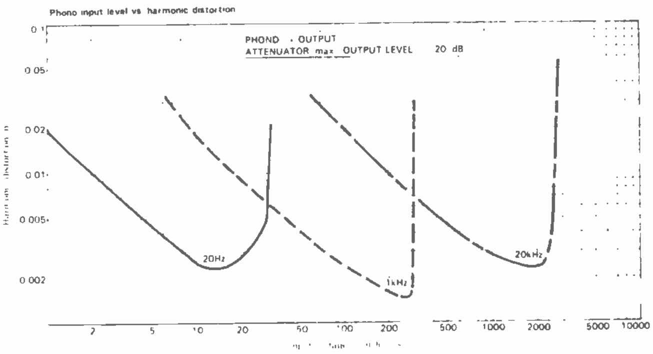
The second stage is a differential amplifier also, to further stabilise and give the overall circuit greater immunity from current source drift. Dual transistors are used in both the second differential amplifier and in the constant current stages of the circuit.

The output is once more an emitter follower following an emitter follower, and the components used are the expensive metal film resistors and polypropylene capacitors. Still when you've got £700 to spend — why not eh?

Equalisation is unusually accurate at 0.2%.

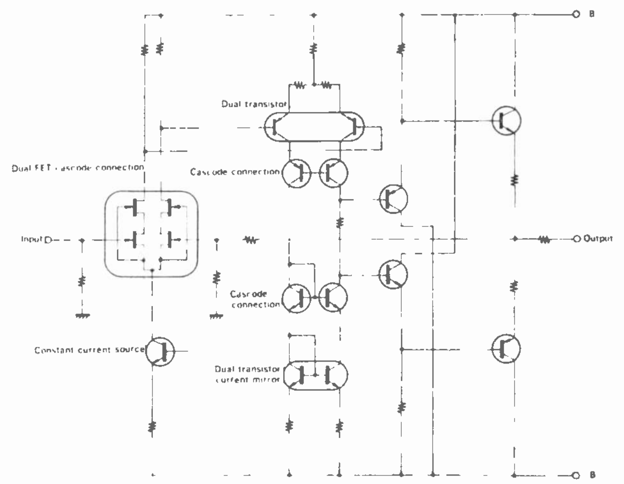


Magnetic cartridge input board.

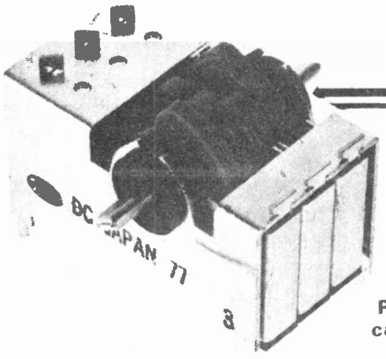


Standing At The Buffers

Buffer stages are liberally employed in the TAE88, between source inputs (non phono) and selector, and then either side of the volume control. Sony call the output amp a 'flat' amplifier for no reason I can fathom.



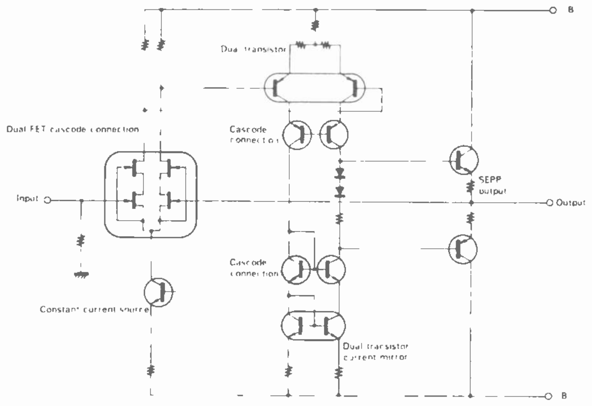
Buffer amplifier circuitry.



One of the PCB mounted cam switches.

You can see the circuit for the buffer circuit opposite. Once again dual FET inputs, and if you thought that there is a very strong similarity between this and the phono amps, I don't think you'll get many arguments from me.

The 'flat' amplifier (below) differs in as much as it is designed to work into the load presented by cable and power amp. To do this without loss of frequency response, a design closely akin to a power amplifier configuration has been adopted.



Output buffer circuit.

Output impedance is about 100 ohms, so that fairly long interconnection runs can be tolerated, and up to 15 V can be safely output at around .001% THD.

Lugged Around

After reading through all the imposing technical info supplied with the unit I was almost afraid to wire up the box into my merely mortal system. I suppose I suspected some form of electron snobbery whereby the TAE88 would refuse to 'talk' to any power amp of less than immaculate pedigree.

In practice however it was a case of 'noblesse oblige' and the Sony worked impeccably with the rest of the universe.' Several power amplifiers were tried, including the Lecson AP3II and a Crimson set up.

At first the TAE88 sounds very impressive with a particularly good bass end. The treble is a little thin, but nothing to comment adversely on. After a while though I came to suspect that maybe the unit wasn't as good as I thought at first, and perhaps adds a certain metallic quality to the sound.

Using the unit is a treat of the first order, and it inspires confidence better than Mr Callaghan ever did. Reservations must inevitably include that optimistic price level, and the less than perfect (just!) sound quality — which is as close to excellent as any other (but no closer!), but is more expensive approximation.

A lovely machine nontheless and if Sony can pull down the price (exit gold?) one which would have received a wholehearted recommendation. ETI

computing today

If you're wondering why COMPUTING TODAY is missing from this copy of ETI the answer is simple, it's probably still on your newsagent's shelf. You guessed it, as promised (or threatened) CT has gone solo, go on, treat yourself, we hope you won't be disappointed.

TANGERINE-ONE BOARD VDU

TANGERINE the sweet alternative to seven segment-displays. Don't be pipped at the post, we've got under the skin of this really versatile one-board VDU.

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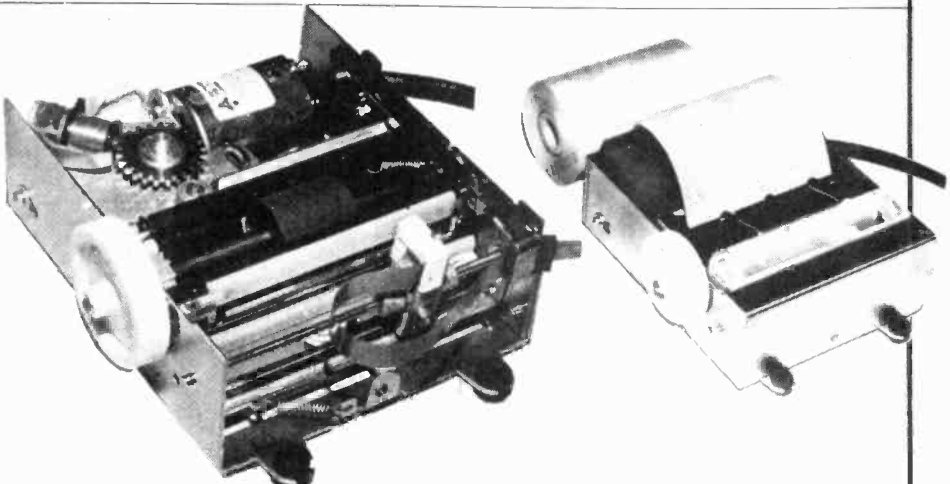
Probably the most widely used 'High Level Language' today. You may forget FORTRAN, even criticise COBOL but never be without BASIC.

The language of MPUs will be explained as you have never seen it before.



MICRO-BIOLOGY

Continuing the series with an almost indecently intimate look at the good old 6800 MPU.

SOFTSPOT

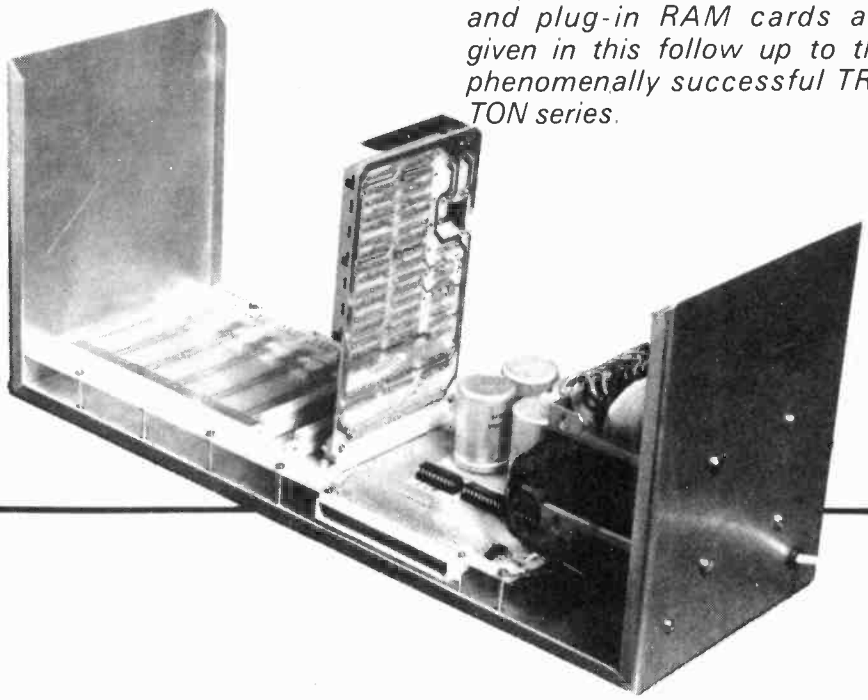
This very popular feature continues to bring you the very latest in new programs, and compiles (groan) all the most up-to-date programming ideas and techniques.

S100 PRINTER

Hard up for hard copy? Tired of losing those valuable programme listings? Then this is for you. This printer uses the almost universal S100 bus format, low cost mechanics and readily available electronics. It will represent a substantial saving over commercial units.

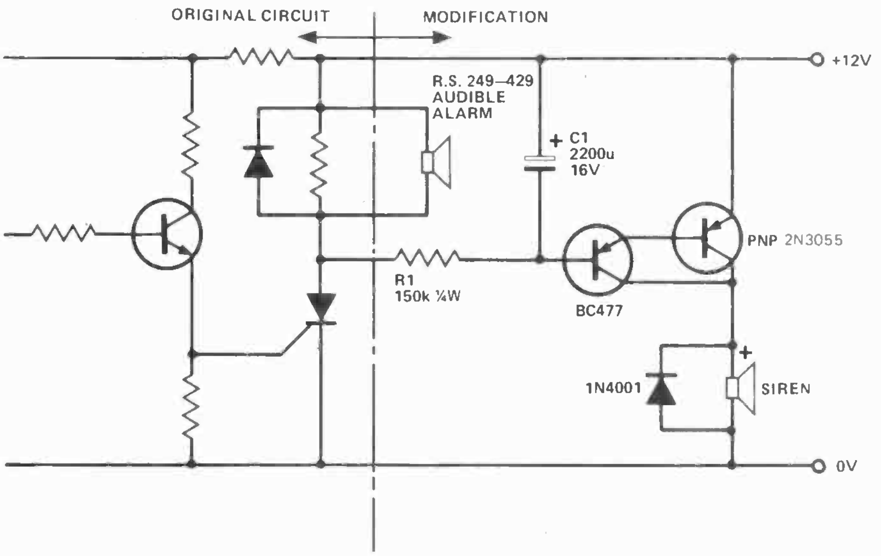
TRITON EXPANSION

Add another 8K of RAM to your TRITON and it will now have the capacity to thank you personally. Details of mother board and plug-in RAM cards are given in this follow up to the phenomenally successful TRITON series.



STOMPER

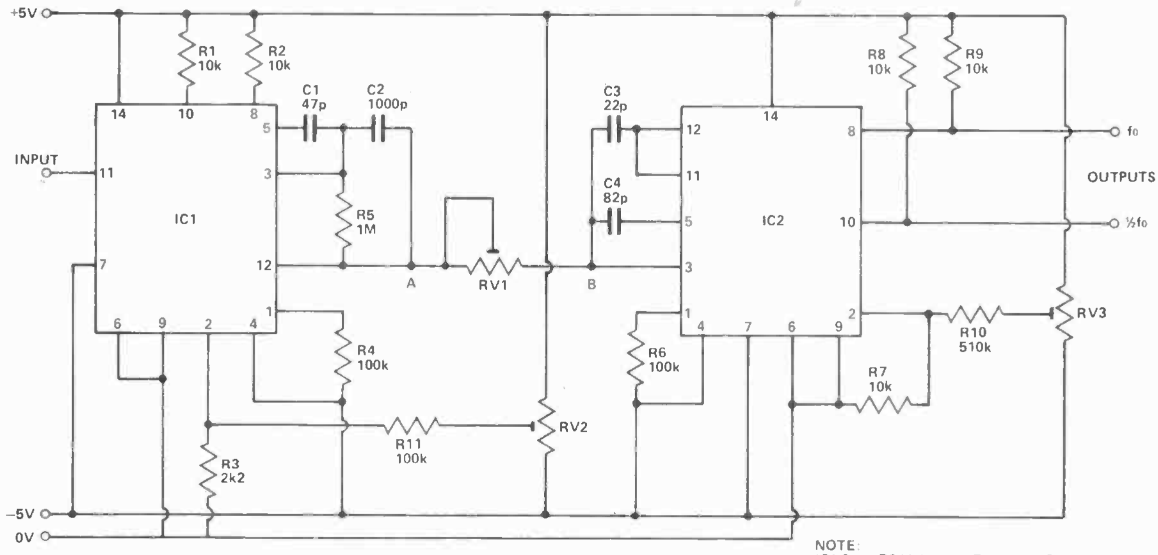
Do you dislike insects? Are you a conservationist? Well this program allows you to stamp on insects without damaging the environment, they even give a satisfying SPLAT when you crush them. Good fun for software Arachniphobiacs.



Less Alarming

J. Master.

The April, 1977 ETI Burglar Alarm works well enough but I thought you may be interested in this modification which enables a low power audible alarm to sound 40 seconds before the main alarm. The main advantage is that the alarm can be set when one is retiring to bed at night and if the alarm is inadvertently triggered at least there is enough time to turn the unit off before the main alarm sounds. This also applies when people come home with the alarm set, no front door by-pass switch is required and accidental setting off of the alarm is avoided. The delay time can be varied by altering RI and CI.



NOTE:
IC1,2 are RS Voltage to Frequency Chip No. 307–070
RV1,2,3 are 50k 20 turn trimmers

Keyboard Guitar

A. Parker

The purpose of this project is to convert the waveform from a guitar or other instrument into pure square or pulse waveforms of the same frequency. The circuit is basically a frequency to voltage converter feeding a linear VCO.

The construction is straightforward provided the usual care is taken with the Cmos chips. For RV1, 2 and 3 we suggest 20 turn presets as these will be needed for fine tuning of the circuit later. Also as an aid in testing we suggest that VR1 should NOT be soldiered in until after initial testing has been completed.

The tuning of the circuit is best done using a Meter, PSU, Signal Generator and frequency meter if possible. First set the sig gen to some suitable frequency (ie 100 Hz) and using the meter between point A and earth adjust RV2 to give a voltage according go the formula

$$V = F_{in} x 10^{-3}$$

(for 100 Hz V = 100—V

Now using an ACCURATE PSU set point B to +1 V and using VR3 adjust the output to 1 kHz then set to +10 V and adjust to 10 kHz. Now solder RV1 and adjust until

$$F_{in} = F \text{ out}$$

(NB This is a gross over simplifcation and patience is vital. Remember the price of the Chips before you throw them out of the window).

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

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

CBM Shoot

I. Holdstock

Shown here is the Shooting Program that I have devised for use on the Commodore PR-100 Programmable Calculator.

The idea is to try to shoot at targets that appear at random ranges. To do this the operator has to guess the correction that is necessary to score a Bullseye. To make things more difficult it is assumed that there is a strong wind blowing from the left, and the correction has to accommodate for this as well. The program works out where the shot would have hit the target and gives a score accordingly out of 5. Points are deducted for complete misses. The number of shots actually fired is stored, together with the total score. To use the program you enter the keystrokes and go to 00. Then 1000 is entered in memory 6. Then take the Sin of any integer less than 100 and run the number obtained. A random range will be displayed. Using the chart below the program listing, the operator has to guess the corrections necessary to score a bullseye and enter them at the correct stages into the program. A score will be displayed after the last correction. To re-use the program, simply press run after the score has been displayed, and a new range will be shown. Before the second correction is entered, 0 will be displayed. If the present range has been forgotten, it is simply obtained by pressing MR 1. (See instructions at the end of the program listing).

STEP NO	KEYSTROKE	CHECK CODE
00	M	51
01	0	91
02	1	81
03	F	21
04	M+	84
05	7	61
06	MR	52
07	0	91
08	+	84
09	pi	45
10	=	95
11	y^x	34
12	5	72
13	=	95
14	F	21
15	Frac	51
16	M	51
17	0	91
18	X	74
19	MR	52
20	6	73
21	=	95
22	M	51
23	1	81
24	STOP	13
25	—	85
26	MR	52
27	0	91
28	inv	31
29	tan	24
30	=	95
31	F	21
32	int	52
33	SKIP	15
34	GO TO	14
35	3	83
36	8	62
37	÷	94
38	M	51
39	2	82
40	C/CE	25
41	STOP	13
42	—	—
43	(	64
44	MR	52
45	1	81
46	X	74
47	2	82
48	tan	24
49	=	95
50	F	21
51	int	52
52	SKIP	15
53	GO TO	14
54	5	72
55	7	61
56	÷	94
57	F	21
58	M+	84
59	2	82
60	5	72
61	—	85
62	MR	52
63	2	82
64	=	95
65	F	21
66	M+	84
67	8	62
68	STOP	13
69	GO TO	14
70	0	91
71	2	82

TO USE: FIRSTLY F C/CE THEN,
A) GO TO 00
B) 1000 in memory 6
C) Any 2 digit number, then SIN it
D) RUN — the range is displayed
E) Enter elevation guess-RUN
F) 0 will be displayed
G) Enter windage guess — RUN
H) Score will be displayed
I) RUN — a new range is displayed
J) Enter elevation guess — RUN
K) 0 will be displayed
L) Enter windage guess — RUN
M) Score will be displayed
— and so on.

USEFUL HINTS

RANGE	ELEVATION	WINDAGE
000	0	0
100	5	3
300	16	10
500	26	17
700	34	24
1000	45	35

The number of shots fired is in memory 7; the score is in memory 8.
BULLSEYE is 5
INNER is 4
MAGPIE is 3
OUTER is 2
MISS is 0 or —N. Points are deducted for misses.

Versatile CMOS Test bed

J. Anderson

It is a cheap and easily constructed transistor tester utilising inexpensive and readily available CMOS ICs.

It not only carries out the normal GO/NO-GO test but will differentiate between PNP & NPN type as well as identifying their base leads.

Use of the tester is simple and is as follows:

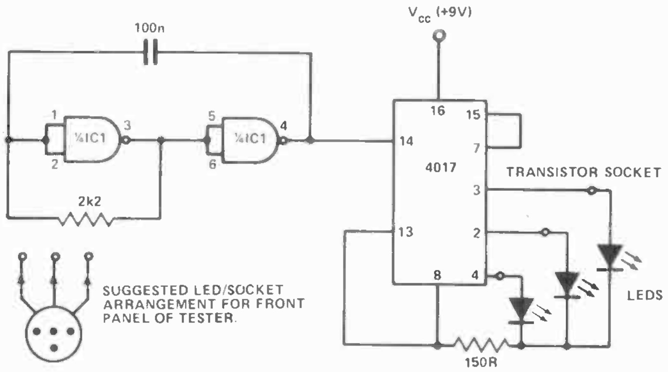
1) GO/NO-GO:—If the transistor is "a dud", either all the LEDs will come on or they will all go out.

2) PNP/NPN differentiation —a PNP only one of the LEDs will come on.

b) NPN one of the LEDs will go out.

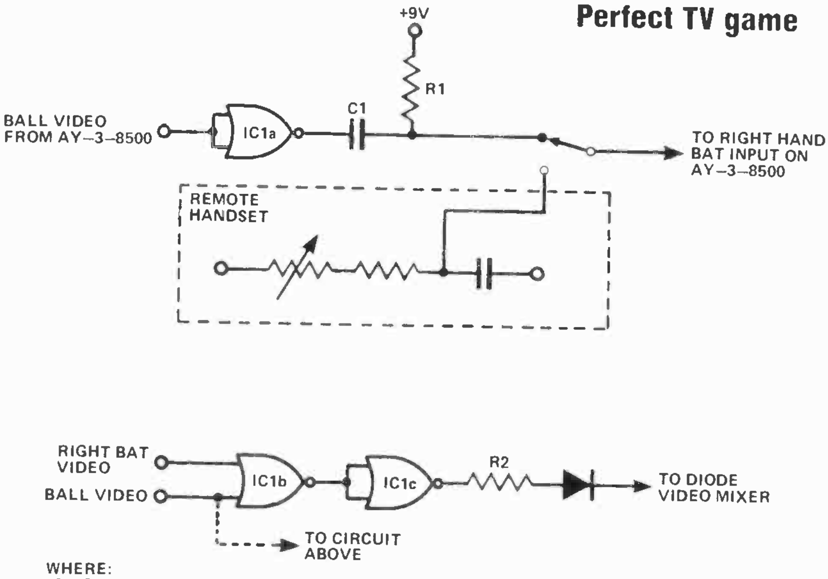
3) base lead identification:—the base lead is identified by the "odd LED out". (ie the one LED that is on with the other two out or the one that is out with the other two on).

The unit will also test diodes by the use of only two of the sockets of the transistor socket in this case the anobe of the diode is identified by the LED associated with its lead going out. The device also tests and identifies the gates of JUGFETs, SCRs & TRIACS.



Perfect TV game

B. Harvey



WHERE:
IC1 IS 4002
R1 IS 82k
R2 IS 1k
C1 IS 68n

The circuit shown allows a player to play tennis or squash against a perfect opponent, which is useful if one wishes to practise and cannot find another player.

The circuit 'plays' tennis or squash simply following the ball up and down the screen, thus it is always in the right place in order to hit the ball.

Although the circuit appears simple, (it only uses one gate from one IC!) the way it works is quite complex, suffice to say that it relies upon the way the AY-3-8500 games chip determines bat position from the setting of the hand controls.

The only modifications to the TV game are: (i) One lead connected to the ball video output of the games chip.

(ii) A switch wired in, selecting either a manual or an automatic player on the right hand bat.

(iii) This may not be necessary in home built games that use CMOS video mixers, but may have to be used in commercial units that sometimes use diode mixing circuits. The modification is shown and uses gates from the same IC. This will give a brighter bat and ball which is useful when playing squash.

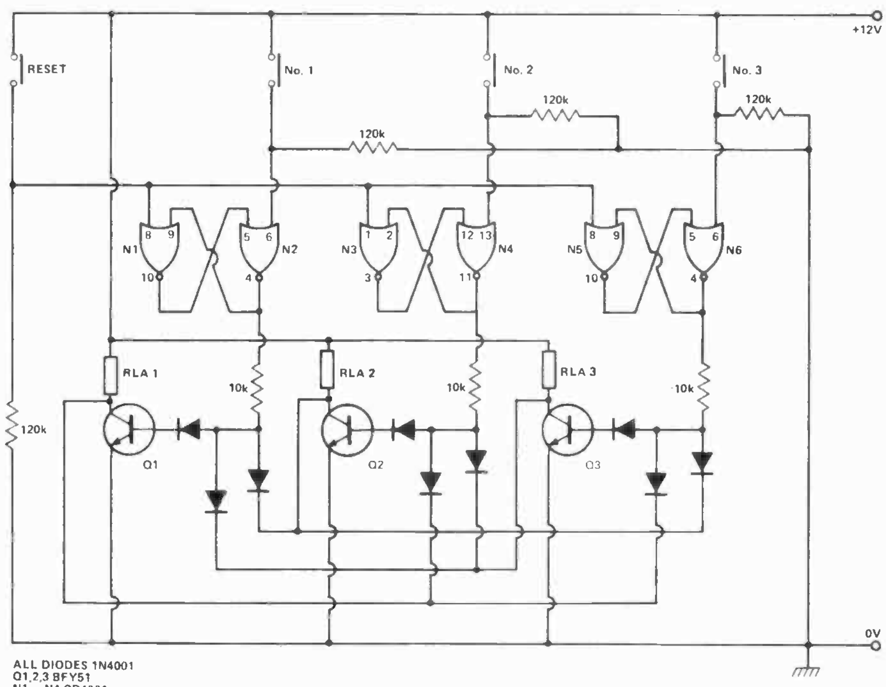
Sequence Switch

B. Willis.

The circuit right was designed to enable three relays to be individually switched by their appropriate buttons but such that only one relay can be energised at any one time. When any one relay has been energised the corresponding collector falls to near zero volts, which is connected to the base of the remaining two transistors; now if another relay is attempted to be energised the base of it's transistor will remain bottomed and keep the relay off. The rest button must be pressed before another relay can be energised. DI ensures that each transistor is kept off until the voltage applied to the base exceeds 0.6 V.

The flip-flops and push buttons can of course be replaced with standard switches if momentary action is not required.

The circuit was used to control three radio transmitters where it was important that two should not be switched on at the same time. The circuit lends itself to further applications; for example, switching various inputs into an amplifier where it can replace the self-cancelling selector buttons.



ALL DIODES 1N4001
Q1,2,3 BFY51
N1 – N4 CD4001
N5, N6 ½CD4001
RELAYS 120R OR ABOVE

ambit international ®

The PW Sandbanks Metal Locator: a kit based on this recently published design for this uniquely effective type of metal locator is available for only £35.00 + 8% VAT. The kit closely resembles the appearance as published, except that a close fitting injection molded housing replaces the vacuum molded electronics box - to improve the enviromental suitability of the construction. Carriage for complete kits £1.

The New Catalogue - "Tecknowledgey Part 2"
Part 2 of the catalogue: by the time this advert reaches the press, part 2 should be on sale. Sorry it's late, but it contains so many new and interesting things that we felt we had to hold up production to include them. Part three by the autumn -and already there are many new items to go in! Part one 45p, part 2 50p. (inc PP etc).

Radio ICs

TDA1062	HF/VHF tunerhead	1.95
TDA1083	One chip AM/FM rx	1.95
TDA1090	One chip HiFi am/fm	3.35
TDA1220	One chip am/fm rx	1.75
HA1197W	HiFi AM tuner IC	1.40
CA3123E	AM tuner IC	1.40
TBA651	AM tuner IC	1.81
CA3089E	Famous FM IF system	1.94
CA3189E	As 3089+ deviation mute AF preamp, adj, agc	2.75
HA1137W	Improved S/N 3089	2.20
TBA120	limiting amp+detector	0.75
TBA120S	high gain	1.00
MC1350P	agc'd IF preamp	1.20
MC1330P	synch AM/video detector	1.35
KB4406	Cascode IF preamp	0.65
uA753	limiting FM preamp	1.95

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SD6000	DMDS RF/Mixer pair	3.75
KB4412	Bal mixers, IF+agc	2.55
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KB4417	mic processor	2.55
MC3357	best thing in NBFM yet	3.12
MC1496P	popular double bal mixer	1.25

Multiplex decoders + noise blanker

MC1310P	popular PLL decoder	2.20
uA758	buffered 1310	2.20
CA3090AQ	RCA PLL decoder	3.25
HA1196	improved PLL decoder with stereo preamps	3.95
HA11223	19kHz pilot cancel, low distortion, high S/N	4.35
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Discrete devices: more than ever:

BF960	800MHz/2.8dB nf mosfet	1.60*
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40822	FM RF amp	0.43*
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40673	Famous MOSFET	0,55*
2SJ49/2sK133	120v/100W MOSPOWER output devices	10.50*

LEDS: the best value today

	3mm	5mm	2.5x5mm
Red	0.14	0.14	0.17
Green	0.18	0.16	0.20
Yellow	0.18	0.15	0.20
Orange	0.22	0.29	0.24

100 off mix, 25% discount. All are AEG first grade types - absolutely no junk. 5mm clips for panel mounting 0.03 each

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U237B	5 LED bargraph driver	0.80*
SAS6610	4 station touch tune IC	1.48*
SAS6710	adds 4 stations to 6610	1.48
MSM5523/4	LW,MW,SW and FM digital frequency readout plus clock, timers, stopwatch	£14 *
MSM5526	LW/MW/FM DFM with direct drive for LCD	£11 *
TCA730	DC volume control	3.50
TCA740	DC tone control	3.50
TDA1028	DC input switch	3.50
TDA1029	DC mode switch	3.50

Radio and Tuner modules
We cannot really list all the details we would like to here - but with advent of the new mark 3 tuner system, the Dorchester and matching AF units, Ambit offers you the widest choice ever, plus hardware and styling that matches the very high standards we have set in this new range.

TERMS etc: CWO please, VAT on Ambit Items is generally 12½%, except where marked (*). Catalogue part 1:45p, part 2 50p all inclusive. Postage 25p per order, carriage on tuner kits £3. Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays .

At last, DIY HiFi which looks as if it isn't.

That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb . A small pic here would be an insult, so send an SAE for details on the kit that looks as if isn't. It's something else.............

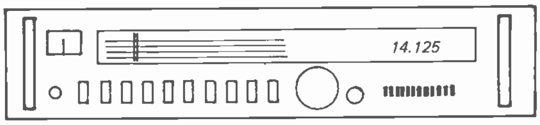
* Exceptionally high performance - exceptionally straightforward assembly
* Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
* Various options and module line-ups possible to enable an installment approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

* Matching both the style and design concepts of the MkIII HiFi FM tuner
* Hitachi VMOS power fets - characterized especially for HiFi applications
* Power output readily multiplied by the addition of further MOSFETs
* VU meters on the preamp - not simply dancing according to vol level
* Backed with the usual Ambit expertise and technical capacity in audio

The PW Dorchester · LW, MW, SW, & FM stereo tuner

THE DIGITAL DORCHESTER ALL BAND TUNER



With styling and dimensions to fit in with the rest of AMBIT's new range of tuner & audio equipment.

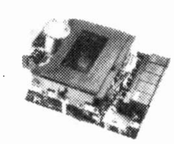
When the new range of OKI digital frequency display ICs was announced, the original prototype of the Dorchester had been made - but since so many of you wanted to use the OKI frequency counterdisplay system with the Dorchester, we quickly designed a unit to incorporate the necessary facilities. The Digital Dorchester is designed in 19 inch form, and forms a perfect match for the other units in the range. If you don't want to go to the expense of the full Ambit DFM1 module, with AM/FM/Time/Timers, then the MA1023 clock module can be used instead -

The Dorchester has been described in PW Dec., Jan. and Feb. issues - but for those of you who may have missed it - it is an All Band broadcast tuner, covering LW/MW/SW and FM stereo in 6 switched ranges. Construction is very straightforward, with all the switching being PCB mounted - and the revolutionary TDA1090 IC used for AM/FM.

The electronics for the radio section of the Dorchester remain unchanged at £33.00, with 12.5% VAT. The hardware package, of case, meter, PSU now costs £33.00 + 8% with the MA1023 available for an extra £5 only.
For the fully digital version, with Ambit DFM1, the price is £56.50 + 8% VAT.

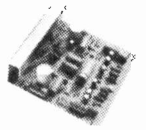
2 Gresham Road, Brentwood, Essex.

AUDIO MODULES
1 Stereo Cassette Deck N999
Complete with electronics uses: Music centres, disco consols, tape editing, etc. Freq resp 63 Hz-10KHz. WOW: 0.15% FLUTTER. 0.18% channel; separation 55dB. Electronic speed control. ALC Mic and line inputs. JAPANESE manufacture — requires 12 VDC. **£23.95.**

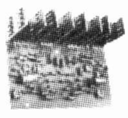


2 Preamp Amp — PSU Wimborne 11W per channel. Four Rotary controls. Vol., Bass, Treble, Bal. 2 x PSUs for RF Board — cassette deck, LM 387 preamp IC driver. TIP 31 — TIP 32 Output Pairs. Special price includes transformer, **£16.95.** (October, 1978, PW).

3 **AMP 041** 8 watt RMS per channel amp — preamp supplied with pots. Fully complementary requires 28 VDC. Price complete **£6.99.**

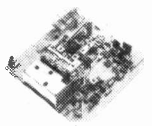


4 **AMP 020** Stereo power amp 30 W RMS per channel. Class ABI TIP 34A — TIP 33A. 16 Transistor circuit. Fre. resp. 15Hz — 18 KHz — 1dB. **£7.99.**



5 **Matching Hi-Fi Preamplifier,** four rotary controls, Vol., Bal., Treble,. Bass. Treble — 14dB Bass-14dB facility for loudness control. **£6.99.**

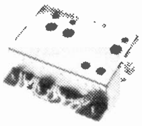
RF MODULES
6 **Surplus RF Board 020**
Complete MW/LW/FM/MPX Tuner uses 3-stage FET front end 2 ceramic filters 3089E-1310 Decoder. AM section built around 3132E, 2-stage tuning comes with 4-way switch — ferrite rod aerial. **£9.99.**



7 **RF 030**
Improved version of above extra gain stage imposed S/N ratio and 1.5 μV sensitivity for 26dB S/N way selector switch AFC stereo/mono switching — two additional inputs. **£19.95.**

8 **RF 040** MW/LW/FM/MPX varicap tuned RF board as per 78 Nov./Dec. PW Dual gate MOSFET front end, 2 x 1F gain stages 3189 Deviation mute, interstation mute, MPX filters. STab PSU 1μV sensitivity and 75dB S/N ratio. AM Section also varicap tuned HA1197, excellent performance. Special price **£28.95.**

9 **VT01** 108-150MHz MOSFET front end 26dB gain. 10.7MHz 1F output. Covers 2 metres. Amateurs. Aircraft, etc. **£7.99.**



10 IF15 Matching IF Strip double conversion 10.7MHz/470 KHz AM/NB/FM. Excellent performance. **£12.95.**

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NASCOM 1 AT MICRODIGITAL

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NASCOM I. £178.20

From 10th February 1979.
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The Nascom I was exceptional value for money at the old price, now it is unbeatable.

The **Nascom** I is the best possible introduction to the world of personal computing, yet it has the power and flexibility to be expanded into a full data processing system.

The specification includes powerful Z80 processor, parallel I/O controller with two 8 bit ports. UART driving cassette interface or most serial peripherals, video output to plug in the ariel socket of your T.V., 2K bytes of RAM (IK user and IK video), proven IK byte monitor program in EPROM and a spare EPROM socket.

The kit is complete, all that is required is a power supply a domestic T.V. and a domestic cassette recorder.

POWER SUPPLIES

There are two power supplies available, a 3 amp supply which will power the basic kit and some expansion and an 8 amp supply with toroidal transformer which will power a very large system. Both supplies can be mounted in the vero frame.

3 amp P.S.U. kit	£26.46
8 amp P.S.U. kit	£64.80

EXPANSION

Nascom I is expanded by connection to a buffer board which creates a 77 way bus structure "NASBUS" into which expansion boards plug directly. The bus structure is carried along a motherboard which allows future boards to be added and to keep your computer neat the **Nascom** I, power supply, buffer board, mother board and expansion boards can all be mounted in a vero frame.

Buffer Board	£27.00
Mother board	£10.26
Mini Motherboard	£3.13
Vero frame	£31.86

NASBUS

The 77 way **Nasbus** has the following advantages:—

1. Uses standard Veroboard as a motherboard and Standard 0.1 single sided edge connectors for expansion cards. These components are readily and cheaply available.
2. The bus structure leaves 8 spare data lines and 4 spare address lines for future use of 16 bit processors.
3. The power lines are regulated, on board regulators are therefore not needed which obviates the necessity for fan assisted cooling.
4. All cards use lower power, low noise shottky buffering which means the bus is quiet and does not need sophistications like active termination or interleaved ground planes.
5. Expansion boards are standard 8" x 8" vero DIP boards which are economic and give a good useable area.

MEMORY

The memory expansion board can carry 16 dynamic RAM chips, these can be either 4K bit or 16K bit chips and the board is offered with8,16 or 32K bytes of RAM. The 16K board can be expanded to 32K by plugging in 8 more 4116 chips.

The memory expansion board also has room for 4 2708 UVEPROMS each of IK bytes and a lot of pre-programmed systems software is available to fit these sockets.

8K RAM board kit	£91.80
16K RAM board kit	£151.20
32K RAM board kit	£216.00
Set 8 x 4116	£75.60
Additional 2708	11.34

INPUT/OUTPUT

For people wanting to use more peripherals than the standard kit allows for, **Nascom** are producing an I/O board which can carry a counter timer chip and a number of PIO's and UARTS. This will be available in March.

I/O board	£37.80
CTC	£8.64
UART	£5.94
PIO	£8.64

BASIC

To allow high level language programming **Nascom** have produced a 2K Tiny basic and a 3K Super Tiny Basic in 2 or 3 2708 EPROMS respectively. Also available is an 8K Microsoft precision floating point basic in 8 2708's which will be available in April on a single 64K bit ROM to fit the EPROM board.

Tiny Basic	£27.00
Super Tiny Basic	£37.80
8K Basic (8 x 2708)	£108.00
8K Basic (ROM)	£43.20

EPROM BOARD

Available in March this board will carry 8 x 2708 UVEPROMS and the 64K bit ROM containing basic. The board can also be used for burning in 2708 UVEPROMS.

EPROM BOARD	£43.20

GRAPHIC BOARD

Allows high resolution graphics on your Nascom I. Contains 4K of RAM.

Graphics board	£102.60

MONITOR

Nascom have written a new monitor, T4 the most powerful yet available for this machine it contains many desirable features not found on any other monitor. T4 comes in 2 x 2708 to plug into the main **Nascom** I board.

Nasbug T4	£27.00

FIRMWARE

A powerful editor assembler zeap is available to run under Nasbug in 3 x 2708 or on tape. ICL Dataskill have produced a letter Editor available in 2 x 2708.

Zeap (tape)	£32.40
Zeap (Eprom)	£48.60
Letter Editor	£75.60

THE FUTURE

In the near future a mini-floppy disk system will be available with either single or double drive. These will probably offer in excess of ½ a megabyte and 1 megabyte respectively at prices that will allow even the hobbyist to have a large data base. To take full advantage of the business and scientific uses opened up by disks **Nascom** intend to release several high level languages. Looking further forwards **Nascom** is a developing product, and the fact that many thousands are now in use will ensure that the latest in computer technology will be available at a competitive price.

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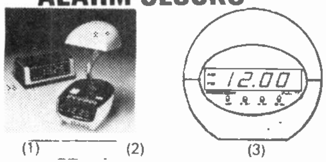

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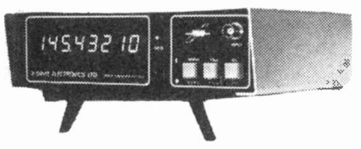

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