

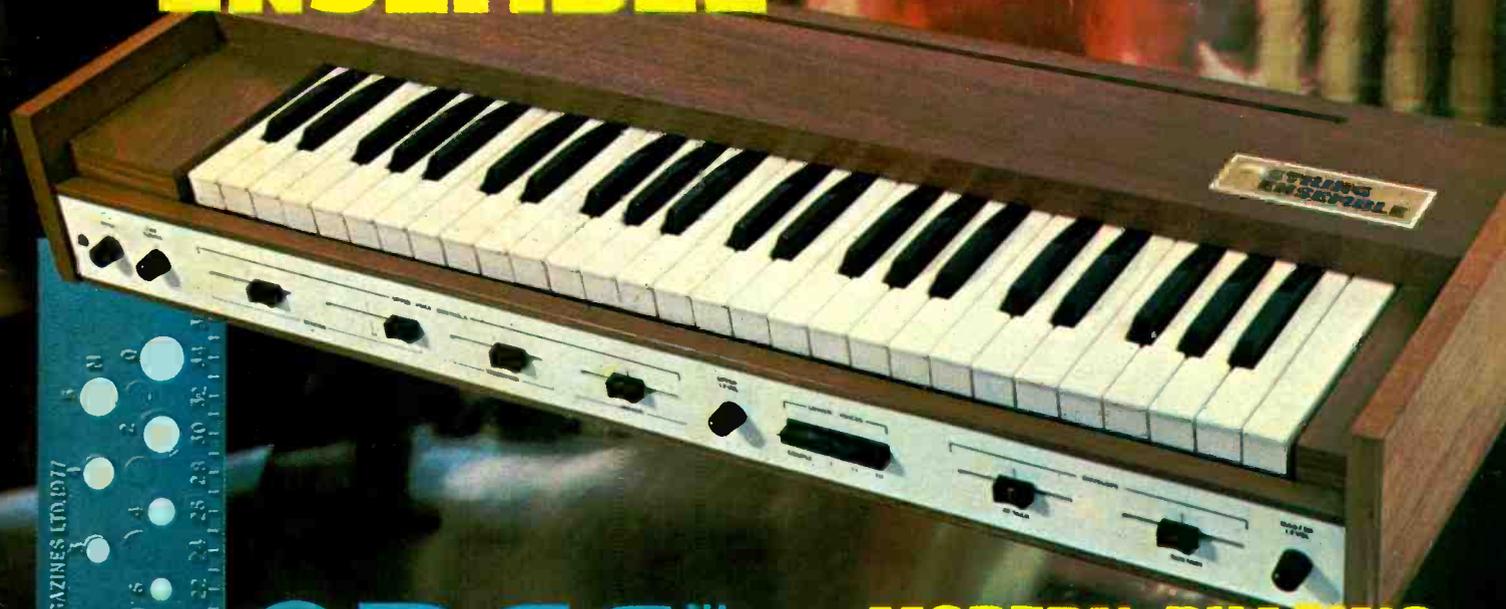
PRACTICAL

ELECTRONICS

MARCH 1978

45p

PE **STRING ENSEMBLE**



**MODERN PHASING
TECHNIQUES GIVE
'MULTI-STRING'
SOUND**

FREE!

... with this issue

**MATRIX
MARKER**

Also inside:

**'AUTOMATIC'
ENLARGER TIMER**

PRESENTED FREE WITH PRACTICAL ELECTRONICS BY IPC MAGAZINES LTD 1977

WATFORD ELECTRONICS

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.O.'s 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 £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE.

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VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 8% to devices marked *. To the rest add 12%. We stock many more items. Send S.A.E. for our free list. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am - 6.00 pm. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type. (Values are in µF)
400V: 0.001 0.0015 0.0022 0.0033 8p; 0.0047 0.0068 0.01 0.015 0.018 9p; 0.022 0.033 10p; 0.047 0.068 14p; 0.10 15p; 0.15 0.22 22p; 0.33 0.47 39p; 0.68 45p; 1.0 160V: 0.039 0.15 22 13p; 0.33 0.47 22p; 0.68 1.0 29p; 1.5 33p; 2.2 39p; 4.7 47p. **DUBILIER:** 1000V: 0.01 0.015 16p; 0.022 18p; 0.047 16p; 0.1 34p; 0.47 43p.

POLYESTER RADIAL LEAD (Values in µF) 250V:
0.01 0.015 6p; 0.022 0.027 7p; 0.033 0.047 0.068 0.1 18p; 0.15 12p; 0.22 0.33 14p; 0.47 16p; 0.68 20p; 1.0 24p; 1.5 27p; 2.2 31p.

FEED THROUGH CAPACITORS
100µF 350V 8p

ELECTROLYTIC CAPACITORS: Axial lead type. (Values are in µF)
63V: 0.47 1.0 1.5 2.2 2.5 3.3 4.7 6.8 8 10 15 22 9p; 47 32 50 12p; 63 100 27p; 50V: 1.0 7p; 5.0 100 220 25p; 4.7 50p; 1000 2200 68p; 40V: 22 33 9p; 100 12p; 300 62p; 4700 64p; 35V: 1.0 33 7p; 330 470 32p; 2000 49p; 25V: 1.0 22 47 6p; 80 130 160 8p; 220 250 13p; 470 640 25p; 1000 27p; 1500 30p; 2200 41p; 3300 52p; 4700 54p; 16V: 1.0 40 47 8p; 100 125 8p; 470 16p; 1000 1500 20p; 2200 34p; 10V: 4 100 6p; 640 10p; 1000 14p.

TAG-END TYPE: 70V: 2000 98p; 4700 121p; 50V: 3000 75p; 40V: 4000 70p; 2500 65p; 25V: 4700 48p; 2000 37p; 40V: 2000 29p; 1000 25p; 325V: 200 10V 50 100 190p.

TANTALUM BEAD CAPACITORS
20V: 0.1µF 0.22 0.33 0.47 0.68 1.0 2.2µF 3.3 4.7 6.8 25V: 1.5 10 35V: 1.5 16V: 10µF 13p each
47.100 40p; 10V: 22µF 33 47p each
47.68 100 3V: 68 100µF 20V each

POTENTIOMETERS (AB or EGEN)
Carbon Track 1W Log & 1W Linear values
500Ω 1K & 2K (lin only) Single 26p
5KΩ 2MΩ single gang 26p
5KΩ 2MΩ single gang D/P switch 55p
5KΩ 2MΩ dual gang stereo 70p

MYLAR FILM CAPACITORS
100V: 0.001 0.002 0.005 0.01µF 5p
0.015 0.02 0.04 0.05 0.056µF 6p
0.1µF 0.15 0.22 30V 50V 0.47µF 10p

SLIM POTENTIOMETERS
0.25W Log and linear values 60mm
5KΩ 500KΩ single gang 70p
10KΩ 500KΩ dual gang 80p
Self Stick Graduated Bezels 25p

CERAMIC CAPACITORS 50V
0.5µF to 10nF 3p each
15nF 22nF 33nF 47nF 4p each
0.1µF 6p

RESET POTENTIOMETERS
Vertical & Horizontal
0.1W 500Ω 5MΩ Miniature 6p
0.1W 500Ω - 3.3MΩ Horiz 10p
0.25W 200Ω - 4.7MΩ Vert 10p

POLYSTYRENE CAPACITORS
10µF to 1nF 6p; 1.5nF to 47nF 10p

RESISTORS - Eric make 5% Carbon Miniature - High Stability Low noise
RANGE VAL 1 99 100 1p
1W 2 20 4 7M E24 1 5p 1p
1W 2 20 10M E12 2p 1.5p
2.5W Metal Film 100 1M 1p 4p
100 p.p.p applies to Resistors of each type not mixed values

SILVER MICA (Values in pF) 3 4 7 6 8 10 12 18 27 33 47 50 68 75 82 85 100 120 150 220 270 330 390 470 560 680 820 1000 1500 2000 2200 2700 3300 3900 4700 5600 6800 8200 10000 15000 20000 22000 27000 33000 39000 47000 56000 68000 82000 100000 150000 200000 220000 270000 330000 390000 470000 560000 680000 820000 1000000 1500000 2000000 2200000 2700000 3300000 3900000 4700000 5600000 6800000 8200000 10000000 15000000 20000000 22000000 27000000 33000000 39000000 47000000 56000000 68000000 82000000 100000000 150000000 200000000 220000000 270000000 330000000 390000000 470000000 560000000 680000000 820000000 1000000000 1500000000 2000000000 2200000000 2700000000 3300000000 3900000000 4700000000 5600000000 6800000000 8200000000 10000000000 15000000000 20000000000 22000000000 27000000000 33000000000 39000000000 47000000000 56000000000 68000000000 82000000000 100000000000 150000000000 200000000000 220000000000 270000000000 330000000000 390000000000 470000000000 560000000000 680000000000 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Our April issue will be on sale Friday, 10 March, 1978
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TRANSFORMERS

ALL EX-STOCK—SAME DAY DESPATCH. VAT 8%

12 AND 24 VOLT OR 12-0-12V PRIMARY 220-240 VOLTS				
Ref	12V	24V	£	P & P
111	0.5	0.25	2.20	0.45
213	1.0	0.5	2.64	0.78
77	2	1	3.51	0.78
18	4	2	4.03	0.96
70	6	3	5.35	0.96
108	8	4	6.98	1.14
72	10	5	7.67	1.14
116	12	6	8.99	1.32
17	16	8	10.39	1.32
115	20	10	13.18	2.08
187	30	15	17.05	2.08
226	60	30	26.82	OA

30 VOLT RANGE				
Ref	Amps	£	P & P	
112	0.5	2.64	0.78	
79	1.0	3.57	0.96	
3	2.0	5.27	0.96	
20	3.0	6.20	1.14	
21	4.0	7.44	1.14	
51	5.0	8.37	1.32	
117	6.0	9.92	1.45	
88	8.0	11.73	1.64	
89	10.0	13.33	1.84	

50 VOLT RANGE				
Ref	Amps	£	P & P	
102	0.5	4.41	0.78	
103	1.0	4.57	0.96	
104	2.0	6.98	1.14	
105	3.0	8.45	1.32	
106	4.0	10.70	1.50	
107	6.0	14.62	1.64	
118	8.0	17.05	2.08	
119	10.0	21.70	OA	

MAINS ISOLATING (SCREENED)				
Ref	VA (Watts)	£	P & P	
07*	20	4.40	0.79	
149	60	6.20	0.96	
150	100	7.13	1.14	
151	200	11.16	1.50	
152	250	12.79	1.84	
153	350	16.28	1.84	
154	500	19.15	2.15	
155	750	29.06	OA	
156	1000	37.20	OA	
157	1500	45.60	OA	
158	2000	54.00	OA	
159	3000	79.05	OA	

*Please specify 115 or 240V required

Our wide range of transformers are too numerous to list, please call (open 9am-5pm Mon-Fri) or send your requirements. Electrofit & semiconductor stockists. Panel, Multi Meters, Audio accessories, send 15p stamps for lists.

SCREENED MINIATURES				TEST METERS		BRIDGE RECTIFIERS			
Ref	mA	Volts	£	P&P	AVO 8 MK5	£17.00	200V	2A	£0.45
238	200	3-0-3	1.99	0.55	AVO 71	£29.00	400V	2A	£0.55
212	1A	0-0-0-6	2.85	0.78	AVO 73	£39.10	200V	4A	£0.65
13	100	0-0-0	2.14	0.38	AVO MM5	£24.00	400V	4A	£0.80
235	330, 330	0-9-0-9	1.99	0.38	AVO TT169 in circuit		400V	6A	£1.05
207	500, 500	0-8-9-0, 0-8-9	2.59	0.71	Transistor Tester	£30.00	500V	10A*	£2.35
208	1A, 1A	0-8-9-0, 0-8-9	3.53	0.78	U4315 Budget Meter 20kV/		VAT 12% *VAT 8% 15p P & P		
236	200, 200	0-15-0-15	1.99	0.38	VDC 2kV/AC 1000V AC/DC		Audio Kit 25W . 25W Complete with instructions £35.50. Teak cab mounting hardware £14.50 P & P £1 73 VAT 12%		
214	300, 300	0-20-0-20	2.58	0.78	2.5A AC/DC 500k res. in.		Magnetic to Ceramic Cartridge Converter operating voltages 20-45V only £3.50, VAT 12% P & P 35p		
221	700 (DC)	20-12-0-12-20	3.41	0.78	robust steel case & lead. £14.95.				
206	1A, 1A	0-15-20-0-15-20	4.63	0.96	VAT 8% P & P £1.15.				
203	500, 500	0-15-27-0-15-27	3.99	0.96	AVO cases and accessories.				
204	1A, 1A	0-15-27-0-15-27	5.39	0.96	Wee Megger	£58.80			
S112	500	12-15-20-24-30	2.64	0.78	Plastic Cases				
239	50	11-0-12	1.99	0.38	PB1-77x56x37mm	-46p			
					PB2-95x71x35mm	-56p			
					PB3-115x95x37mm	-60p			
					P&P 29p	VAT 8%			

HIGH QUALITY MODULES		MUSIC CENTRE CHASSIS	
10 WATT RMS AMPLIFIER	£3.66	FM (STEREO) MW LW 15 - 15W	£4.57
25 WATT RMS AMPLIFIER	£6.95	Music Power inc. Var. Tran.	£6.95
35 WATT RMS AMPLIFIER	£15.95	Price £22.50 inc. VAT P & P £1.50	
125 WATT RMS AMPLIFIER	£6.70	*VAT 8%	
PRE-AMP for 5-10 WATT	£13.88	PLUG IN SAVE BATTERIES	
POWER SUPPLIES 5-10 WATT	£1.30	Stabilised 3-6-7-9/400mA	
POWER SUPPLIES 25 WATT	£3.75	multiplug outlet	£6.61
TRANSFORMER 5-10 WATT	£3.09	3300 filis into 13A socket 6-7.5-9V	
*TRANSFORMER 25 WATT	£4.79	300mA multiplug outlet	£3.30
P & P Modules 35p. Trans. 96p. VAT 12%		B12-3, 4, 5, 6, 7.5, 9, 12V 500mA	
		DC plug outlet	£8.32
		VAT 12% P & P 55p	
		-DECS SOLDERLESS	
		BREAD-BOARDING	
		S Dec 70 contacts	£1.98
		T Dec 208 contacts	£3.63
		U Dec "A" for I.C.s etc	£3.99
		U Dec "B" for I.C.s etc	£6.99
		VAT 8% P & P 40p	
		ANTEX SOLDERING IRONS	
		15W	£3.75
		18W	£3.75
		25W	£4.40
		25W Stand	£1.40
		25W	SM245
		16W	SM240
		P & P 46p	VAT 8%
		MINI-MULTIMETER	
		DC-1000V AC-1000V DC-100mA	
		Res-150kΩ 1000ΩV Bargain £5.86	
		P & P 62p	VAT 8%
		STEREO FM TUNER WITH	
		PHASE-LOCK LOOP	
		4 Pre-selected stations, varicap tuning,	
		switched AFC, LED Beacon	£20.45
		VAT 12% P & P 40p	

BLOB BOARD (Pack of 3)		ELECTRONIC CONSTRUCTION KIT	
2 5" x 5 1" or 2 5" x 5 1" 15"	£0.75	10 projects (including electronic organ). No	
3 75" x 5 1" or 3 75" x 5 1" 15"	£1.14	soldering needed £7.29. VAT 8% P & 70p	
10" x 6" 1" or 10" x 6" 15"	£3.78		
IC Range	£0.96	4 75" x 7 5" £2.13	
4 8" x 3 2"	£0.96	P & P 35p	VAT 8%
		COMPONENT PACKS	
		200 Mixed value resistors (count by weight)	
		150 Mixed value capacitors (count by weight)	
		30 Mixed value precision resistors 1/2W 2%	
		15 Assorted pots	
		10 Reed switches	
		15 Wire wound resistors—mixed wattage	
		1 Pack wire 50 metres assorted colours	
		25 pre-set assorted types and values	
		Please state pack required.	
		60p per pack. VAT 12% P & P 40p	

AUTO TRANSFORMERS		CASED AUTO TRANSFORMERS	
Ref	VA (Watts) Volts	£	P & P
113	15 0-115-210-240	2.48	0.71
64	75 0-115-210-240	3.95	0.96
4	150 0-115-200-220-240	5.35	0.96
67	500 0-115-200-220-240	10.99	1.64
84	1000 or 30-0-30-240	18.76	2.08
93	1500 0-115-200-220-240	23.36	OA
95	2000 0-115-200-220-240	34.82	OA
73	3000 0-115-200-220-240	48.00	OA

HIGH VOLTAGE MAINS ISOLATING		TRIAC BARGAINS	
VA	Ref	£	P & P
60	243	5.89	1.32
350	247	14.11	1.84
1000	250	35.65	OA
2000	252	54.25	OA

Prices correct 7.11.77. Please add VAT after P & P.

24 HR. CLOCK/APPLIANCE TIMER KIT



Switches any appliance of up to 1kW on and off at preset times once a day. KIT contains: AY-5-1230 Clock/Appliance Timer IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full instructions. £14.85
Special white box (56 x 131 x 71mm) with red Acrylic window - undrilled £2.38
drilled £2.70

TOUCH CONTROLLED LIGHTING KITS

These KITS replace conventional light switches and control 300W of lighting. No mains rewiring required. Insulated touch plates. Complete with easy to follow instructions.

TS300K - TOUCHSWITCH and DIMER combined. ONE touchplate to switch light on or off. Brightness controlled by small knob. £5.62

TS300K - TOUCHSWITCH. TWO touch plates. One for ON one for OFF. £4.32

TSA300K - AUTOMATIC TOUCHSWITCH. ONE touch plate. Touch for ON and light stays on for preset time (variable from 2 secs. to 3 1/2 mins.). Ideal for stairs and hall. £4.32

LD300K - 300W LIGHT DIMMER KIT. Replaces conventional light switches. £3.02					
AY-5-1230 Clock/Appliance Timer I.C.	£5.24				
LM3911 Thermometer/Temperature Control IC (with dots)	£1.08				
NE555 Timer I.C. 8 pin dill 39p (3 for £1.08)					
741 Op. Amp. I.C. 8 pin dill 26p (5 for £1.08)					
BC147	9p	8F50	16p	2N6027 PUT	37p
BC148	9p	2N3055	43p	TIS43 UJT	26p
BC158	11p	TIP31A	54p	1N4148	5p
BC182L	9p	TIP32	54p	1N4004	5p

CMOS LOW PRICES							
4000	19p	4012	19p	4023	19p	4077	49p
4001	19p	4013	55p	4025	19p	4501	22p
4002	19p	4015	98p	4040	105p	4510	162p
4007	19p	4016	55p	4049	54p	4516	162p
4011	19p	4017	98p	4050	54p	4519	61p

OPTO ELECTRONICS				
0.2" Red LED	11p	C280 Polyester Capacitors 250V d.c. (values in µF)		
0.2" Green LED	23p	01 5p; 022, 033, 047, 0.68 6p; 0.1 7p; .5 8p; .22 9p;		
0.2" Yellow LED	27p	33 12p; .47 13p; .68 19p; 1.0 22p; 2.2 39p.		
DL727 Dual 0.5" Display	£1.62	RESISTORS. 33W 5% 22 ohm to 10M ohm	2p	
		Push Button, push to make	23p	

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PRICES VAT INCLUSIVE. ADD 25p P&P. MAIL ORDER ONLY TO:
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PRE AMPLIFIERS

Designed for use with TUAC power amplifier modules



VA08

Vol. Treb. Mid. and Bass controls. HI IMP. FET I/P suitable Mid. Guitar, Radio Crystal/Ceramic P.U. Sensitivity 4mV. Treble+35dB at 16kHz. Mid+20-15dB at 1kHz. Bass+20-10dB at 40Hz.

VA06

Vol. Treb. and Bass controls. Sensitivity 8mV. Treb +28-15dB at 12kHz. Bass ±18dB and 40Hz.

SVA08 STEREO PRE AMP

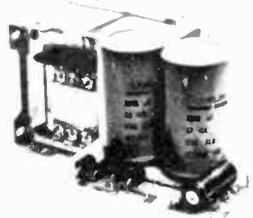
Vol. Treb. Mid. and Bass controls. I/P suitable Guitar, Radio, Crystal/Ceramic P.U. Sensitivity 4mV. Treble+35dB at 16kHz. Mid+20-7dB at 4kHz. Bass+20-18dB at 30Hz Plus Full Balance Control. Fully I/C operation supply voltage +25VDC.

£9.00

£7.75

£15.00

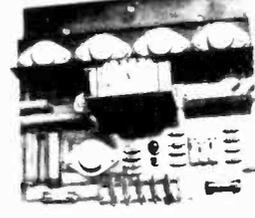
POWER SUPPLIES



Vacuum varnish impregnated. Transformers with supply board incorporating pre-amp supply:

PS250 for supplying 2 TP125s	£28.50
PS200 for supply to TL100	£28.50
PS60/60 for supplying 2 TL60s	£17.75
PS125 ±45 volts for TP125	£16.25
PS100 ±43 volts for TL100	£16.25
PS60 ±38 volts for TL60	£15.25
PS30 ±25 volts for TL30	£11.75
PSU 2 for supplying disco mixer	£7.50

AMPLIFIER MODULES



TL30 D.C. COUPLED 5 × 5 × 1/4in.

• 30 watt R.M.S. continuous sine wave output
• 8 transistors 4 diodes

£12.75

TL60 5 × 5 × 3in

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

£18.75

TL100 5 × 5 × 3in

• 100 watt R.M.S. continuous sine wave output
• 2 R.C.A. 150 watt 15 amp transistors

£20.75

TP125 7 × 6 1/2 × 3in

• 125 watt R.M.S. continuous sine wave output
• 4 R.C.A. 150 watt 15 amp output transistors

£25.75

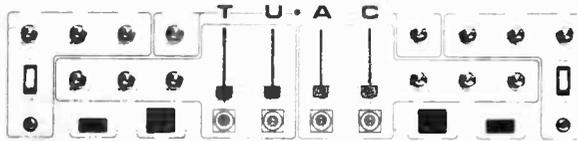
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER - 4LSMI

- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from 1/2W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£20.75

Model 501 500W per channel as above without sound triggering

£12.25



STEREO DISCO MIXER

With touch sensitive switching and auto fade

INPUTS: Four identical stereo inputs available with any equalisation. Two magnetic and two flat supplied as standard. High quality slider control on each channel. Volume, treble and bass controls for each pair of sliders. Sensitivity mag. 3mV (R.I.A.A. comp.) Flat 50mV at 1kHz. Bass controls: 18dB at 60Hz. Treble controls: ±18dB at 15kHz.

OUTPUT: Up to 3 volts (+12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz - 25kHz ± dB. P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator.

Miscellaneous Facilities: Two illuminated deck on/off switches. Mains illuminated on/off switches. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions. Size: 25in long x 6in high x 3in deep.

Mono Disco Mixer with autofade £45.00

£129.00

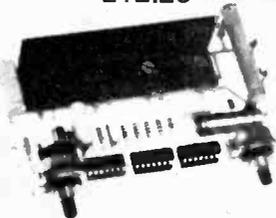
3 CHANNEL LIGHT MODULATOR SILMB

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

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Single Channel Version 1500 Watts

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FRONT PANEL FOR LIGHTING EFFECT MODULES

(complete with switches, neons and knobs) as illustrated



For S1LMB £6.50
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Amber £23.50



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Size 9" x 4 1/2"
Combined with 3SDM1

new from TUAC... ULTRA QUALITY HIGH POWER TD 500 POWER AMPLIFIER New DC coupled design

Output power using PS250
300w into 2 Ohms
220w into 4 Ohms
140w into 8 Ohms
75w into 15 Ohms
RMS continuous sine wave output
INPUT Sensitivity 0.775V
RMS (ODB) at 25 KOHMS
Hum and Noise - 100dB
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THD = at Full Power 0.1%



7" x 9" x 1 3/4" £45

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Geo Mathews, 85/87 Hurst Street, Birmingham (Tel. 021-622 1941).
Bristol Disco Centre, 25 The Promenade, Gloucester Road (Tel. Bristol 41666).
Soccodi, 9 The Friars (Tel. Canterbury 60948)
Cookies Disco Centre, 132 West Street (Tel. Crewe 4739).
Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
Luton Disco Centre, 88 Wellington Street, Luton (Tel. Luton 411733)
Mitchell Electronics, 7 Queen Street (Tel. Salisbury 23689).
Session Music, 163 Mitchem Road, Tooting (Tel. 01-672 3413).
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- Full logic integrated circuitry
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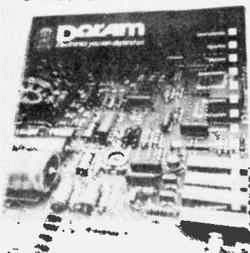


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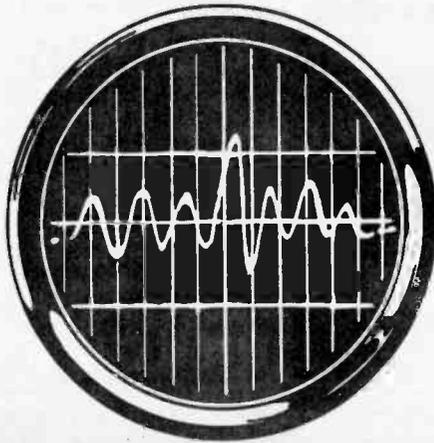


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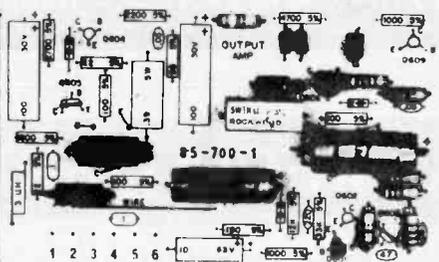
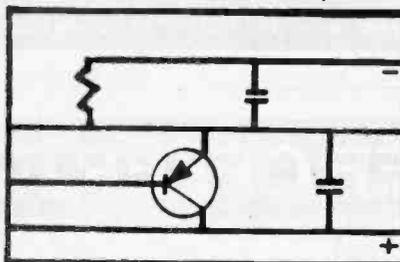
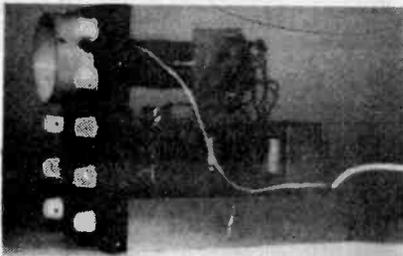
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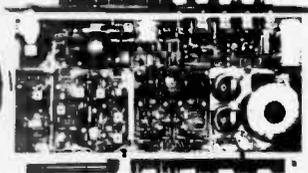
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TWO YEAR GUARANTEE



illustration shows GXL Centaur System

These systems feature full mixing for two decks
tape & mic with monitoring facilities - override
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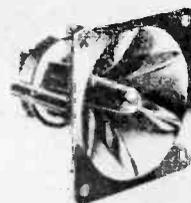
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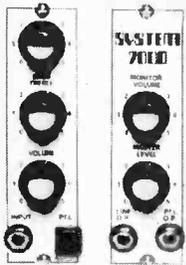


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7403	18p	7444	74p	CD4003	80p	CD4025	25p	CD4091	POA
7404	22p	7447	182p	CD4007	26p	CD4026	190p	CD4092	POA
7405	22p	7448	182p	CD4008	87p	CD4027	90p	CD4093	POA
7406	44p	7454	18p	CD4009	82p	CD4028	96p	CD4094	POA
7407	44p	7470	39p	CD4010	82p	CD4029	110p	CD4095	POA
7408	23p	7472	28p	CD4011	18p	CD4030	82p	CD4096	POA
7409	23p	7473	39p	CD4012	18p	CD4031	13p	CD4097	POA
7410	18p	7474	33p	CD4013	50p	CD4032	87p	CD4098	POA
7411	24p	7475	48p	CD4015	97p	CD4033	95p	CD4099	POA
7412	24p	7483	90p	CD4016	95p	CD4034	95p	CD4100	POA
7413	36p	7480	46p	CD4017	99p	CD4035	13p	CD4101	POA
7414	41p	7482	81p	CD4018	99p	CD4036	13p	CD4102	POA
7415	33p	7483	90p	CD4019	85p	CD4037	13p	CD4103	POA
7417	33p	7485	104p	CD4020	110p	CD4038	13p	CD4104	POA
7420	18p	7486	36p	CD4021	85p	CD4039	85p	CD4105	POA
7425	28p	7489	39p						
7427	28p	7490	39p						
7430	20p	7491	82p						
7432	28p	7492	57p						
7437	28p	7493	57p						

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CA3046	90p	NE555	23p	OC47	7p	IN4002	8p	2N1306	21p
CA3052	152p	NE561	38p	OA70	8p	IN4003	8p	2N1307	21p
CA3078	136p	NE561	38p	OA73	10p	IN4004	7p	2N1308	21p
CA3080	37p	NE562	38p	OA81	15p	IN4005	7p	2N1309	21p
CA3089	136p	NE562	38p	OA85	14p	IN4006	7p	2N1310	21p
CA3090	327p	NE565	134p	OA91	15p	IN4007	11p	2N1311	21p
CA3130	113p	NE566	124p	OA95	15p	IN4008	11p	2N1312	21p
CA3140	74p	NE567	175p	OA200	8p	IN4009	11p	2N1313	21p
CA3160	140p	SN7603	185p	OA202	8p	IN4010	11p	2N1314	21p
LM301	26p	SN7603	185p	IN414	4p	IN4011	11p	2N1315	21p
LM308	54p	SN7603	185p	IN415	4p	IN4012	11p	2N1316	21p
LM380	100p	SN7603	185p	IN416	4p	IN4013	11p	2N1317	21p
LM381	125p	SN7603	185p	IN417	4p	IN4014	11p	2N1318	21p
LM411	41p	SN7603	185p	IN418	4p	IN4015	11p	2N1319	21p
LM471	24p	TA561	25p	IN419	4p	IN4016	11p	2N1320	21p
LM472	24p	TA561	25p	IN420	4p	IN4017	11p	2N1321	21p
LM473	24p	TA561	25p	IN421	4p	IN4018	11p	2N1322	21p
LM474	24p	TA561	25p	IN422	4p	IN4019	11p	2N1323	21p
LM475	24p	TA561	25p	IN423	4p	IN4020	11p	2N1324	21p
LM476	24p	TA561	25p	IN424	4p	IN4021	11p	2N1325	21p
LM477	24p	TA561	25p	IN425	4p	IN4022	11p	2N1326	21p
LM478	24p	TA561	25p	IN426	4p	IN4023	11p	2N1327	21p
LM479	24p	TA561	25p	IN427	4p	IN4024	11p	2N1328	21p
LM480	24p	TA561	25p	IN428	4p	IN4025	11p	2N1329	21p
LM481	24p	TA561	25p	IN429	4p	IN4026	11p	2N1330	21p
LM482	24p	TA561	25p	IN430	4p	IN4027	11p	2N1331	21p
LM483	24p	TA561	25p	IN431	4p	IN4028	11p	2N1332	21p
LM484	24p	TA561	25p	IN432	4p	IN4029	11p	2N1333	21p
LM485	24p	TA561	25p	IN433	4p	IN4030	11p	2N1334	21p
LM486	24p	TA561	25p	IN434	4p	IN4031	11p	2N1335	21p
LM487	24p	TA561	25p	IN435	4p	IN4032	11p	2N1336	21p
LM488	24p	TA561	25p	IN436	4p	IN4033	11p	2N1337	21p
LM489	24p	TA561	25p	IN437	4p	IN4034	11p	2N1338	21p
LM490	24p	TA561	25p	IN438	4p	IN4035	11p	2N1339	21p
LM491	24p	TA561	25p	IN439	4p	IN4036	11p	2N1340	21p
LM492	24p	TA561	25p	IN440	4p	IN4037	11p	2N1341	21p
LM493	24p	TA561	25p	IN441	4p	IN4038	11p	2N1342	21p
LM494	24p	TA561	25p	IN442	4p	IN4039	11p	2N1343	21p
LM495	24p	TA561	25p	IN443	4p	IN4040	11p	2N1344	21p
LM496	24p	TA561	25p	IN444	4p	IN4041	11p	2N1345	21p
LM497	24p	TA561	25p	IN445	4p	IN4042	11p	2N1346	21p
LM498	24p	TA561	25p	IN446	4p	IN4043	11p	2N1347	21p
LM499	24p	TA561	25p	IN447	4p	IN4044	11p	2N1348	21p
LM500	24p	TA561	25p	IN448	4p	IN4045	11p	2N1349	21p

AC126	21p	BC148	10p	BC547	14p	BF183	37p	MJ2955	99p	2N1305	21p
AC127	21p	BC149	10p	BC548	14p	BF194	13p	MJE340	64p	2N1306	21p
AC128	21p	BC150	11p	BC549	27p	BF195	13p	MJE355	99p	2N1307	21p
AC176	21p	BC158	11p	BC557	14p	BF196	13p	OC71	18p	2N2219	21p
AC187	23p	BC159	11p	BCY34	74p	BF197	18p	OC28	108p	2N2904	21p
AC188	23p	BC158	11p	BCY70	17p	BF200	36p	OC35	108p	2N2905	21p
AD145	85p	BC168	12p	BCY71	20p	BF224	18p	OC71	18p	2N2906	21p
AD161	50p	BC171	12p	BCV72	17p	BF257	37p	OC84	46p	2N2926G	9p
AD162	50p	BC172	12p	BD115	39p	BF258	40p	TIP99C	50p	2N2926R	9p
AF174	30p	BC173	12p	BD116	39p	BF259	44p	TIP99D	50p	2N2926S	9p
AF175	27p	BC177	18p	BD117	47p	BF259	44p	TIP131A	47p	2N3053	13p
AF176	25p	BC178	18p	BD118	47p	BF259	44p	TIP132A	51p	2N3054	54p
AF177	23p	BC179	18p	BD119	47p	BF260	36p	TIP133	90p	2N3055	54p
AF178	23p	BC180	18p	BD120	47p	BF260	36p	TIP134	155p	2N3072	10p
AF179	23p	BC181	18p	BD121	50p	BF261	36p	TIP35	292p	2N3703	10p
AF180	23p	BC182	18p	BD122	50p	BF262	36p	TIP36	292p	2N3704	10p
AF181	23p	BC183	18p	BD123	50p	BF263	36p	TIP37	292p	2N3705	10p
AF182	23p	BC184	18p	BD124	50p	BF264	36p	TIP38	292p	2N3706	10p
AF183	23p	BC185	18p	BD125	50p	BF265	36p	TIP39	292p	2N3707	10p
AF184	23p	BC186	18p	BD126	50p	BF266	36p	TIP40	292p	2N3708	10p
AF185	23p	BC187	18p	BD127	50p	BF267	36p	TIP41	292p	2N3709	10p
AF186	23p	BC188	18p	BD128	50p	BF268	36p	TIP42	292p	2N3710	10p
AF187	23p	BC189	18p	BD129	50p	BF269	36p	TIP43	292p	2N3711	10p
AF188	23p	BC190	18p	BD130	50p	BF270	36p	TIP44	292p	2N3712	10p
AF189	23p	BC191	18p	BD131	50p	BF271	36p	TIP45	292p	2N3713	10p
AF190	23p	BC192	18p	BD132	50p	BF272	36p	TIP46	292p	2N3714	10p
AF191	23p	BC193	18p	BD133	50p	BF273	36p	TIP47	292p	2N3715	10p
AF192	23p	BC194	18p	BD134	50p	BF274	36p	TIP48	292p	2N3716	10p
AF193	23p	BC195	18p	BD135	50p	BF275	36p	TIP49	292p	2N3717	10p
AF194	23p	BC196	18p	BD136	50p	BF276	36p	TIP50	292p	2N3718	10p
AF195	23p	BC197	18p	BD137	50p	BF277	36p	TIP51	292p	2N3719	10p
AF196	23p	BC198	18p	BD138	50p	BF278	36p	TIP52	292p	2N3720	10p
AF197	23p	BC199	18p	BD139	50p	BF279	36p	TIP53	292p	2N3721	10p
AF198	23p	BC200	18p	BD140	50p	BF280	36p	TIP54	292p	2N3722	10p
AF199	23p	BC201	18p	BD141	50p	BF281	36p	TIP55	292p	2N3723	10p
AF200	23p	BC202	18p	BD142	50p	BF282	36p	TIP56	292p	2N3724	10p
AF201	23p	BC203	18p	BD143	50p	BF283	36p	TIP57	292p	2N3725	10p
AF202	23p	BC204	18p	BD144	50p	BF284	36p	TIP58	292p	2N3726	10p
AF203	23p	BC205	18p	BD145	50p	BF285	36p	TIP59	292p	2N3727	10p
AF204	23p	BC206	18p	BD146	50p	BF286	36p	TIP60	292p	2N3728	10p
AF205	23p										

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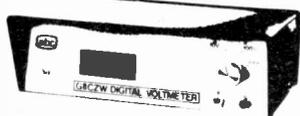


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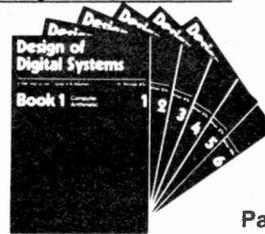
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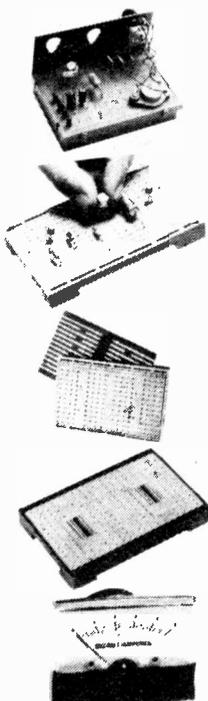
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AC176	16p	8C183	*9p	BFX29	22p	TIP41C	36p	2N2219	15p
AC176K	24p	8C183L	*9p	BFX84	18p	TIP42A	36p	2N2219A	18p
AC187	16p	8C184	*9p	BFY50	12p	TIP42B	37p	2N2221	15p
AC187K	26p	8C184L	*9p	BFY51	12p	TIP42C	38p	2N2221A	18p
AC188	16p	8C212	*10p	BFY52	12p	TIP2955	65p	2N2222	15p
AC188K	26p	8C212L	*10p	MPSA05	*22p	TIP3055	42p	2N2222A	18p
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162 MP		8C213L	*10p	MPSA55	*22p	ZTX108	*6p	2N2904	14p
AF139	30p	8C214	*10p	MPSA56	*22p	ZTX109	*7p	2N2904A	15p
AF239	30p	8C214L	*10p			ZTX300	*7p	2N2905	14p
8C107	6p	8C251	*10p	OC44	12p	ZTX301	*7p	2N2905A	15p
8C108	6p	8C251	*10p	OC45	12p	ZTX302	*9p	2N2906	12p
8C109	6p	8C270	12p	OC71	9p	ZTX500	*8p	2N2906A	14p
8C118	*10p	8C272	12p	OC72	12p	ZTX501	*10p	2N2907	12p
8C147	*8p	8D115	40p	OC75	10p	ZTX502	*12p	2N2907A	13p
8C148	*8p	8D131	*35p	OC81	14p	2N696	10p	2N2926G	*7p
8C149	*8p	8D132	*37p			2N697	10p	2N2926Y	*7p
8C154	*16p	8F115	17p	TIP29A	35p	2N706	7p	2N3053	12p
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8C158	*9p	8F173	20p	TIP29C	38p	2N708	8p	2N3072	*7p
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BA115	5p	BY100	15p	BYZ19	28p	OA95	7p
BA144	5p	BY127	*10p			IN5400	10p
BA148	10p	BY210	32p	OA47	5p	IN5401	11p
BA173	10p	BY211	32p	OA70	5p	IN5402	12p
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No. 1510	707 LED Display	70p each	No. 1507	10 x LED's Assorted	75p
No. 1511	747 LED Display	£1.50 each	LED CLIPS		
No. S53	DL33 Triple 7 Segment LED Display Character height .11"		No. 1508/125	.125	5 for 12p
	Common Cathode 12 pin DIL		No. 1508/2	.2	5 for 15p
			SPECIAL REDUCTIONS		
LED's			No. 1514	NORP 12	45p each
No. S51	Red TL1209 (5 x .125")	50p	No. S76	OCPT7	5 for £1.00
No. S52	Red FLV117 (5 x .2")	50p	No. S83.5	NIXIE Tubes ITT 5870 ST (including Data)	£2.00
No. 1502	Green .125"	18p each	No. S77	Neon Indicator Lamps 230V A.C State Colour (Red, Amber and Green.)	25p each
No. 1505	Green .2"	18p each			
No. 1503	Yellow .125"	18p each			
No. 1506	Yellow .2"	18p each			
No. S82	Clear .2" (illuminating red)	12p			

D.I.Y. PRINTED CIRCUIT KIT

Contains 6 pieces of copper laminate board, box of etchant powder, measure, tweezers, marker pen, high quality pump drill, Stanley knife and blades and 6 in. metal rule.
Full easy to follow instructions.
Order No. S64 **Sale Price £5.50.**

MAMMOTH I.C. PAK

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**

P.C.B. BOARDS

S61	8 pieces 8" x 3½" (approx.) single sided paper	50p
S62	4 pieces 8" x 3½" (approx.) single sided fibreglass	50p
S63	3 pieces 7" x 3½" (approx.) double sided fibreglass	50p

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Order No. 1609 **50p each**

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5m of 18 sw Multi-core Solder.
Order No. S60 **50p**

I.C. INSERTION EXTRACTION TOOL

Order No. 2015 **30p**

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

P.O. RELAYS

S85 - 2 Off Post Office relays **40p**

BATTERY HOLDERS

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

EX. G.P.O. MICROSWITCHES

Order No. S84A. 4 for 50p

CABLE CLIPS

S84 - 50 2.5mm round single pin fixing **30p**

UNTESTED SEMICONDUCTOR PAKS

Code No.'s shown below are given as a guide to the type of device. The devices themselves are normally unmarked.

No. 16130	100 Germ. Gold bonded diodes like OA47	40p
No. 16131	150 Germ. Point contact diodes like OA70/81	40p
No. 16132	100 200mA Sil. diodes like OA200	40p
No. 16133	150 75mA Sil. Fast switching diode like IN4148	40p
No. 16134	50 75mA 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
No. 16147	10 NPN to 3 Power trans. like 2N3055	80p

I.C. SOCKET PAKS

No. S66	11 x 8 pin DIL Sockets	£1.00
No. S67	10 x 14 pin DIL Sockets	£1.00
No. S68	9 x 16 pin DIL Sockets	£1.00
No. S69	4 x 24 pin DIL Sockets	£1.00
No. S70	3 x 28 pin DIL Sockets	£1.00

TRANSISTOR SOCKETS

No. S71	15 x TO18 Sockets	£1.00
No. S72	10 x TO5 Sockets	£1.00

MOUNTING PADS

No. S73	50 Mixed Transistor Pads TO18 and TO5	40p
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TRANSISTOR HEATSINK PAK

20 Assorted types, TO1, TO5, TO18, TO92
Our Mix
Order No. S75 **60p**

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Mica washers and bushes assorted types i.e. TO220, TO66, TO3 etc. Approx. 100 pieces. (Approx. 40 sets).
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No. S48	40 x 50V	60p
No. S49	30 x 200V	60p
No. S50	20 x 700V	60p

G.E. HIGH VOLTAGE SILICON RECTIFIERS

GR559	10mA 14KV (14,000)	20p each
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FD2.5	2.5-KV Voltage Doubler	20p each

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Slider 40mm TRAVEL		
Order No.		
16191	6 x 470 Ohm LIN Single	40p*
S24	6 x 1 K LIN Single	40p*
S25	6 x 5 K LIN Single	40p*
16192	6 x 10 K LIN Single	40p*
S26	6 x 10 K LOG Single	40p*
16193	6 x 22 K LIN Single	40p*
16194	6 x 47 K LOG Single	40p*
16195	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	40p*
S31	6 x 10 K LIN Single	40p*
S32	6 x 50 K LIN Single	40p*
S33	6 x 250 K LOG Single	40p*
S34	4 x 5 K LOG Dual	40p*
S35	4 x 10 K LIN Dual	40p*
S36	4 x 100 K LOG Dual	40p*
S37	4 x 1.3 MEG LOG Dual	40p*
S38	20 MIXED SLIDER POTS - VARIOUS VALUES AND SIZES - OUR MIX ONLY £1.00*	
	S39 6 x CHROME SLIDER KNOBS	40p*

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A range of wirewound single gang pots. with linear tracks of 1 watt rating.

Order No.	Value	Order No.	Value
1891	10 ohms	1894	100 ohms
1893	47 ohms	1895	220 ohms
1896	470 ohms	1898	2K2
1897	1K	1899	4K7

NOW 35p* each

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16186	25 Pre-sets Assorted Values and types	40p*

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S40 3 x 100 K LIN ONLY 50P*

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Order No.		
S1	5 x 3.5 mm Plastic Jack Plugs	40p*
S2	5 x 2.5 mm Plastic Jack Plugs	40p*
S3	4 x Std. Plastic Jack Plugs	50p*
S4	2 x Stereo Jack Plugs	30p*
S5	5 x 5 Pin 180° DIN Plugs	50p*
S6	8 x 2 Pin Loudspeaker Plugs	50p*
S7	6 Phono Plugs Plastic	50p*
S8	5 x 3.5 mm Chassis Sockets (Switched)	25p*
S9	5 x 2.5 mm Chassis Sockets (Switched)	25p*
S10	4 x Metal Std. Chassis Switched Jack Sockets	50p*
S11	2 x Stereo Jack Sockets with instruction leaflet for H/Phone connection.	50p*
S12	5 x 5 Pin 180° DIN Chassis Sockets	40p*
S13	8 x 2 Pin DIN Chassis Sockets	50p*
S14	6 x Single Phono Sockets	40p*

AUDIO LEADS

Order No.		
117	A.C. Mains connecting lead for cassette recorders and radios Telefunken type	45p*
118	5 pin DIN headphone plug to stereo socket	78p*
119	2 x 2 pin plug to inline stereo socket for headphones	60p*
123	20 ft. of coiled guitar lead	£1.15*
124	3 pin to 3 pin DIN plug	50p*
125	Audio lead 5 pin plug to 5 pin DIN plug	50p*
126	Audio lead 5 pin DIN plug to tinned open ends	50p*
127	Audio lead 5 pin DIN plug to 4 phono plugs	90p*
129	Audio lead 5 pin plug to 5 pin DIN plug - Mirror Image	70p*
130	5 metre lead 2 pin DIN plug to 2 pin DIN inline socket	45p*
132	10 metre lead 2 pin DIN plug	65p*

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With aluminium lid and fixing screws. Size 6 1/2" x 3 1/2" x 2" Order No. S16 Only 78p

74 SERIES TTL ICs

TYPE		QUANTITY		TYPE		QUANTITY		TYPE		QUANTITY	
1	100	1	100	1	100	1	100	1	100	1	100
Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep	Ep
7400	0.09	0.08	7448	0.70	0.68	74122	0.45	0.42			
7401	0.11	0.10	7450	0.12	0.10	74123	0.65	0.62			
7402	0.11	0.10	7451	0.12	0.10	74141	0.88	0.85			
7403	0.11	0.10	7453	0.12	0.10	74145	0.75	0.72			
7404	0.11	0.10	7454	0.12	0.10	74150	1.10	1.05			
7405	0.11	0.10	7460	0.12	0.10	74151	0.65	0.60			
7406	0.28	0.25	7470	0.24	0.23	74153	0.70	0.68			
7407	0.28	0.25	7472	0.20	0.19	74154	1.20	1.10			
7408	0.12	0.11	7473	0.26	0.22	74155	0.70	0.68			
7409	0.12	0.11	7474	0.24	0.23	74156	0.70	0.68			
7410	0.09	0.08	7475	0.44	0.40	74157	0.70	0.68			
7411	0.22	0.20	7476	0.26	0.25	74160	0.95	0.85			
7412	0.22	0.20	7480	0.45	0.42	74161	0.95	0.85			
7413	0.26	0.25	7481	0.90	0.88	74162	0.95	0.85			
7416	0.28	0.25	7482	0.75	0.73	74163	0.95	0.85			
7417	0.26	0.25	7483	0.88	0.82	74164	1.20	1.10			
7420	0.11	0.10	7484	0.85	0.80	74165	1.20	1.10			
7422	0.19	0.18	7485	1.10	1.00	74166	1.20	1.10			
7423	0.21	0.20	7486	0.28	0.26	74174	1.10	1.00			
7425	0.25	0.23	7489	2.70	2.50	74175	0.85	0.82			
7426	0.25	0.23	7490	0.38	0.32	74176	1.10	1.00			
7427	0.25	0.23	7491	0.65	0.62	74177	1.10	1.00			
7428	0.36	0.34	7492	0.43	0.35	74180	1.10	1.00			
7430	0.12	0.10	7493	0.38	0.35	74181	1.90	1.80			
7432	0.20	0.19	7494	0.70	0.68	74182	0.80	0.78			
7433	0.38	0.36	7495	0.60	0.58	74184	1.50	1.40			
7437	0.26	0.25	7496	0.70	0.68	74190	1.40	1.30			
7438	0.26	0.25	74100	0.95	0.90	74191	1.40	1.30			
7440	0.12	0.10	74104	0.40	0.35	74192	1.10	1.00			
7441	0.60	0.57	74105	0.30	0.25	74193	1.05	1.00			
7442	0.80	0.70	74107	0.30	0.25	74194	1.05	1.00			
7443	0.95	0.90	74110	0.48	0.45	74195	0.80	0.75			
7444	0.95	0.90	74111	0.75	0.72	74196	0.90	0.85			
7445	0.80	0.75	74118	0.85	0.82	74197	0.90	0.85			
7446	0.80	0.75	74119	1.30	1.20	74198	1.90	1.80			
7447	0.70	0.68	74121	0.28	0.26	74199	1.80	1.70			

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

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.14	CD4018	£0.85	CD4035	£1.40	CD4056	£1.15
CD4001	£0.16	CD4019	£0.45	CD4037	£0.78	CD4069	£0.32
CD4002	£0.16	CD4020	£0.95	CD4040	£0.78	CD4070	£0.32
CD4006	£0.80	CD4021	£0.85	CD4041	£0.68	CD4071	£0.20
CD4007	£0.17	CD4022	£0.80	CD4042	£0.68	CD4072	£0.20
CD4008	£0.80	CD4023	£0.18	CD4043	£0.78	CD4081	£0.20
CD4009	£0.50	CD4024	£0.64	CD4044	£0.78	CD4082	£0.20
CD4010	£0.50	CD4025	£0.18	CD4045	£1.15	CD4510	£1.10
CD4011	£0.18	CD4026	£1.85	CD4046	£0.95	CD4511	£1.25
CD4012	£0.17	CD4027	£0.48	CD4047	£0.75	CD4516	£1.10
CD4013	£0.42	CD4028	£0.80	CD4049	£0.46	CD4518	£1.10
CD4015	£0.80	CD4029	£0.95	CD4050	£0.46	CD4520	£1.10
CD4016	£0.42	CD4030	£0.46	CD4054	£0.95		
CD4017	£0.80	CD4031	£1.80	CD4055	£1.60		

AUDIO MODULE SALE

Type	Description	Normal Price	Sale Price
AL30A	10W RMS Power Amp	£3.65*	£2.95*
AL60	25W RMS Power Amp	£4.35*	£3.55*
AL80	35W RMS Power Amp	£6.95*	£5.95*
AL250	125 W RMS Power Amp	£16.95*	£14.45*
SPM80	35V Power Supply	£2.75*	£3.10*
PS12	20-30V Power Supply for AL30A	£1.30*	£1.15*
PA12	Stereo Pre-Amp for AL30A	£6.70*	£5.95*
PA100	Stereo Pre-Amp for AL60/AL80	£13.75*	£11.50*
S450	Stereo F.M. Tuner	£20.45*	£18.65*
MPA30	Magnetic-Ceramic Pre-Amp	£2.85*	£2.55*
Stereo 30	Complete Audio Chassis 7W x 7W RMS	£16.25*	£14.95*

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The GE100 has nine 1 octave adjustments using integrated circuit active filters. Boost and Cut limits are ± 12db. Max. Voltage handling 2 V RMS, T.H.D., 0.5%, input impedance 100 K, output impedance less than 10 K. Frequency response 20 Hz-20 KHz (3db). The nine gain controls are centred at 50, 100, 200, 400, 800, 1600, 3,200, 6,400 and 12,800 Hz. The suggested gain controls are 10 K LIN sliders. (Not supplied with the module). See Paks S31 and 16192.

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SG30 Power supply board for GE100 15-0-15 Volt £4.50

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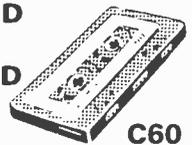
Order No.	Quantity	Price
16164	200 approx. Resistors mixed values. (Count by weight)	40p*
16165	150 approx. Capacitors mixed values. (Count by weight)	40p*
16167	80 1/2W Resistors mixed values	40p*
16168	5 pieces Assorted Ferrite rods	40p*
16169	2 pieces Tuning gangs MW/LW	40p*
16170	50 metres Single strand wire assorted wire	40p*
16171	10 Reed switches	40p*
16172	3 Micro switches	40p*
16176	20 Assorted electrolytics Trans types	40p*
16177	1 pack Assorted hardware nuts/bolts etc.	40p*
16179	20 Assorted tag strips and panels	40p*
16180	15 Assorted control knobs	40p*
16184	15 Assorted Fuses 100mA - 5 amp	40p*
16188	60 1/2W resistors mixed values	40p*
16187	30 metres stranded wire assorted colours	40p*

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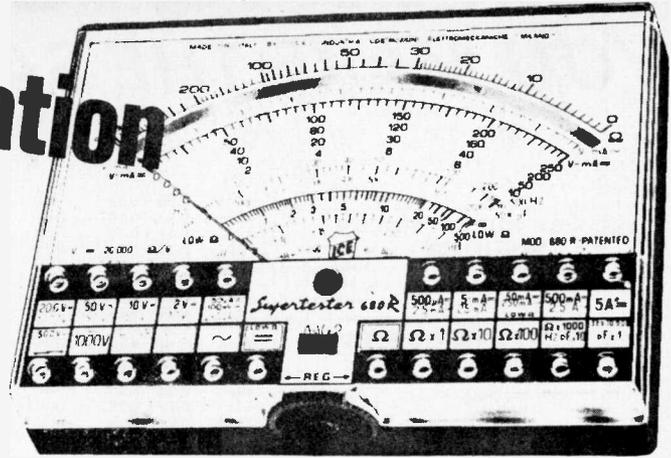
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- * 140 × 105 × 55mm

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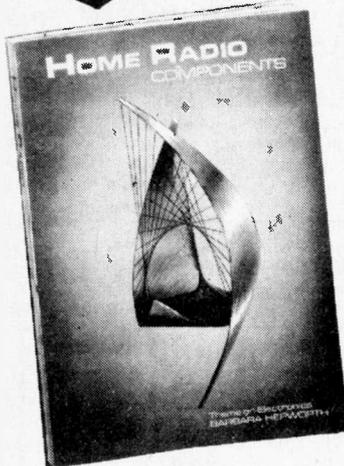
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CLOCK CHIPS: 50253N Alarm 12/24 hour 4/6 digit, £5.67. 50362N Calendar clock, £7.75. MM5385N 12hr 4 digit Alarm £4.32. 6 Decade up/down counters, 50395/6/7 £13.10.

MICROPROCESSOR: Z80 CPU, £22.68. Z80 CTC, £15.70. 1702A UV Erasable PROM, £11.35. Z80 PIO £15.70. 2102NA, 1K Static RAM £2.70. UV PROM Eraser, £103 plus £5 P. & P. 4KX1 16 pin Dyn. RAM £7.05.

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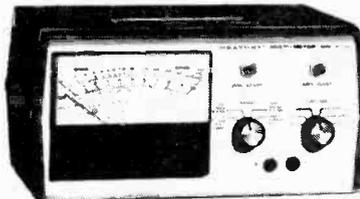
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<p>EASY BUILD SPEAKER DIY KITS Specially designed by RT.VC for cost-conscious hi-fi enthusiasts, these kits incorporate two teak simulate enclosures, two EMI 13" x 8" (approx.) woofers, two tweeters and a pair of matching crossovers. Supplied complete with an easy-to-follow circuit diagram, and crossover components.</p> <p>£2800 STEREO PAIR Input 15 watts rms, 30 watts peak, each unit. Cabinet size 20" x 11" x 9 1/2" (approx.).</p> <p>SPEAKERS AVAILABLE WITHOUT CABINETS. It's the units which we supply with the enclosures illustrated. Size 13" x 8" (approx.) woofer (EMI) 2 1/2" approx. £1700 per tweeter, and matching crossover components. stereo pair Power handling 15 watts rms, 30 watts peak. p & p £3.40</p>	<p>20 x 20 WATT STEREO AMPLIFIER £2990 Superb Viscount IV unit in teak-finished cabinet. Silver fascia with aluminium rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic, magnetic and crystal pick-ups, tape, tuner, and auxiliary Rear panel features two mains outlets, DIN speaker and input sockets, plus fuse.</p> <p>30 x 30 WATT AMPLIFIER KIT Specially designed by RT.VC for the experienced constructor, complete in every detail. Same facilities as Viscount IV amplifier. 60 + 60 peak, p & p £2.50</p> <p>NOW AVAILABLE fully built and tested. £3500</p> <p>FREE To cash or cheque personal shoppers A 4 channel Stereo Adaptor to all buyers of the Viscount 20 x 20 Amplifier at £2990 Available separately £395 + £1.00 p & p.</p>	<p>45 WATT MONO DISCO AMP £3500 p & p £2.50 Size approx. 13 1/2" x 5 1/2" x 6 1/2" 45 watts rms, 90 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push pull switches. Independent bass and treble controls and master volume.</p> <p>70 & 100 WATT MONO DISCO AMP Size approx. 14" x 4" x 10 1/2" Brushed aluminium fascia and rotary controls. Five vertical slide controls: master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2 or vice versa. Pre fade level control 70 watt (PFL) lets YOU hear next disc before fading. 140 watt peak. 100 watt monitors output level. 100 watt RMS 200 watts peak. 100 watt £65</p>
<p>COMPACT FOR TOP VALUE These infinite baffle enclosures come to you ready mired and professionally finished. Each cabinet measures approx. 12" x 9" x 5" deep, and is in wood simulate. Complete with two 8" (approx.) speakers for maximum power handling of 7 watts. 8Ω p & p £2.20</p> <p>SPEAKERS Two models. Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18 1/2" x 13 1/2" x 7 1/2" (approx.). Duo III, 20 watts rms, 40 watts peak, 27" x 13" x 11 1/2" approx. Duo IIb £17 PER PAIR p & p £6.50 Duo III £52 PER PAIR p & p £7.50</p> <p>DECCA 20 WATTS STEREO SPEAKER stereo pair This matching loudspeaker system is hand made, kit comprises of two 8" diameter approx. base drive unit, with heavy die cast chassis laminated cones with roiled P.V.C. surrounds, two 3 1/2" diameter approx. domed tweeters complete with crossover networks. 8Ω £4.00 p & p £20.00</p>	<p>ADD-ON STEREO CASSETTE TAPE DECK KIT Designed for the experienced D.I.Y. man. This kit comprises of a tape transport mechanism, ready built and tested record/replay electronics with twin V.U. meters and level control for mating with mechanism. Specifications: Sensitivity Mic. 0.85 mV ± 20K OHMS; Din. 40mV ± 400K OHMS; Output: 300mV RMS per channel ± 1KHz from 2K OHMS source; Cross Talk: -30db; Tape Counter 3 Digit; Resettable; Frequency Response: 40Hz - 8KHz ± 6db; Deck Motor - 9 Volt DC with electronic speed regulations; Key Functions: Record, Rewind, Fast Forward, Play, Stop & Eject. £2.50 + £1 p & p £2.50 Opt. extras: Mains transformer to suite £2.50 + £1 p & p</p>	<p>CHASSIS RECORD PLAYER DECKS</p> <p>BSR B0 S 95 TYPE illus. £24.95 Belt drive turntable unit, 2 speed, semi automatic, p & p £2.55</p> <p>BSR MP60 TYPE Single play record deck, less cartridge, p & p £2.55</p> <p>Cartridges to suit above: Acos, magnetic stereo £4.95 Ceramic stereo £1.95</p> <p>BSR automatic record player deck cueing device and stereo ceramic head, p & p £2.55 £9.95</p> <p>BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and deluxe plinth and cover, p & p £2.90</p> <p>Home 8 Track cartridge player. This unit will match with the Viscount IV 9" x 8" x 3 1/2" p & p £2.50 £16.50</p>
<p>PERSONAL SHOPPERS STEREO CASSETTE record/replay fully built P.C. board. Used without guarantee. (Ex Equipment.) £1.95</p> <p>AM. FM. TUNER P.C.B. with Mullard L.P. 1186, 1185, 1181 modules. £9.50</p> <p>100K Multiturn Varicap tuning pots. 6 for £1.00</p> <p>PAIR STEREO 8 WATT SPEAKERS 8" bass units with 3 1/2" approx. tweeters. Size 16 1/2" x 11" x 8 1/2" £9.95</p> <p>Plinth & cover BSR or Garrard teak finish £6.00</p> <p>DECCA DC1000 Stereo Cassette P.C.B. complete with switch oscillator coils and tape heads £2.95</p> <p>AM. FM. Stereo Multiplex Car Radio/cassette player in dash fixing Negative earth 5 watts output £36.00</p> <p>I.C. Stereo 8 Track to Cassette adaptor converts, any 8 track player to cassette player. £18.95</p>	<p>RTVC All enquiries send stamped addressed envelope. 323 EDGWARE ROAD, LONDON W2 210 HIGH STREET, ACTON W3 6NG ALL PRICES INCLUDE VAT AT 12 1/2% All items subject to availability. Price correct at 1.12.77 and subject to change without notice.</p>	<p>Tourist IV CAR RADIO KIT For the experienced constructor only Output 4 watts into 4 ohms. 12 volts pos or neg (altered internally) £12.50 p & p £1.50 FREE TO PERSONAL SHOPPERS BUYING CAR RADIO KIT worth £20.00 ELECTROMATE Rear window heater, modern line element. £3.00</p>

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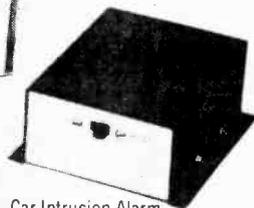
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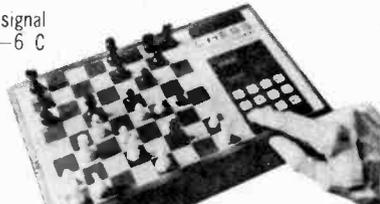


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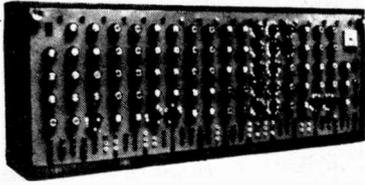
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KITS FOR SYNTHESISERS, SOUND EFFECTS



COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs designed by Phonosonics.

PHOTOCOPIES of the P.E. texts for most of the kits are available—prices in our lists.

PHONOSONICS

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P.E. MINISONIC Mk. 2 SYNTHESIZER

A portable mains-operated Miniature Sound Synthesizer, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, output amp and mixer, power supply.

Set of basic component kits from £64.25
Set of printed circuit boards £9.71

P.E. SYNTHESIZER (P.E. Feb. 73 to Feb. 74)

The well-acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage, notably P.E. Minisonic, Phasing Unit, Wind and Rain, Rhythm Generator, Sound Bender, Voltage Controlled Filter, Guitar Effects Pedal and Overdrive, Fuzz, Tremolo and Wah-Wah units.

The Main Synthesiser: PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp. Full details in lists.

Set of basic component kits £83.03
Set of printed circuit boards £13.20

The Synthesiser Keyboard Circuits (can be used without the Main Synthesiser to make an independent musical instrument) 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and additional PSU. Full details in our lists.

Set of basic component kits £48.18
Set of printed circuit boards £7.66

GUITAR EFFECTS PEDAL (P.E. July 75)

Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

Component set with special foot operated switches £7.59
Alternative component set with panel mounting switches £4.96
Printed circuit board £1.43

SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency-doubler.

Component set for above functions (excl. SWs) £7.84
Printed circuit board £1.81

Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.

Component set (incl. PCB) £2.86

PHASING UNIT (P.E. Sept. 73)

A simple but effective manually controlled unit for introducing the phasing sound into live or recorded music.

Component set (incl. PCB) £2.87

PHASING CONTROL UNIT (P.E. Oct. 74)

For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB) £4.48

SOPHISTICATED PHASING AND VIBRATO UNIT

A slightly modified version of the circuit published in "Elektron", December 1976, and includes manual and automatic control over the rate of phasing and vibrato.

Component set £17.69
Printed circuit board £2.33

WAH-WAH UNIT (P.E. Apr. 76)

The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component set (incl. PCB) £3.55

AUTOWAH UNIT (P.E. Mar. 77)

Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.

Component set, PCB, special foot switches £7.27
Component set and PCB, with panel switches £4.83

P.E. JOANNA (P.E. May Sept. 75)

A five-octave electronic piano that has switchable alternative voicing of Honky-Tonk piano, ordinary piano, harpsichord, or a mixture of any of the three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The power amplifier typically delivers 24 watts into 8 ohms. The PCBs have been redesigned by ourselves making improved use of the space available.

Main power supply, tone generator, 61 envelope shapers, voicing and pre-amp circuits

Set of basic component kits for above £75.29
Set of printed circuit boards for above £20.35
Power amplifier £15.97
Printed circuit board for power amp 95p

ELECTRONIC ORGAN

5-octave electronic organ with 5 basic voices that can be used individually or together, 5 pitches (2ft, 4ft, 8ft, 16ft, 32ft), variable attack, tremolo, vibrato, phasing, and variable sustain. Details in our list.

ORGAN CONVERSION KIT

Converts the P.E. Joanna electronic piano to also provide most of the facilities offered by the above electronic organ.

Basic component set and PCB £12.34

SYNTHESIZER TUNING INDICATOR (P.E. July 77)

A simple 4-octave frequency comparator for use with synthesizers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl. sw.) £7.45

GUITAR FREQUENCY DOUBLER (P.E. Aug. 77)

A modified and extended version of the circuit published. Details in list.

SEE OTHER PAGE FOR KEYBOARDS, AND OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED

WIND AND RAIN UNIT

A manually controlled unit for producing the above-named sounds.

Component set (incl. PCB) £3.72

GUITAR OVERDRIVE UNIT (P.E. Aug. 76)

Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

Component set using dual slider pot £6.86
Component set using dual rotary pot £6.20
Printed circuit board £1.62

FUZZ UNIT

Simple Fuzz unit based upon P.E. Sound Design circuit.

Component set (incl. PCB) £2.03

TREMOLO UNIT

Based upon P.E. Sound Design circuit.

Component set (incl. PCB) £3.64

TREBLE BOOST UNIT (P.E. Apr. 76)

Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component set (incl. PCB) £2.40

P.E. TUNING FORK (P.E. Nov. 75)

Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic and electronic musical instruments alike.

Main component set (incl. PCB) £15.59
Power supply set (incl. PCB) £7.03

P.E. SYNCHRONOME (P.E. Mar. 76)

An accented-beat electronic metronome, providing triple, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply.

Component set (incl. loudspeaker) £11.62
Printed circuit board £2.04

TAPE NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs.

Standard tolerance set of components £2.96
Superior tolerance set of components £3.76
Regulated power supply (will drive 2 sets) £4.69

ENVELOPE SHAPER WITHOUT VCA (P.E. Oct. 75)

Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier.

Component set (incl. PCB) £4.66

ENVELOPE SHAPER WITH VCA (P.E. Apr. 76)

This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.

Component set (incl. PCB) £6.68

TRANSIENT GENERATOR (P.E. Apr. 77)

An envelope shaper, without VCA, having the usual attack decay, sustain and release functions, and in addition it also provides a Repeat Effect, enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo.

Component set £4.52
Printed circuit board £1.82

WAVEFORM CONVERTER

Slightly modified from a circuit published in a German edition of "Elektron". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and square-wave with an externally variable mark-space ratio.

Component set (incl. PCB but excl. sw. s) £8.19

VOLTAGE CONTROLLED FILTER (P.E. Dec. 74)

Part of the P.E. Minisonic now released as an independent kit for use with other synthesizers.

Component set (incl. PCB) (Order as Kit 65-1) £8.22

RING MODULATOR (P.E. Jan. 75)

Part of the P.E. Minisonic now released as an independent kit for use with other synthesizers.

Component set (incl. PCB) (Order as Kit 59-1) £5.50

NOISE GENERATOR (P.E. Jan. 75)

Part of the P.E. Minisonic now released as an independent kit for use with other synthesizers.

Component set (incl. PCB) (Order as Kit 60-1) £3.35

SOPHISTICATED POWER SUPPLIES

A wide range of highly stabilised low noise power supply kits is available—details in our lists.

MICROPHONE PRE-AMP (P.E. Apr. 77)

Component set (incl. PCB) £3.78

VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during talk-over—particularly useful for Disco work or for home-movie shows.

Component set (incl. PCB) £3.97

DYNAMIC RANGE LIMITER (P.E. Apr. 77)

Automatically controls sound output to within a preset level.

Component set (incl. PCB) £4.58

POST AND HANDLING

U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £2.00 plus VAT. Optional insurance for compensation against loss or damage in post, add 35p in addition to above post and handling. Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

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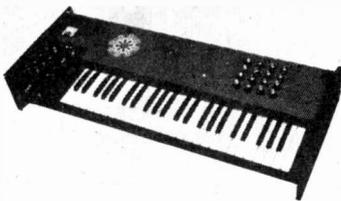
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AND OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components

OVERSEAS enquiries for list Europe—send 20p other countries—send 40p



KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits, including the P.E. Joanna, P.E. Minisonic, and P.E. Synthesiser. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C. The keys are plastic, spring-loaded and mounted on a robust aluminium frame.

3 Octave (37 notes) £25.50. 4 Oct (49 notes) £32.25. 5 Oct (61 notes) £39.75.
Contact Assemblies for use with above keyboards. Single-pole change-over (type SP) as for P.E. Joanna and P.E. Minisonic. Two-pole normally-open make-break (type DP) as for P.E. Synthesiser. Special contact assembly (type 4PS) having 4 poles, 3 of which are normally-open make-break contacts and the fourth is a change-over contact—this special assembly enables THE SAME KEYBOARD to be used with the P.E. Synthesiser, P.E. Minisonic and the P.E. Joanna simultaneously thus avoiding the cost of more than one keyboard. See our list for other contacts

Contact	Each	3 Octave Set	4 Octave Set	5 Octave Set
SP	24p	£ 8.88	£11.76	£14.64
2P	27p	£ 9.99	£13.23	£16.47
4PS	53p	£19.61	£25.97	£32.33

PRINTED CIRCUIT BOARDS for use with the above contacts and thus eliminating most of the inter-wiring required, are available. Details in our lists

MORE KITS!

NEW RHYTHM GENERATOR

Redesigned, improved and extended version of the PE 1974 design and including new automatic rhythm programme selector.

TUNE-PROGRAMMABLE SEQUENCER

(PE Nov 77) The new music unit currently being published

FORMANT SYNTHESISER

(Elektron Magazine 1977). Very sophisticated music synthesiser for the advanced constructor and for whom cost is secondary to performance

GUITAR SUSTAIN UNIT

(PE Oct 77)
 Details in lists. Please send S A E

SOUND-TO-LIGHT (P.E. Aurora) (P.E. Apr–Aug 71)
 Four channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities

Basic component set (excl. thyristors) £15.92
 Printed circuit board for above £3.90
 Power supply £5.78
 PCB for power supply £1.79

3-CHANNEL SOUND-TO-LIGHT (P.E. Apr 76)

A simple but effective sound-to-light controller capable of operating 3 lamps each of approximately 700 watts. Includes power supply, thyristors and by-pass switches

Component set (incl. PCB) £11.95

DISCOSTROBE (P.E. Nov 76)

4-channel light-show controller giving a choice of sequential, random or full strobe mode of operation

Basic component set £18.19
 Printed circuit board £3.45

BIOLOGICAL AMPLIFIER (P.E. Jan Feb 73)

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

Pre-Amp Module Component set (incl. PCB) £4.22

Basic Output Circuits—combined component set with PCBs for alphaphone, cardiophone, frequency meter and visual feedback lampdriver circuits £6.59

Audio Amplifier Module Type PC7 £7.35

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

Essential test equipment for the enterprising home constructor. While stocks last

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB £9.63
 Panel meter (500µA) £5.70

TRANSISTORS

AC128	26p
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BC148	12p
BC149	12p
BC157	13p
BC158	13p
BC159	13p
BC182L	12p
BC184	12p
BC187	25p
BC204	14p
BC209C	14p
BC212L	15p
BC213	15p
BC478	29p
BCY71	22p
BD131	44p
BD132	54p
BFY50	22p
BFY51	22p
BFY52	24p
BSY95A	22p
MD8001	172p
OC28	60p
OC71	25p
OC72	25p
OC84	25p
ORP12	70p
ZTX107	12p
ZTX108	9p
ZTX501	13p
ZTX503	15p
ZTX531	23p
2N706	13p
2N914	22p
2N1304	22p
2N2219	27p
2N2905	35p
2N2905A	36p
2N2907	22p
2N3053	18p
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µA7808 TO220	205p
µA7812 TO220	205p
µA7815 TO220	205p
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AY-1-6721/6	195p
CA3046	90p
MC3340	150p
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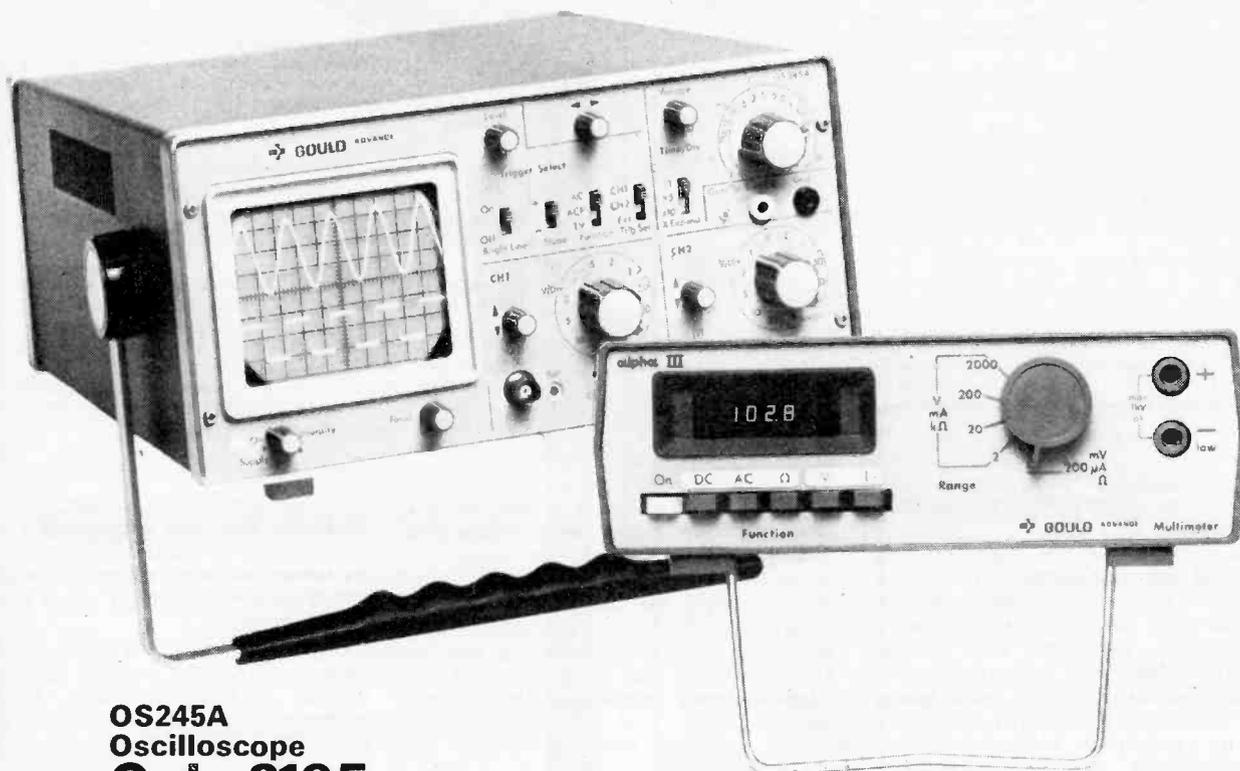
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THE FUTURE

WHERE do we go from here? The question is often put to us, sometimes by people who, one might feel, are in a far better position to provide a sensible answer than the staff of P.E.! Maybe they think we have a crystal ball, or that everyone on the frontiers of technology confides in us—alas not so.

Unfortunately many of the individuals beating new paths have neither the time nor the interest in publicity or keeping others informed. It is also often true that the ideas they are developing do not have any obvious impact on the public at large.

Well, where do we go from here? Our simple answer is to look at those items around us just crying out for some form of improved (electronic) control, or to look at the systems already developed which could stand expansion and improvement. Do not let the mind be restricted by restraints of the present technology; try to concentrate on how things could be improved.

We once asked a high ranking official of Tek, the company that make Tektronic equipment, where he saw possible uses for the microprocessor in the home. He simply said "everywhere!" Digging a little further it became clear that, to him, applications were so obvious that they should really need no explanation. He continued his reply by going over basic movements

during the day. Almost every operation could be computer controlled e.g. it is so much easier to get up if the bed is hard, your morning cuppa has been served, the lighting has been controlled to provide an artificial dawn and your shower is running—at the correct temperature of course.

Other obvious development areas are in the video field where Viewdata is on the way and video discs should soon be making a real appearance into everyday life.

PRINTING

There are a number of mechanical systems that are being or have been updated and sometimes even totally replaced by electronics. The print you are reading in this magazine has, since P.E. was first produced in 1964, been set by a linotype machine: A wonder of mechanical engineering with coded type transport systems; a compositors keyboard with the sensitivity of a modern electric typewriter; a mechanical justification system to get the spaces in each line accurate and finally a bowl-full of hot metal to actually cast the line of type. Watching one of these machines in action has always been fascinating with their mass of levers and cams, travelling bits of type and the final production of an "upside down, inside out" line of cast words.

The linotype machines producing P.E. will, within the next two months,

be replaced by a photocomposition system and the words you read will never have "seen" hot metal or "type" of the soon-to-be-outdated kind. The factory atmosphere of the typesetting department will give way to the clean air, clean floor atmosphere of a computer room with copy being entered—via a keyboard and eventually, maybe, via an optical reader straight off the typewritten page—into a v.d.u. for correction and then onto punched tape, to be later read and set by a photo-scanning system onto light sensitive paper.

CHANGES

So there is a pretty good example of "where do we go from here?" that has, or will have, improved the production of your magazine without any obvious changes as far as you are concerned.

One or two changes will however soon be obvious within these pages. The use of colour from our next issue onwards may not improve P.E. technically but it should help with presentation of such things as multiple curve graphs and double sided printed circuit boards.

So that is where we are going from here. We are not content to be the highest setting electronic hobbyist magazine in the U.K., we want to go on improving the quality and value of P.E.

Mike Kenward

EDITORIAL

EDITOR

Mike Kenward

Gordon Godbold ASSISTANT EDITOR

Mike Abbott TECHNICAL EDITOR

Alan Turpin PRODUCTION EDITOR

David Shortland TECHNICAL SUB EDITOR

Jack Pountney ART EDITOR

Keith Woodruff SENIOR ARTIST

George Dilkes TECHNICAL ILLUSTRATOR

Editorial Offices:
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West Quay Road, Poole,
Dorset BH15 1JG
Phone: Editorial Poole 71191

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Back Numbers and Binders

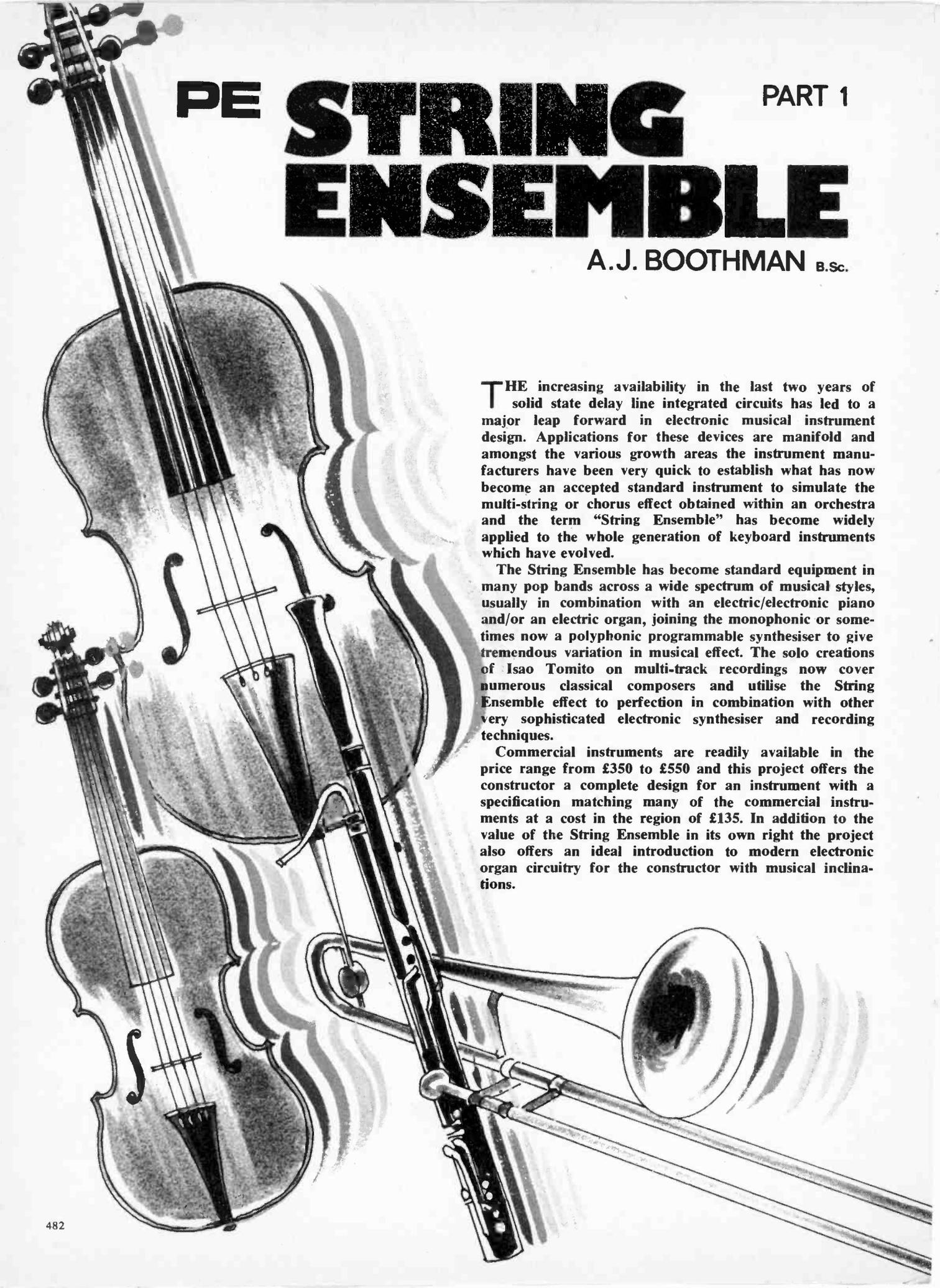
Copies of our June 1977 and subsequent issues are available from: Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 65p each including Inland/Overseas p & p.

Binders for PE are available from the same address at £2.85 each to UK addresses, £3.45 overseas, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Cheques and postal orders should be made payable to IPC Magazines Limited.

Letters

Queries regarding articles published in PE should be addressed to the Editor, at the Editorial Offices, and a stamped, addressed envelope enclosed. We cannot undertake to answer questions regarding other items, nor to answer technical queries over the telephone.

A detailed black and white illustration of a violin and a trumpet. The violin is positioned vertically on the left side of the page, with its neck extending towards the top. The trumpet is positioned diagonally across the bottom right, with its bell pointing towards the right. Both instruments are surrounded by stylized, concentric sound waves emanating from them, suggesting they are playing. The background is plain white.

PE STRING ENSEMBLE

PART 1

A.J. BOOTHMAN B.Sc.

THE increasing availability in the last two years of solid state delay line integrated circuits has led to a major leap forward in electronic musical instrument design. Applications for these devices are manifold and amongst the various growth areas the instrument manufacturers have been very quick to establish what has now become an accepted standard instrument to simulate the multi-string or chorus effect obtained within an orchestra and the term "String Ensemble" has become widely applied to the whole generation of keyboard instruments which have evolved.

The String Ensemble has become standard equipment in many pop bands across a wide spectrum of musical styles, usually in combination with an electric/electronic piano and/or an electric organ, joining the monophonic or sometimes now a polyphonic programmable synthesiser to give tremendous variation in musical effect. The solo creations of Isao Tomito on multi-track recordings now cover numerous classical composers and utilise the String Ensemble effect to perfection in combination with other very sophisticated electronic synthesiser and recording techniques.

Commercial instruments are readily available in the price range from £350 to £550 and this project offers the constructor a complete design for an instrument with a specification matching many of the commercial instruments at a cost in the region of £135. In addition to the value of the String Ensemble in its own right the project also offers an ideal introduction to modern electronic organ circuitry for the constructor with musical inclinations.

SCOPE OF THE INSTRUMENT

The prime object of the instrument is to simulate the multiple source situation present in the string section of an orchestra, but a number of playing features have been introduced into the String Ensemble which add to its enjoyment and have practical advantages during a performance.

The split keyboard facility which operates on the bottom 16 notes commencing at E^b below middle C (See Fig. 1.1) allows the musician to select a register in the left hand which is either below or above the general compass of the right hand. The effect thus obtained of a moving string section in the right hand passing through a chord in the left hand is impressive. An inverse situation is the use of a single bass note in the left hand against moving chords in the right hand. Many combinations of this sort are possible giving effectively two manual capability.

A Pitch Transposition Control is available primarily for B^b and E^b instrumentalists who would like to use the Ensemble as a rest from playing saxophone or trumpet using their existing music pad, while the B transposition makes it easy to play with those determined guitarists who insist on playing everything in E major. For the home entertainer the apparent increase in the musical capability can bring forth admiration.

The alternative voices are not designed to achieve the same degree of simulation as the strings, but by using these voices in combination with the attack and sustain controls a wide range of sounds can be obtained from trumpet against strings, through piano accordion to the proverbial "Mighty Wurlitzer".

Due to the non-percussive nature of the String Ensemble it is safe to use with a normal hi-fi system although some care should be exercised in the use of heavy bass at full volume! Use with an existing organ speaker system is an alternative solution.

OVERALL SYSTEM

The block diagram shown in Fig. 1.1 contains the complete system and illustrates the inter-relationship of the various sub-assemblies within the system.

A single printed circuit board assembly contains regulated power supplies and a complete 96 pitch tone generator of which 85 pitches are used in the Ensemble. An oscillator running at approximately 2MHz, controlled by the transposer switch and Fine Tuning potentiometer, feeds into a 12 note master tone generator integrated circuit. Each M.T.G. output is followed by a seven stage divider giving a total of 96 available different frequency square waves, including the top octave.

Diode gating circuit boards are attached to the back of the keyboard with solder bands to anchor the contact wires which travel from the open circuit condition to a positive rail on depression of a key. The envelope available from the gates is controlled by attack and sustain sliders, and each keyer switches four octave related square waves, obtained from the tone generator, onto busbars at 16ft, 8ft, 4ft and 2ft pitch. The gating boards are arranged such that the lower 16 notes are transferred separately from the upper 33 notes, each section having for "footage" busbars as described feeding into the voice circuitry.

On the Voice Circuits Board the square waves are mixed and filtered to produce the required instrumental voices as controlled from the front panel. Balance, Expression Pedal and Master Level control are also connected to the Voice Board.

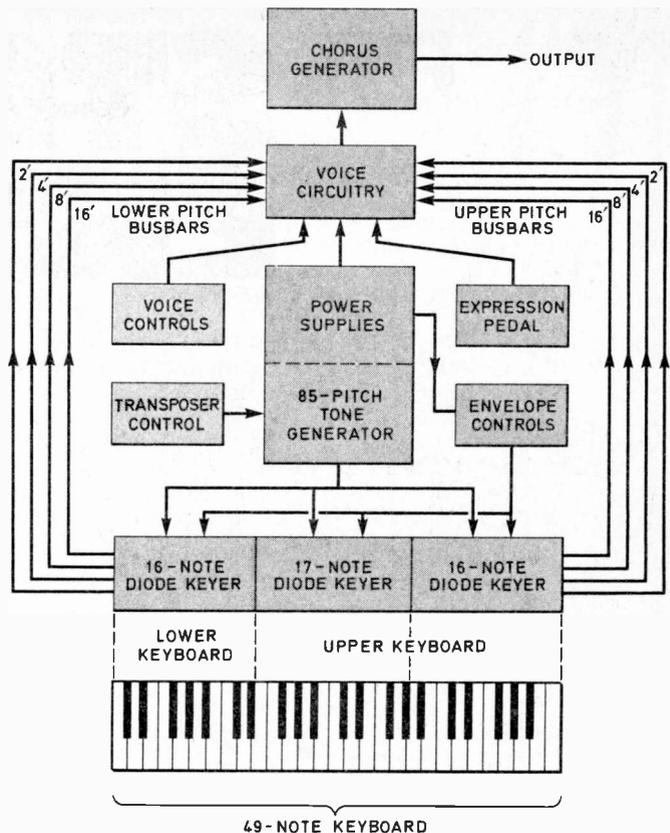


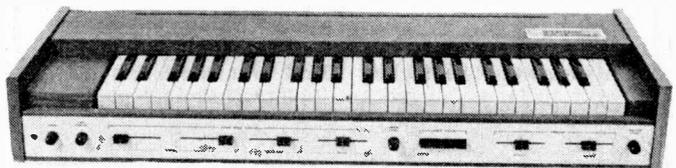
Fig. 1.1. Block diagram of complete system

The description to this stage follows one of the most popular methods employed in electronic organ design, and is easily adaptable to the conventional two manual type of instrument based on square wave tone generation. The circuitry used throughout is of CMOS type and the result is a very economic and easily constructed system.

CHORUS GENERATION

The fundamental difference between the String Ensemble and a conventional electronic organ comes from the chorus generation technique coupled with suitable voice circuitry.

Chorus generation will be covered in depth later in the series, but for readers not familiar with the term in this context, it can be defined as the creation of an apparent multiplicity of sound sources from a single generator, each source producing on average the same note. Within a string section the score will dictate that a group of instruments play the same note but due to changing variations in the phase relationship of each sound the ear detects the fact that more than one instrument is playing.



SPECIFICATION . . .

MUSICAL COMPASS

Four Octaves C to C—49 Notes
Keyboard Split—16 Notes Lower Section/33
Notes Upper Section
Strings available at 16ft and 8ft
Transposable Pitches C-B-B^b-E^b

FREQUENCY COMPASS (Concert Pitch)

Fundamental Range (16ft) 60Hz to 1kHz approx
Fundamental Range (8ft) 120Hz to 2kHz approx
Even Harmonic Generation up to 8.2kHz
Master Oscillator Frequency 2MHz approx

NOMINAL OUTPUT LEVELS

High Level IV
Low Level 100mV

MAINS INPUT

240 Volts, 10 Watts

SIZE AND WEIGHT

Dimensions 33½in × 12½in × 5in
Weight 20lb approx

CONTROLS

Power Indicator (l.e.d.)
Transposition Switch
Fine Tuning
Upper Voice Sliders
String I (16ft)
String II (8ft)
Woodwind (16ft)
Brass (16ft)
Upper Level Balance
Lower Voice Push Buttons
Couple Strings
String I (16ft)
String II (8ft)
String III (4ft)
Master Level
Expression Pedal
Envelope Sliders
Attack Rate
Sustain Length

REAR PANEL TERMINATIONS

Mains Supply Socket and Switch
Mains Fuse
Pedal Socket
High and Low Level Output Sockets

COMPONENTS . . .

POWER SUPPLY/TONE GENERATOR

Resistors

R1 1.8kΩ
R2 3.9kΩ
R3 470Ω
R4 1.5kΩ
All ¼W 5% carbon

Capacitors

C1-C2 1000μF elect. 25V (2 off)
C3-C4 10μF ceramic (2 off)
C5 4.7μF elect. 16V

Potentiometers

VR1-VR4 1kΩ presets (100 mW sub miniature)
VR5 500Ω linear

Semiconductors

D1-D9 1N4002
D10-D12 1N4148
D13 TIL209
IC1 LM341-15 + ve regulator
IC2 LM320-15 - ve regulator
IC3 4069
IC4 AY-1-0212
IC5-6 4069 (2 off)
IC7-18 4024 (12 off)

Miscellaneous

FS1 315mA slow blow fuse and holder. S1 Mains on-off switch. S2 4-way rotary switch. T1 Mains transformer with two secondaries each 15V 10VA. SK1 Mains input socket. 15 off 14 lead d.i.l. sockets. 1 off 16 lead d.i.l. socket. 114 off terminal pins. 1 printed circuit board.

The changing phase difference is caused by many factors associated with physical variations in the instruments, for example string tension, mass and length, body resonance and bridge design, bow characteristics, in addition to the effects introduced by the instrumentalist through bowing technique and small changes from absolute pitch. The controlled addition of vibrato introduces a further major variation in phase relationships, which are very noticeable, particularly when it is realised that the ear is extremely sensitive to small changes in phase relationships between two sound waves.

In the String Ensemble the effective length of electronic delay lines are controlled in a continually changing manner such that the phase relationship between similarly pitched notes coming out of the lines is continuously changing thus simulating a multiple source.

ENSEMBLE LAYOUT

All the circuitry of the string ensemble is laid out on printed circuit boards which are mounted either on the underside of the keyboard or flat on the chipboard base panel. The simplicity of the concept can be seen in the photograph. Three p.c.b.s contain all the diode gating circuits and contact wires which are pressed onto the keyswitch rest when a note is played. The transformer, P.S.U. Tone Generator, Chorus and Voice p.c.b.s are mounted on the base. An earthed screen covers the chorus and voice circuitry to prevent pick-up from the tone generator harness. All controls are fixed to a front panel and input/output sockets are mounted within apertures in the rear panel.

BUILDING SEQUENCE

The cabinet has been designed to give a convenient construction sequence for the whole project. The base panel of the cabinet is cut to 32in × 11in × ½in chipboard

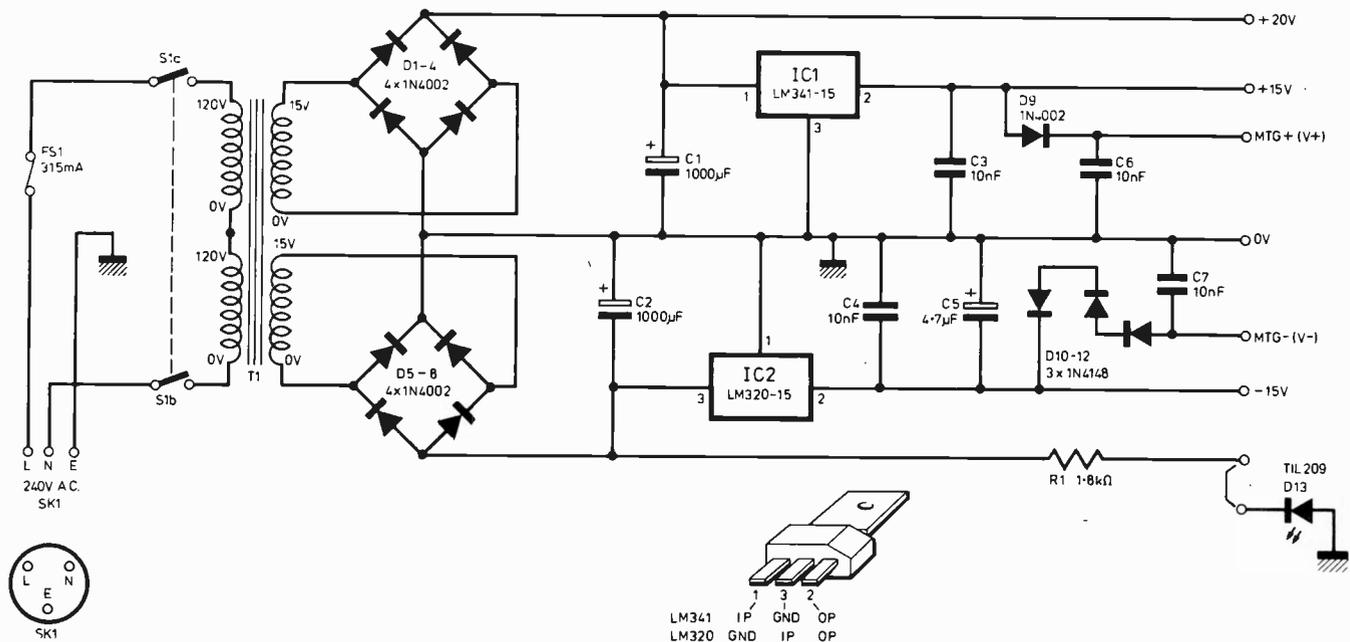


Fig. 1.2. Circuit of power supply

and used as the test bed throughout the project. Veneered sections of the cabinet may be assembled towards the end of the sequence to avoid damage to the surfaces.

The first sub-assembly described is the P.S.U./Tone Generator consisting of the transformer and one printed circuit board. These units can be fixed to the base panel, interwired and tested. The keyboard is then mounted onto the base panel from a timber key-bar supporting the rear of the keyboard via hinges. The Diode Gating p.c.b.s will be described, followed by the method of fixing to the keyboard and setting up the keyswitch action. After interwiring of the diode gate inputs to the tone generator, square wave tests may be carried out from the keyer output busbars. The Chorus printed circuit board will be described and may be initially tested using the square waves available at that stage. Finally, the Voice p.c.b. is constructed, and after interwiring to the front panel controls, and construction of rear ad side panels, the instrument is complete.

POWER SUPPLY

The circuit of the power supply is shown in Fig. 1.2, and consists of a transformer with two 15 volt secondary windings, followed by two bridge rectifiers, which give an efficient running condition for the transformer, producing unregulated supplies of approximately plus and minus 20 volts. The positive rail provides the supply to the key-switch busbar via the attack potentiometer, whilst the negative rail supplies the l.e.d. front panel power indicator (D13) via R1.

After capacitive smoothing integrated circuit voltage regulators produce plus and minus 15 volts which are used to supply the Voice and Chorus boards. Diodes D9-D12 reduce the supply levels to conform with the requirements of the AY-1-0212 master tone generator, taking into account the tolerance spread which can be obtained from

the 15 volt regulators and the voltage supply envelope given in the AY-1-0212 data sheet. In the prototype instrument +14.8 and -15.0 volts were obtained from the regulators giving +14.0 volts and -12.5 volts at the AY-1-0212. This is equivalent of the General Instruments Microelectronics data sheet definition of $V_{DD} = -14$ volts and $V_{GG} = 26.5$ volts which is the best condition for use at its highest operating frequency as required in the String Ensemble.

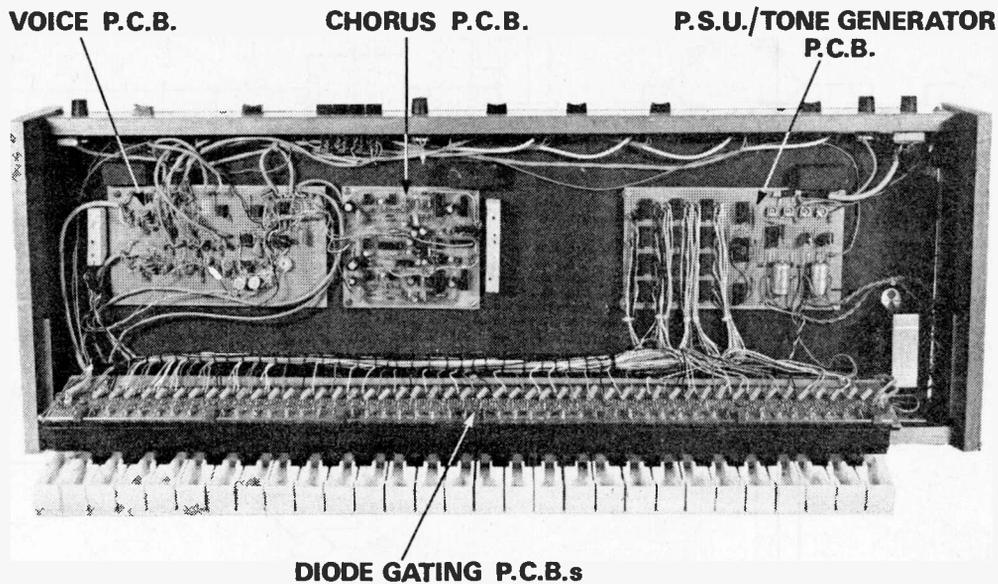
The integrated circuit dividers are also supplied from the voltage derived after D9 and were operating at 14.0 volts in the prototype. Whilst the mains current taken by the power supply is only 40mA, the surge at switch-on created by the inductance in the transformer can be many times greater and it is therefore recommended that a slow blow fuse be used; the 315mA version being a convenient standard type which gives ample protection to the instrument.

TONE GENERATOR SYSTEM

Frequency generation is centred on the use of the G.I. integrated circuit type AY-1-0212. The remainder of the tone generation circuitry is entirely dependent on CMOS integrated logic circuits producing a system which is very economic, easy to construct and reliable in operation.

A single integrated circuit is used to produce the starting frequency of approximately 2MHz. Many application notes produced by CMOS manufacturers give the simple oscillator shown in Fig. 1.3 which consists of two inverting gates, which in themselves are high gain amplifiers.

Gates connected this way are inherently unstable such that if one considers the input to Inverter 1 to be low, its output and hence the input to Inverter 2 to be high, and the output to Inverter 2 to be low, then capacitor C will charge through resistor R until the voltage at point (A) rises sufficiently to change the state of Inverter 1 such



Internal layout of String Ensemble

that its output becomes low. Inverter 2 then also changes its state to become high at the output. The low state of the output of Inverter 1 then provides a low impedance to ground for C to discharge through R thus reversing the cycle.

The CMOS oscillator shown in Fig. 1.4 has considerable advantages over that previously described, the first of which is that it must oscillate. Some polyphonic instruments have been manufactured which when switched on do not always operate due to the fact that the oscillator does not start. Usually this can be cured by switching off and on again quickly but it can be disconcerting to the non-electronically minded musician.

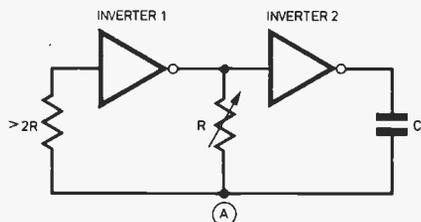


Fig. 1.3. Two inverter CMOS oscillator

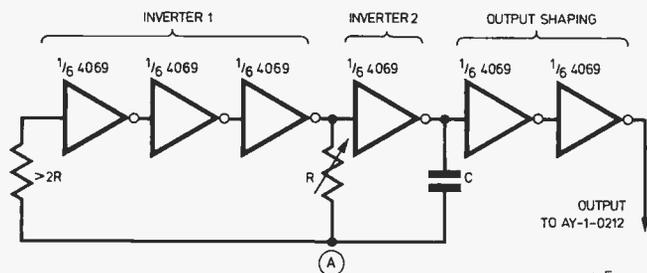


Fig. 1.4. Multi-inverter CMOS oscillator

In Fig. 1.4 the first inverter comprises three gates, and it is a fact that any odd number of gates connected from the final output back to the input will oscillate at a frequency determined by the total delay through the chain obtained by running the propagation delay time of each gate. The three gate circuit in the String Ensemble has a natural oscillating frequency of approximately 10MHz.

Inverter 2 consists of one gate and, by the process described for the simple oscillator, the C and R now slow down and determine the frequency of oscillation.

Two extra gates (inverters) finally shape the driving signal to a good square wave swinging over the full power supply range and not degrading as the frequency is changed.

MASTER TONE GENERATOR

The very clean driving wave form produced by the last two gates in the multi-inverter oscillator allow the AY-1-0212 to be used reliably over its full operating frequency range, and although the G.I.M. specification gives a 1.5MHz maximum for the standard device, out of twenty or so samples tried all worked in excess of 2MHz, many over 3.5MHz.

The slightly more expensive AY-1-0212A is guaranteed to work up to 2.5MHz and this could be used instead of the standard device.

Since its initial introduction the specifications associated with the AY-1-0212 have varied, particularly in respect of operating voltage. As described earlier the power supply has been designed to meet the latest recommendations, particularly for high frequency operation, but it should be noted that circuit descriptions in the String Ensemble adopt the convention of $V_{DD} = \text{Ground}$, V_{SS} is positive, and V_{GG} is negative for the AY-1-0212.

TONE GENERATOR CIRCUIT

The complete Tone Generator circuit is shown in Fig. 1.5 and is capable of producing 96 tones of which 85 are used.

A single 4069 CMOS integrated circuit, IC3, provides the

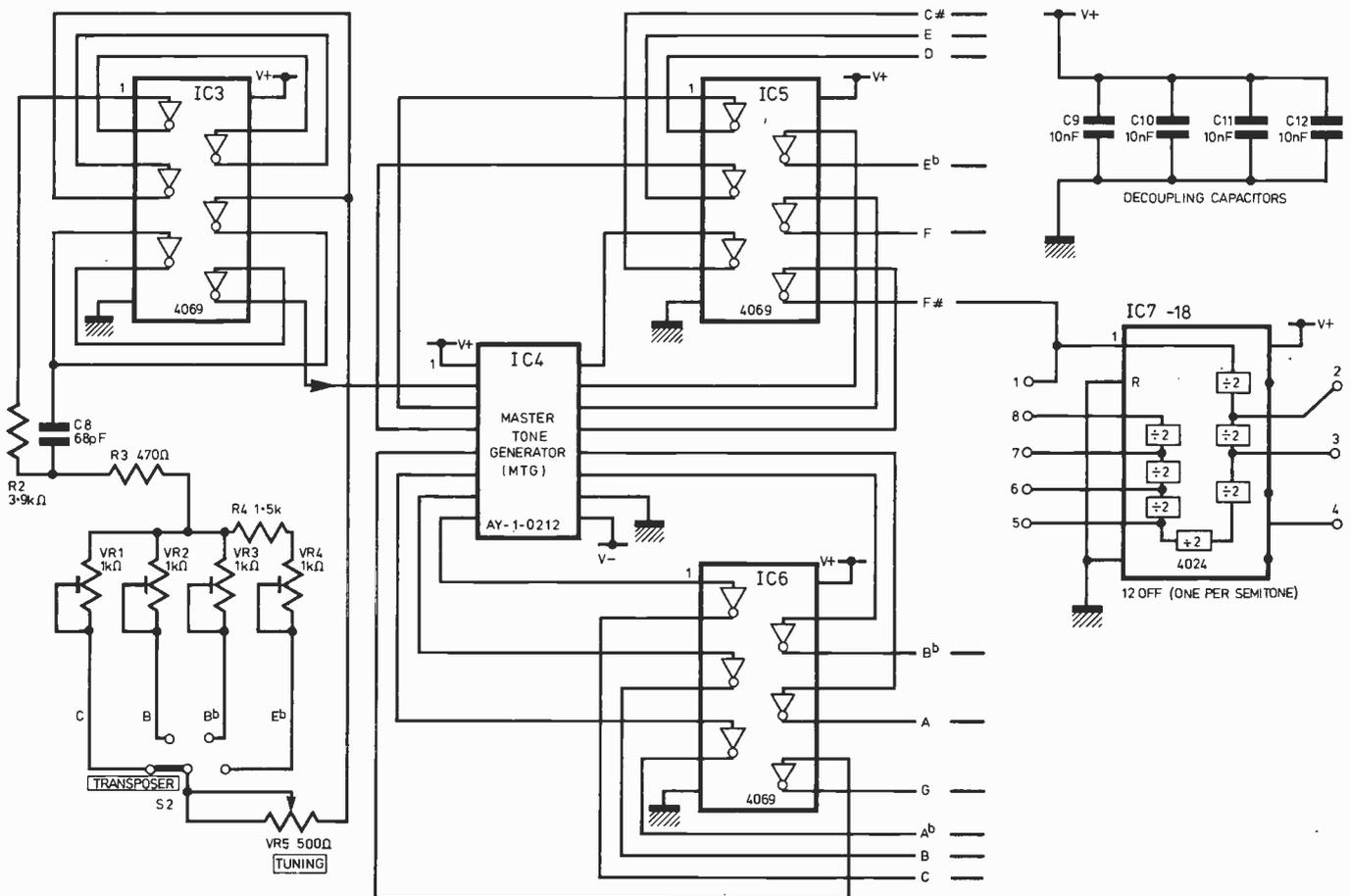


Fig. 1.5. Circuit of 96 Tone Generator

six inverters required for the oscillator, the frequency determining network consisting of C8 and the resistive combination of R3 in series with VR5 and VR1, VR2, VR3 or R4 plus VR4.

The alternative resistor combinations are switched by S2.

Following IC4, two hex inverters, IC5 and IC6, are used as buffers to ensure reliable operation of the 4024 seven stage dividers.

Twelve dividers are required, one for each semitone produced by the master tone generator.

The mains input socket, fuse holder and switch feeding the P.S.U./Tone Generator p.c.b. are mounted on a sub-panel at the rear of the cabinet, details of which will be given later.

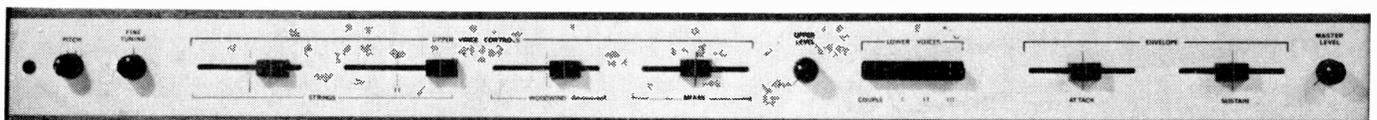
The transformer T1 is mounted on the base panel which it is suggested is used for all construction work as the project proceeds.

All other power supply and tone generator components are mounted on a single printed circuit board, the etching and drilling details of which are given in Fig. 1.6 with the component assembly details in Fig. 1.7.

To assemble the board the terminal pins should be fitted, followed by resistors, diodes, i.c. sockets, preset potentiometers, small capacitors and finally the large capacitors C1 and C2 and the voltage regulators IC1 and IC2. Sockets have been recommended for all dual in line integrated circuits on this board, partly due to the relative cost of the i.c.s and for easy fault tracing, and also to minimise handling of the i.c.s.

HANDLING PRECAUTIONS

The AY-1-0212 and CMOS integrated circuits are susceptible to damage by static electricity. All contain internal protection networks designed in by the manufacturers, and after handling considerable quantities of CMOS the author is convinced that he has never damaged a device through static even though handling of the devices has been careless. Nevertheless it is wise to take the precaution of minimising device handling, and carry out the advice of touching an earthed lead before proceeding to insert the integrated circuits into their sockets. *Damage will occur if the devices are reversed.*



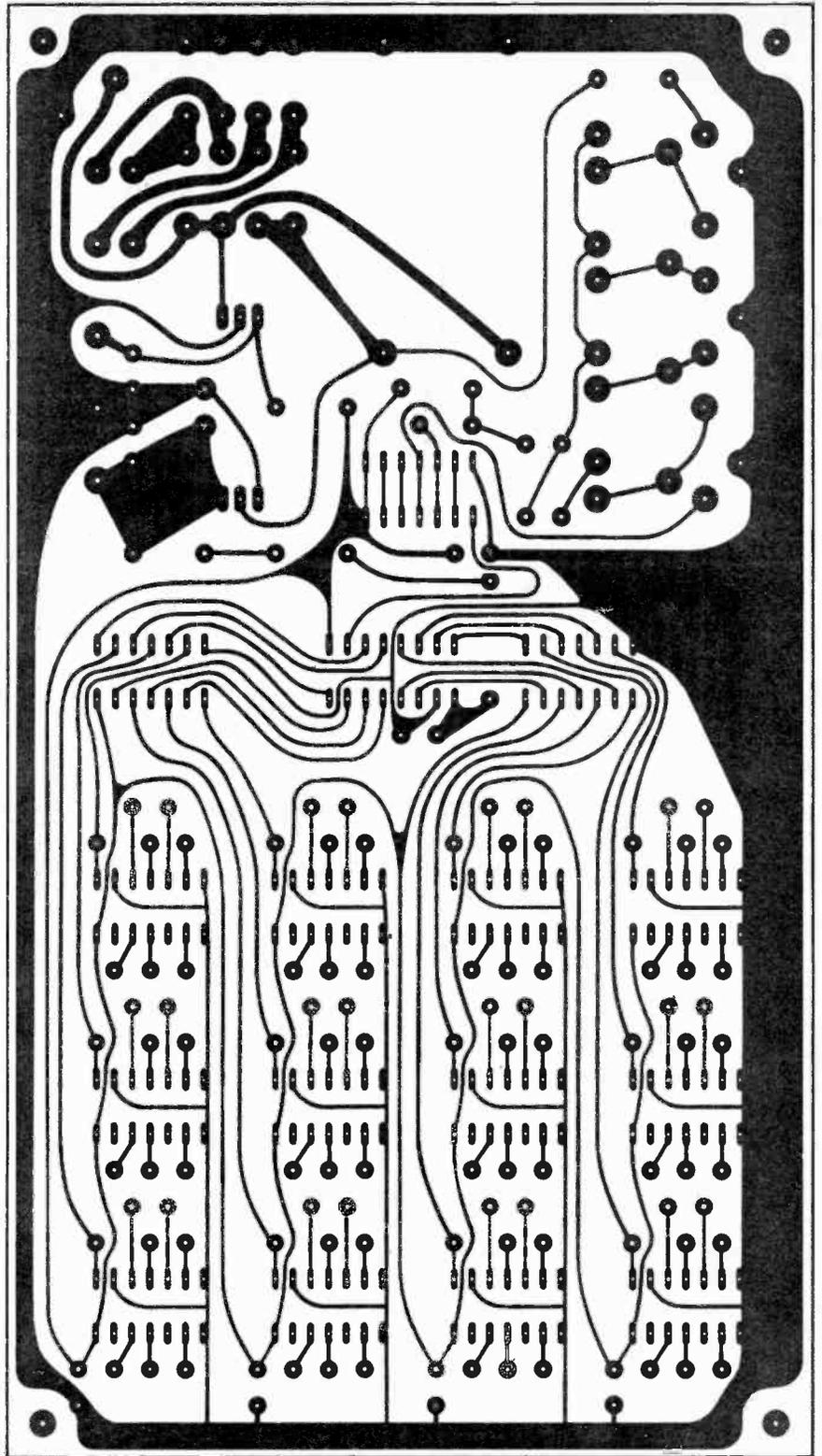
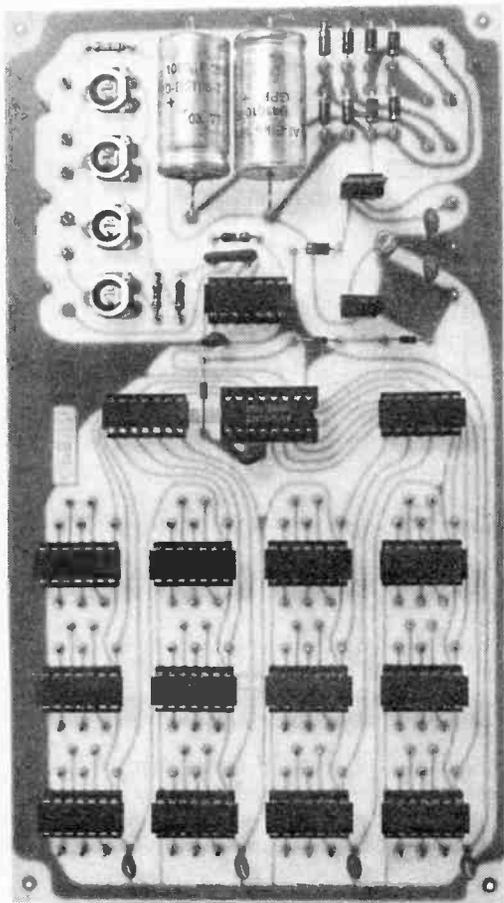


Fig. 1.6. Printed circuit layout of P.S.U./Tone Generator p.c.b.



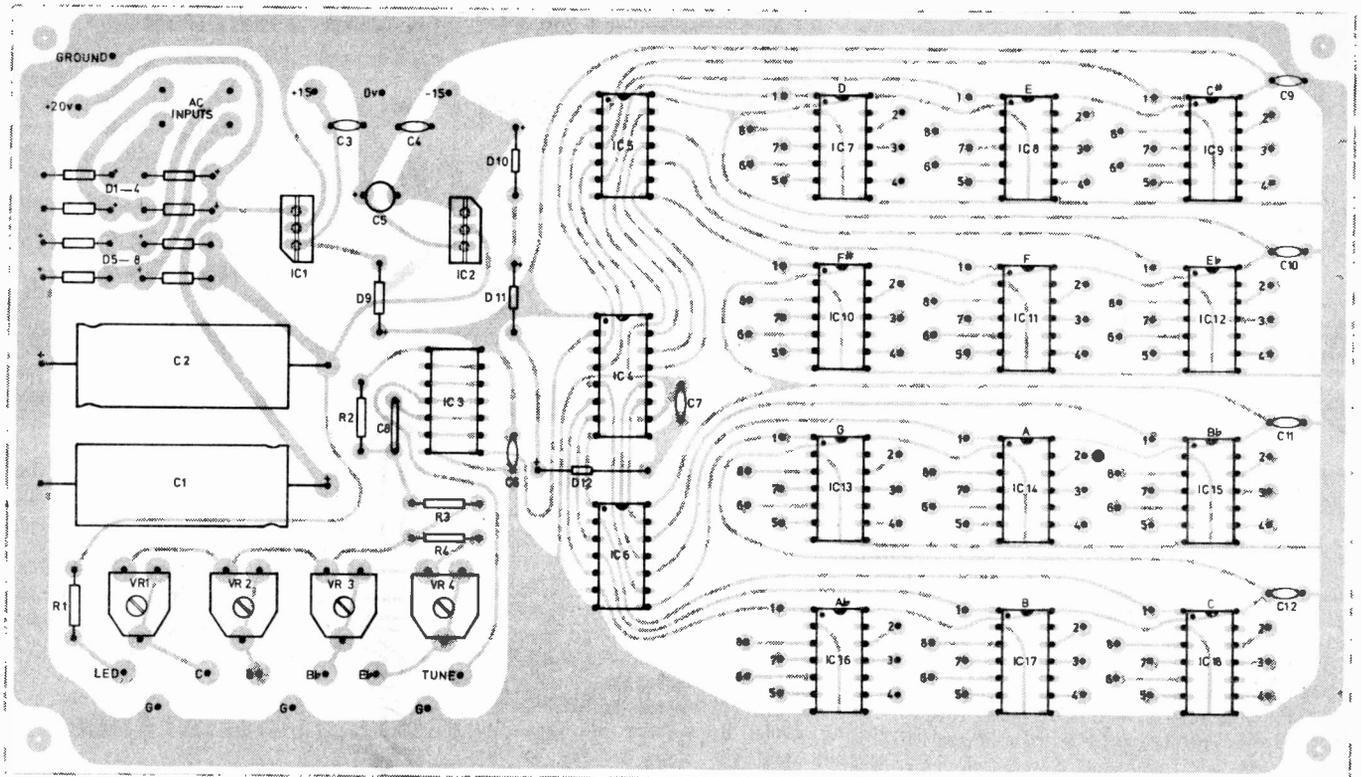


Fig. 1.7. Component layout of P.S.U./Tone Generator p.c.b.

The danger of incorrect insertion could arise on the voltage regulators IC1 and IC2. A clearly identified p.c.b. is recommended to avoid this, but for those constructors who may not be using p.c.b.s your attention is drawn to Fig. 3 and to the point that IC1 and IC2 pin connections are different.

INTERWIRING AND TESTING

Wiring at this stage is limited to connecting the T1 secondaries to the printed circuit board AC input pins as shown in Fig. 1.8. The sketch also shows how the base panel can be prepared by fitting the key bar, and after mounting T1 and the P.S.U./Tone Generator printed circuit board a sub-assembly test can be performed.

To simulate the Transposer and Tuning controls a test resistor of 270 ohms should be soldered between the pins marked "Bb" and "Tune". On connecting the mains, signals should be present at all the output pins grouped around each of the twelve 4024 integrated circuits, and the frequency should be variable by adjusting VR3.

To check the operation the probe network shown in Fig. 1.8 could be used which reduces the signal to approximately 300mV to feed a test amplifier. It is important to note that the 47 kilohm resistor is necessary in order not to overload the dividers. The 14 volt peak-to-peak voltage available from these is far too high for the average amplifier without the 3.3 kilohm attenuation resistor shown.

This test should be carried out *very carefully* since shorting the output pins to each other or ground could cause damage to the divider integrated circuits.

Next Month: Keyboard, keyswitch and diode gating assemblies.

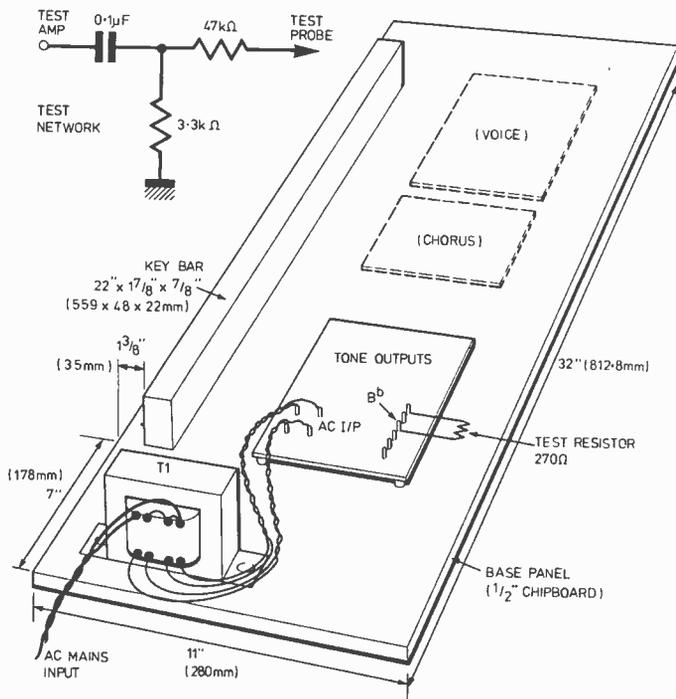


Fig. 1.8. Mounting of P.S.U./Tone Generator components on base panel for initial test

MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

WIRE WRAPPING

Any constructor building the P.E. CHAMP system will be pleased to learn that Verospeed can supply Kynar insulated wire. The extremely tough but thin insulation of this wire is part of the requirement for wire wrapping applications. Although no wrapping is necessary for CHAMP, Kynar wire is excellent for high density wiring, even with soldered connections.

An extensive range of wire wrap and unwrap tools are also illustrated in the Verospeed catalogue, including battery driven, hand operated, and mains types.

The Kynar wire (0.254mm dia and rated at 3.5A) is available in 500m reels, and in the following colours: Red, Green, Yellow, White, Blue, Black and Natural, each of which are currently priced at £11.85.

Tubes of pre-stripped lengths are available, in steps ranging from 25mm through to 254mm with corresponding prices of £2.56 and £5.98. These packs consist of 500 wires, and the specified lengths refer to the insulated portion, there being about an extra 25mm stripped wire at each end.

Further details can be found in the new Verospeed catalogue, and we are informed that the company is well equipped to supply small quantities without surcharge, and all items in the catalogue are subject to only 8 per cent VAT.

Verospeed, 10 Barton Park Industrial Estate, Eastleigh, Hants, SO5 5RR.

RADIO CONTROLLED GARAGE DOOR OPERATOR

A radio controlled garage door opener is now being introduced to electrical, do-it-yourself and car accessory retailers throughout the U.K. by the Haos Company Limited. It is designed to be either radio or key operated and will fit most up-and-over garage doors.

In response to a signal it has the facility to open the garage door, turn on the light and then close and securely

lock the door. After 1½ mins it will automatically turn off the light, having allowed sufficient time for the driver to get out of the car and leave the garage.

The radio control works on the long-wave frequency and is not subjected to interference from other electrical equipment; nor does it impair radio or television in the area.

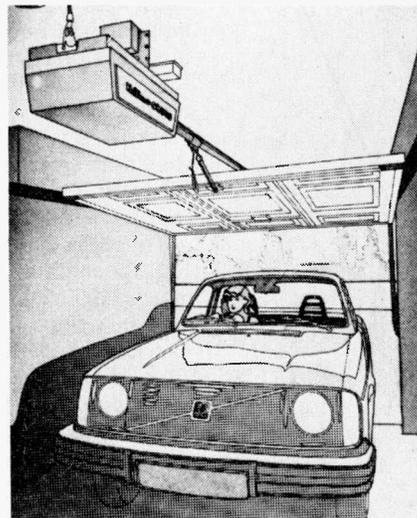
The compact transmitter unit runs on a 9V battery and has a transmitting range of 40 feet. Each radio controlled unit is individually coded to ensure that only the transmitter with the corresponding code can set the motor in motion. Any number of additional transmitters with the same frequency can be purchased as an optional extra.

The system includes a push button switch that can be placed within the home, garage or suitable outbuilding to enable operation of the system without the use of the transmitter. In situations where there is no secondary entry into the garage an outside key release is available, allowing the garage door to be opened manually from the outside in the event of a power failure.

If the door is obstructed during the closing cycle, the motor automatically reverses and the door returns to the fully open position. If an obstruction occurs within 50mm of the ground—or in the fully closed position—the clutch falls into neutral stopping the door until the closing cycle is completed and the motor shuts off.

The system is available in two sizes, deluxe and standard, depending on the size of the door to be lifted, the deluxe model also has a built-in light. The cost ranges from £150 to £250 depending on the type of unit required. As a licence is required before operating the appliance the Haos Company obtain the first licence on behalf of the purchaser.

For further information contact **The Haos Company Limited, Built in Centre, 32 Letchworth Drive, Bromley, Kent.**



Radio controlled garage door operator from the Haos Company

CABLE STRIPPER

The new A.B. MK 02 cable stripper which has been developed by A.B. Engineering Co. is a very useful tool, as it has an additional facility which allows electrical power cable insulation to be slit longitudinally.

It is suitable for all sizes of round cable from 4.5mm to 28.5mm dia and it has an adjustable cutting blade which can be set by turning the knurled screw to match the precise thickness of the insulation to be stripped.

The cable is retained by a spring loaded gripping clamp, rotation of the tool around the cable cuts cleanly through the insulation. The cutting blade is then turned through 90 degrees by depressing a knob on the side of the tool, this allows the insulation to be cut along the length of the cable and simply peeled away from the core.

Further details of the range of cable strippers may be obtained from A.B. Engineering Co, Apem Works, St Albans Road, Watford, WD2 4AN.

DECADE RESISTANCE UNIT

A very useful 7 decade resistance unit covering the range 1 ohm to 11 Megohms in 1 ohm increments has just been produced by Electronic Services & Products.

It is called the R-Decade 111 and the unit, which fits into one hand, could solve the frustrating problem of being unable to find the right value resistor.

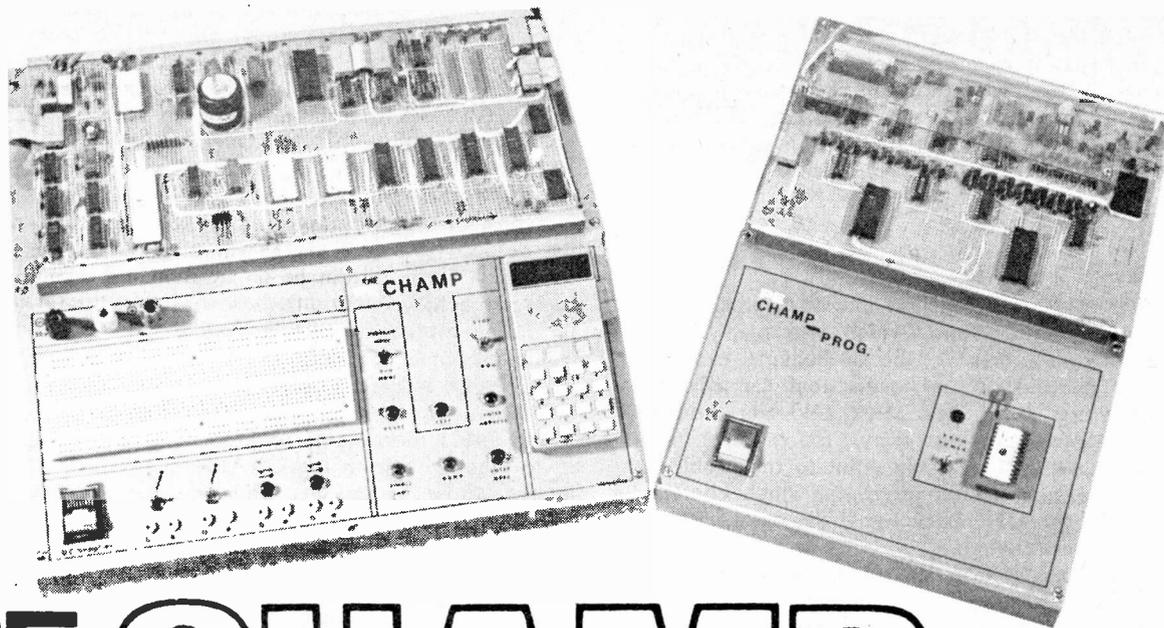
A third terminal allows the unit to be used as an accurate potential divider or as an attenuator, variable from 0 to 140dB.

The R-Decade 111 employs 0.5W 1 per cent high stability metal film resistors and uses a b.c.d. switching technique.

Further details can be obtained from E.S.P. Unit 2, Middle March, Long March Industrial Estate, Daventry, Northants.



Decade resistance unit from E.S.P.



PE CHAMP

PART SEVEN

R. W. COLES
B. CULLEN

WITH the construction of CHAMP and its keyboard behind us, and with a 4702A containing the CHOMP program plugged into the Chip Zero socket, we can now move on and put the system to work for its living.

This month we will be covering the operation of the system, and showing how it can be used for the development of software and hardware, which can later be used in a separate "SON OF CHAMP" dedicated system, or be used as an extension of CHAMP itself.

LOADING A PROGRAM

When CHAMP is turned on, with the keyboard connected, a display of 000 200 should appear. The 200 tells us that the CHOMP address counter points to the first available RAM location, Chip 2 Location 00, and that program loading can now begin. Program instructions or data are entered one byte at a time, by pressing the two appropriate hexadecimal keys in succession. As each key is pressed the digits appear in the proper position on the left of the display, replacing the zeros which existed to start with. If an error is made on entry, the incorrect digits can be replaced with zeros or overwritten simply by pressing extra keys until the display is satisfactory.

If all is well, pressing the ENTER DATA key will enter the single byte into RAM location 200 and the CHOMP counter will be incremented to show 201, the next location in sequence. A complete program can be entered in this step by step fashion quite rapidly, each pair of hexadecimal digits being entered into the next available location by means of the ENTER DATA key.

If you wish to enter subroutines or data tables starting at some address *other* than 200H, the ENTER ADDRESS key can be used to reset the CHOMP address counter. A CHAMP address is twelve bits long, and so three

hexadecimal keys are pressed before using the ENTER ADDRESS key. Any address in the range 200H to 3FFH can be entered in this way, in preparation for program entry, and in fact any address from 000H to 3FFH can be entered ready for an examination of its contents using the DUMP key. This means that a PROM based user program in the Chip One socket, or even CHOMP itself, can be examined if required.

Operation of the DUMP key will display on the two left-hand digits the hexadecimal content of the memory location indicated by the three right-hand display digits. Note that it displays the byte whose address was indicated *before* depression of the DUMP key, and that DUMP, like ENTER DATA, automatically increments the CHOMP address counter so that whole programs can be quickly examined by rapid operation of this key.

After using the DUMP key once, the two left-hand digits display the byte resident at the next lowest address to that indicated on the three right-hand digits.

RUNNING A PROGRAM

When a program has been entered and is considered satisfactory, it may be allowed to run by changing the MODE switch to RUN MODE. Operation of this switch causes CHOMP to carry out a JUN to location 200H where the first instruction of any user program should be situated.

CHOMP assumes that *every* program starts at 200H and this may be inconvenient, particularly if a number of small programs are co-resident in the CHAMP RAM area. To ensure that entering RUN MODE starts the required program, regardless of its position in memory, a JUN can be entered into locations 200H and 201H. To leave this option open it is best to begin any program which

starts at 200H with a couple of NOP instructions, thereby leaving room for the JUN should it ever be required.

Once a user program has been started, CHOMP takes no further part in the proceedings until PROGRAM MODE is re-selected and the RESET key is depressed. User programs can of course use any of the CHOMP subroutines such as DDRV or CLRf, without prejudice.

PROGRAM DE-BUGGING

When a program is tried out for the first time, it is normal for it to contain "bugs" which prevent it from operating correctly. To help in the de-bugging process CHAMP can be set to STOP and instructions carried out one at a time using the SINGLE SHOT key. For simple programs which control lamps or relays, for example, the use of the SINGLE SHOT can quickly point to the problem area, but for more complicated programs which contain several JCN, JMS, or JUN instructions, the SINGLE SHOT capability alone is not enough.

In these circumstances it is an advantage to have a knowledge of the 4040 data bus contents, or the 4289 data and address bus contents so that the operation of the program can be closely studied, and the changes after each instruction execution, monitored.

Monitoring the data and address buses cannot be achieved with software of course, and requires the use

of a hardware device normally called a "Bus Analyser" which samples the buses at an appropriate moment and latches their content for display on l.e.d.s or lamps.

A very simple bus analyser which we have called "BUS BOX" has been designed for use with CHAMP, and the circuit for this unit is shown in Fig. 7.1. The "BUS BOX" can be plugged into sockets 2, 4 or 6 on CHAMP to observe the 4040 main data bus, the program memory data bus, or the program memory demultiplexed address bus, respectively. BUS BOX will display up to eight bits in binary form, although a hexadecimal format could easily be achieved with the use of appropriate decoders and seven bar displays if required.

The principle of operation is quite simple: The 4040 SYNC pulse is used to start a variable delay formed by a 74121 monostable circuit. When the delay expires, a second 74121 monostable generates a strobe pulse to load up to eight bits from the CHAMP buses into 7475 quad latches whose \bar{Q} outputs drive l.e.d. lamps. When the BUS BOX is connected to the four bit 4040 bus (SK2) any of the eight time periods from A1 to X3 (see 4040 manual, Fig. 1-2) can be monitored and the bus contents displayed on four of the eight l.e.d.s. By this means all twelve bits of the current address, eight bits of the fetched instruction, four bits of the current accumulator value, and the eight bit SRC address can all be monitored in sequence by selecting an appropriate delay with the first 74121 monostable.

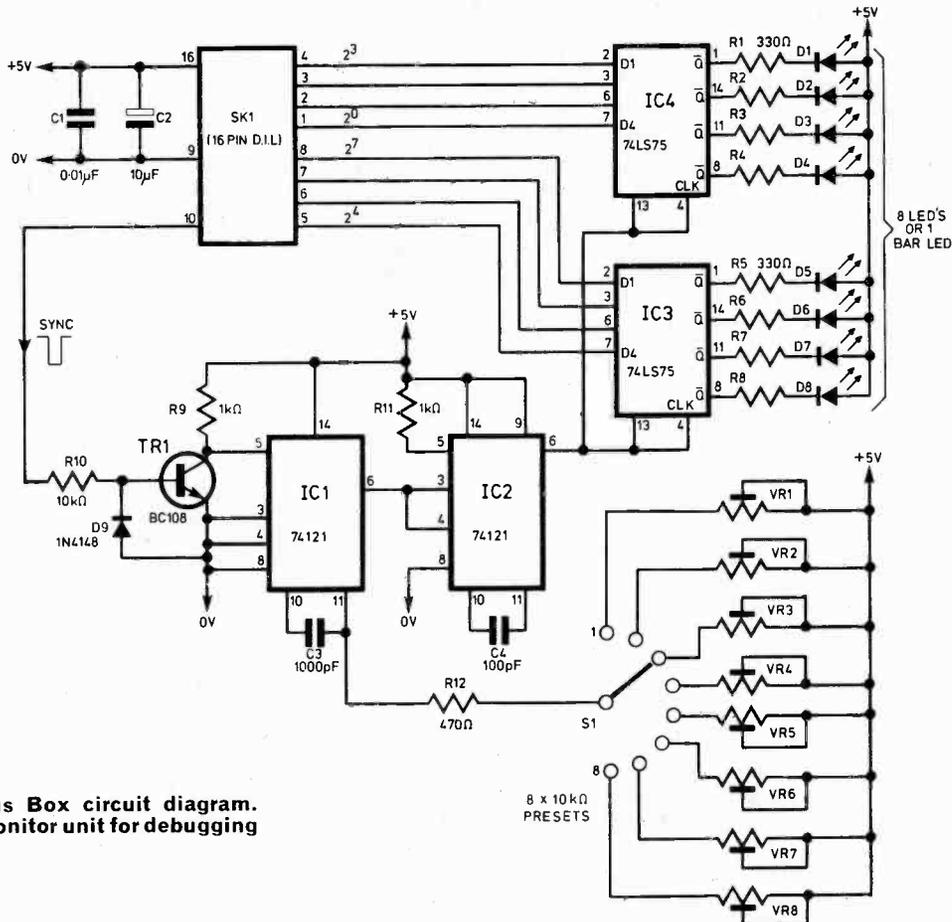


Fig. 7.1. Bus Box circuit diagram. A simple monitor unit for debugging CHAMP

Notice that the data on the 4040 bus is inverted by TR2 to TR5 on the CHAMP main board so that the required positive logic 1 = i.e.d. ON is realised. Being able to monitor the main data bus is very useful when sorting out elusive bugs, but looking at the data four bits at a time can be tedious if all you need to do is to follow the address flow of a program, or to monitor each instruction byte as it is fetched. To simplify this task the BUS BOX can also be connected directly to the 4289 data and address buses (SK4, SK6) where all eight i.e.d.s are used simultaneously, and in this case the delay is set so that it monitors the M2 bus time slot when both address and data information are available on their respective buses.

SIMPLE

The Bus Box circuit presented here is of the most basic type possible, and suffers from several disadvantages as a result. This was a deliberate policy so that construction costs could be kept to an absolute minimum; but anyone who feels that the rather crude method of time slot selection (which really requires an oscilloscope for initial set-up) or the primitive binary display, are not good enough can of course design something better. A counter, reset by the SYNC pulse can be used with a decoder for time slot selection, and combined hexadecimal latch, decoder, display chips can be used to present bus content.

All kinds of other embellishments can be added to produce a very powerful de-bugging tool, but if low cost is high on your list of priorities the Bus Box makes a good starting point.

WRITING PROGRAMS FOR CHAMP

Program writing for a simple four-bit chip like the 4040 can be carried out quite successfully at the machine code level, and there is no need for an extensive knowledge of computer science or of any high level languages such as Fortran. If you are already knowledgeable about such things, the simplicity of the 4040 might strike you as a disadvantage, but if you are basically a "hardware person" you will soon feel at home thanks to an intimate contact with the registers, gates and flip-flops which you will control via your programs. The creation of programs is of course a skill which must be learned gradually, by trial and error really, and the most important tip that we can give is to start with something simple, so that the almost inevitable "bugs" can easily be unravelled.

To start you on your way we have put together a simple program which involves both hardware and software design, and which serves as a useful springboard for a greater range of more sophisticated projects. As we describe the creation of this program we will introduce a number of useful programming tips and aids.

SAMPLE PROGRAM

The program we have written is called "TONE", and its sole purpose is to generate an audio tone of about 1kHz in an external speaker whenever the CHAMP TEST button is depressed.

The first step in program writing is of course the flow chart, and Fig. 7.2 illustrates this first stage in the design of TONE.

Box 1 indicates that we want to do nothing but idle while waiting for TEST to be pressed, and here we have a simple wait loop which will use the JCN conditional branch instruction to monitor the state of the TEST input.

Box 2 is entered when TEST is pressed and here we want to generate a delay of about one millisecond to set the frequency of the generated tone. The best way to generate delays of this sort is to set up a counter chain using ISZ instructions with 4040 registers acting as the counters; it also seems reasonable (though not essential) to make this a separate subroutine. After the delay, we can activate the output pulse which will drive the speaker, and one of the 4265 output lines which is subject to the bit set/reset command, WRM, seems a good choice to receive this output signal.

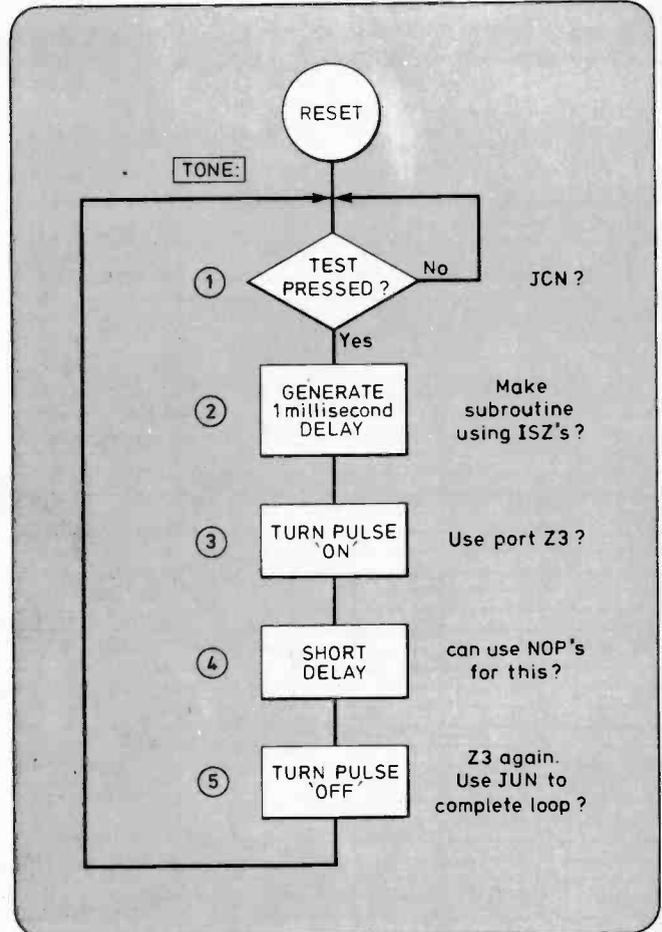


Fig. 7.2. Flow chart for the TONE program

In this simple program we are not after a 1:1 mark space ratio for the tone signal and so we can set the output pulse width by means of a very simple delay formed from NOP instructions (Box 4) before turning the pulse off again (Box 5). Having generated a single pulse we must of course loop back to see whether TEST is still depressed, and we can achieve this by means of a JUN.

Note that after drawing the basic boxes and lines required, we have added notes on the way we may want to code the program when we eventually reach that stage.

HARDWARE

During the flow-charting stage, port Z3 was proposed as a suitable interface to the external hardware, in this case, the speaker. A glance at the 4265 data sheet (page 5-41, 4040 Handbook) shows that any of the Z outputs can sink 1.6mA in the low state, whereas their high

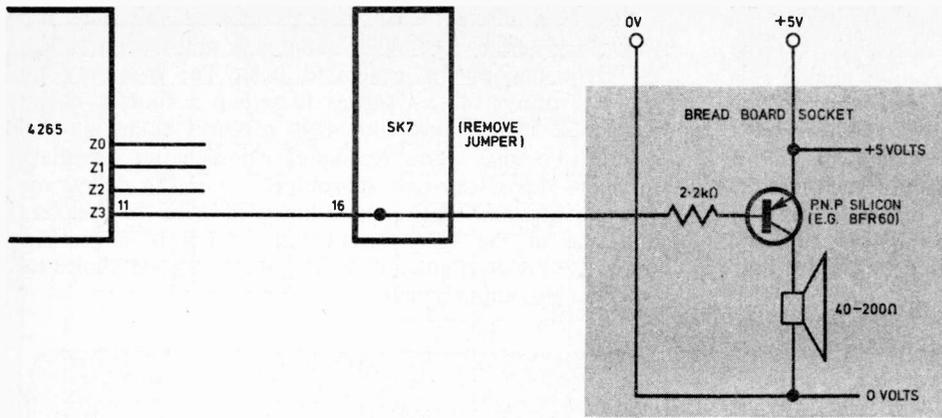


Fig. 7.3. Hardware required by TONE program. The breadboard mounted on the CHAMP fascia is provided for such supporting hardware.

MCS 40 PROGRAM SHEET							
TITLE		TONE Generates 1Kz note when TEST is pressed				DATE 26-11-77	
HEX		BIN		MNEMONIC			
PAGE	LINE	ROM	CODING	LABEL	OPERATION	OPERAND	COMMENTS
2	0	00		TONE:	NOP		
	1	00			NOP		
	2	11			JNT		(Wait for TEST)
	3	00			TONE		
	4	52			JMS		(Delay subroutine)
	5	18			ONEK		
	6	28			FIM	8	(Address 4265
	7	80			B	0	I/O chip)
	8	29			SAC	9	
	9	DE			LDM	E	
	A	E0			WRM		(Pulse "ON")
	B	00			NOP		
	C	00			NOP		
	D	00			NOP		
	E	00			NOP		
	F	00			NOP		
2	1	0F			LDM	F	
	1	E0			WRM		(Pulse "OFF")
	2	42			JUN		(Continue while
	3	00			TONE		TEST Pressed)
	4	XX					
	5	XX					
	6	XX					
	7	XX					
2	1	8	22	ONEK:	FIM	2	(Preset counters)
	9	DD			D	D	
2	1	A	72	LOOP:	1SZ	2	(821 microsecond
	B	1A			LOOP		delay)
	C	73			1SZ	3	
	D	1A			LOOP		
	E	CO			BBL	0	(Branch back)
	F	XX					
NOTES (1) Port Z3 used for TONE output (2) Keyboard disconnected at Jumper (3) XX = don't care 1							

Fig. 7.4. TONE program instructions laid out on a standard program sheet

state sourcing ability is probably poor. This fact suggests the use of a p.n.p transistor stage to drive the speaker, and so the final hardware circuit is as shown in Fig. 7.3. Notice that these few external components can be assembled on the breadboard socket, and that the SK7-SK8 jumper is removed to gain access to Z3 on pin 16.

CODING THE PROGRAM

With the flow-charting and hardware design out of the way it is now possible to turn the program outline into a set of ready-to-load 4040 instructions, and our attempt at this is shown in Fig. 7.4. To make life a little easier we have designed our own 4040 program sheets which we duplicate and make up into pads, each sheet having room for 32 separate instructions. If you can get sheets like this duplicated then it is a good idea to copy our design, although an exercise book with a few lines ruled on it would serve just as well.

Each line on the sheet corresponds to a single address in program memory, hexadecimal address information being entered in the first two columns as required. The second two columns are for entry of hexadecimal instruction codes (and the binary equivalent if required) but these columns are filled out last of all. Column 5 is used to hold any address label or name that may be applied to any particular location, and columns 6 and 7 are used to write out the mnemonic form of the instructions as the program is developed.

Column 8 allows the insertion of plain-English comments to explain the action of the program; a necessary addition as you will soon appreciate when trying to unravel programs which you may have written some weeks previously, without useful comments!

The first address of TONE is 200H, the start of program RAM, and the first four lines of the program represent Box 1 of the flow chart. The two NOPs are not essential but we inserted them to allow a JUN to be entered when running programs elsewhere in the RAM address range, as discussed earlier.

SUBROUTINE

The one millisecond delay is coded as a subroutine which we have called ONEK. The actual location of the subroutine is unimportant but we chose address 218H, to allow some room between it and the end of the main TONE program, in case TONE "grew" after de-bugging. Reference to page 2-18 of the 4040 manual shows that a one millisecond delay can be achieved with two four bit counters, given the standard 5.185MHZ clock frequency normal with 4040 systems, including CHAMP.

Since the total period of the pulse stream is determined not only by ONEK but also the time the pulse is ON and the time taken to execute other instructions in the loop, a value of 821 microseconds is actually used, and the "fine tuning" of this delay is achieved by loading the two

count registers with hexadecimal data before counting begins. This register, preset to DDH, is performed by means of the FIM instruction at the start of ONEK.

After the JMS ONEK instruction in the main program, comes another FIM which loads register-pair 8 with the SRC address value of the 4265 (actually 80H). This is then sent out by the SRC 9 in line 208H to select the 4265 ready for output.

The pulse is turned on by setting Z3 to the low output state using LDME WRM, a sequence which can be best understood by reference to page 5-39 of the 4040 manual. After the 54 microsecond delay produced by the five NOPs, LDMF, WRM is used to return Z3 to its high state, followed by a JUN back to TONE. When all the mnemonics and comments had been entered, we coded the program by looking up the hexadecimal equivalents in the manual and entered these along with hexadecimal addresses (in place of the labels) into column 3 of the program sheet.

REGISTER MAP

The subroutine ONEK required Index registers for use as counters, and the main program used an Index register pair as a source for SRC addresses, but you may be wondering just *why* we used the registers that we did use.

TONE is a very simple program which uses only two register pairs out of the total of twelve available, and so we *could* have used any of the Index registers with equal success. When writing larger programs this is often not the case; CHOMP and PROMPT use every available

MCS 40 . INDEX REGISTER MAP																																																											
TITLE		TONE																																																									
<table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th colspan="4">BANK 0</th> </tr> <tr> <th>0</th> <th>1</th> <th>2</th> <th>3</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>ONEK COUNTER</td> <td>3</td> <td>ONEK COUNTER</td> </tr> <tr> <td>4</td> <td></td> <td>5</td> <td></td> </tr> <tr> <td>6</td> <td></td> <td>7</td> <td></td> </tr> <tr> <td>8</td> <td>SRC</td> <td>9</td> <td>USE</td> </tr> <tr> <td>A</td> <td></td> <td>B</td> <td></td> </tr> <tr> <td>C</td> <td></td> <td>D</td> <td></td> </tr> <tr> <td>E</td> <td></td> <td>F</td> <td></td> </tr> </tbody> </table> <table border="1" style="display: inline-table;"> <thead> <tr> <th colspan="4">BANK 1</th> </tr> <tr> <th>0</th> <th>1</th> <th>2</th> <th>3</th> </tr> </thead> <tbody> <tr> <td>2</td> <td></td> <td>3</td> <td></td> </tr> <tr> <td>4</td> <td></td> <td>5</td> <td></td> </tr> <tr> <td>6</td> <td></td> <td>7</td> <td></td> </tr> </tbody> </table>				BANK 0				0	1	2	3	2	ONEK COUNTER	3	ONEK COUNTER	4		5		6		7		8	SRC	9	USE	A		B		C		D		E		F		BANK 1				0	1	2	3	2		3		4		5		6		7	
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3	SRC RAM ADDRESS	EVEN X2 CHIP REGISTER	ODD X3 CHARACTER																																																								
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	SRC 4265	CHIP / DONT	CARE																																																								
	SRC PROGRAM MEMORY	HIGH ORDER	LOW ORDER																																																								
	SRC RAM O/P	CHIP DONT	CARE																																																								
	SRC RAM STATUS	CHIP REGISTER	DONT CARE																																																								
4	BANK 1 CAN BE USED DURING INTERRUPTS TO SAVE BANK 0																																																										

Fig. 7.5. Index register map. A standard sheet such as the one shown would serve as a method of recording the deployment of each register, and this one has been entered up for TONE

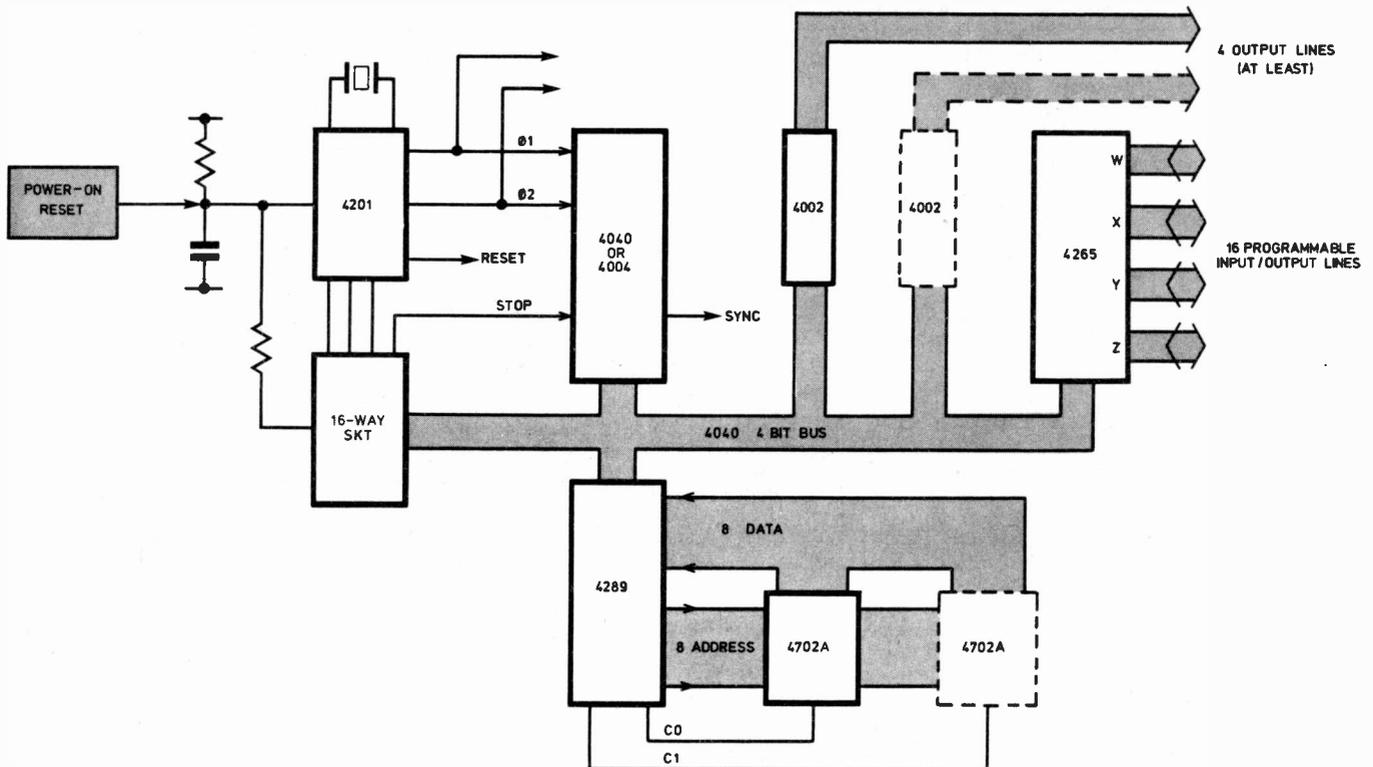


Fig. 7.6. Possible "Son of CHAMP" layout for a 4040 or 4004 based system for dedicated application. The 16-way socket is for bus analyser testing and a manual control unit. The 4002s and 4702As should be socket mounted so that only the required chips are used

COMPONENTS...

BUS BOX

Resistors

8 off 330Ω	R1-R8
2 off 1kΩ	R9, R11
1 off 470Ω	R12
1 off 10kΩ	R10
All ½W 5% carbon	

Potentiometers

8 off 10kΩ presets	VR1-VR8
--------------------	---------

Capacitors

1 off 0.01μF	C1
1 off 10μF elect	C2
1 off 1000pF	C3
1 off 100pF	C4

Semiconductors

8 off discrete i.e.d.s, or	
one bar i.e.d. array D1-D8	
1 off 1N4148	D9
1 off BC108	TR1

Integrated circuits

2 off 74121	IC1, IC2
2 off 74LS75	IC3, IC4

Miscellaneous

1 off 16-way d.i.l. socket	SK1
1 off single pole 8-way rotary switch	S1
Stripboard, cabinet e.t.c.	

CHAMP PROGRAMMING SERVICE

Readers who have no PROM programming facilities may have their own 4702A or 1702A PROM programmed by post with the following:

(a) CHOMP	£5.35
(b) Reader's own software	£10.35
(c) Reader's own software re-programmed with up to 16 corrections to original program	£3.35

All prices include postage and packing.

Programs, or corrections to programs, *must* be supplied as a *clear* list of two-digit hexadecimal code with hex' address information alongside. Also, PROMS should be sent well packed, and protected with conductive foam.

CHOMP software will be tested on a CHAMP system, otherwise programs are committed to PROM at reader's own risk.

This service is provided by, and payment should be made to:

C. C. CONSULTANTS,
Dept P.E., 3 Gainsborough Drive, Worle, Weston-super-Mare, Avon.
Do not send PROMS to P.E.

register for example, and use some of them for several different jobs. This means that keeping track of Index register usage is very important. To help with this aspect of programming we have put together another duplicated sheet which we call an Index Register Map, and Fig. 7.5 shows how this looks for TONE.

Of course TONE is a very simple program and not much use as it stands, but we feel that its basic principles can be incorporated in such projects as Stylophone type instruments, musical doorbells and a host of others.

DEDICATED SYSTEM

After developing hardware and software for, say, a musical doorbell, you will need to produce a small dedicated hardware system into which you can plug the PROMS programmed by CHAMP-PROG.

Figure 7.6 shows a possible layout for a small 4040 or 4004 based system which could be put to a multitude of different uses, and which would fit onto a six inch square circuit board.

NEXT MONTH: CHAMP-PROG.

NEWS BRIEFS

SOUND 78 INTERNATIONAL

This exhibition has been organised by the Association of Sound and Communications Engineers (formerly the Association of Public Address Engineers), and is to be held at the Cunard International Hotel, Shortlands (near Hammersmith flyover), London W6.

The Sound 78 International Exhibition will be held over the period from March 14-16 inclusive, and on display will be some of the most sophisticated and up to date sound and communications equipment in the world. It will be possible to view amplifiers, microphones, automatic announcement equipment, alarm systems, background music systems, sports event timing equipment, loudspeakers, hotel and hospital communication systems, discotheque equipment, intercoms and paging equipment, mixers, studio recording and audio visual equipment.

There will also be experts present who can discuss the design, installation and function of most of the equipment on display.

The exhibition is to be open each day from 10.00 to 18.00 (17.00 on the last day), and admission will be absolutely free to anyone having a professional or business interest.

Now even better, even more powerful! The unique wrist calculator.

AVAILABLE ONLY AS A KIT.



Assembling the Science of Cambridge wrist calculator.

The wrist calculator comes as finished components, ready for assembly. All you need is two or three hours, and a fine-tip soldering iron.

If anything goes wrong, we'll replace damaged components free. We want you to enjoy building the kit, and to end up with a valuable, useful, powerful calculator.

Contents.

Acrylic/ABS case and display window parts. Two-part stitched strap and spring bar clips. PCB. Special direct-drive chip (no interface chip required). Display. Keyboard components. Batteries.

Each of the 34 components is contained in a plastic box; and neatly shrink-wrapped, accompanied by full instructions for assembling and using the calculator. All components are fully guaranteed.

A wrist calculator – the ultimate in common-sense portable calculating power. Goes where you go, ready for action at a flick of your wrist.

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Put real calculating power up your sleeve.

The Science of Cambridge wrist calculator gives you the full range of arithmetic functions (+, -, ×, =). It uses ordinary algebraic logic, which means you enter calculations as you would write them. It has a % key, the convenience functions, \sqrt{x} , $1/x$, x^2 and a full 5-function memory.

And incredibly, it has a clear-last-entry key, pi, brackets, and $\div 4$. It even has an automatic linear metric conversion function!

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All those functions, from just 10 keys? In such a small calculator? The secret lies in the special four-level keyboard. Each level has a different set of functions. Simple two-way switching system allows you to select any keyboard level quickly and easily. Each set of functions is carefully grouped, to let you whisk through calculations with the minimum of switching.

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Plus VAT, P&P

The wrist calculator kit is available only direct from Science of Cambridge. If, for any reason, you're not completely satisfied with your wrist calculator, return it to us within 10 days for a full cash refund. Send the coupon today!

Science of Cambridge Ltd.

(Previously Sinclair Instrument Ltd)

6 Kings Parade, Cambridge, Cambs. CB2 1SN.

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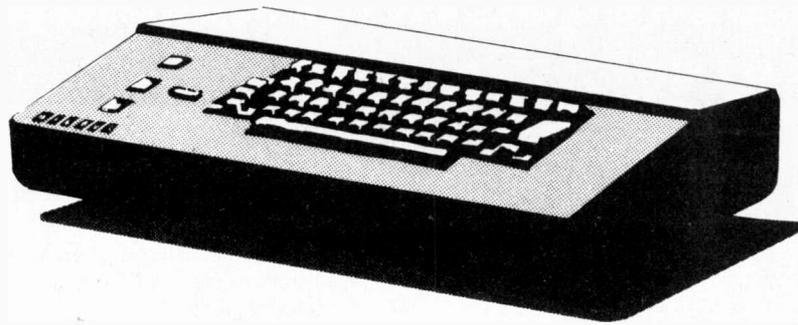
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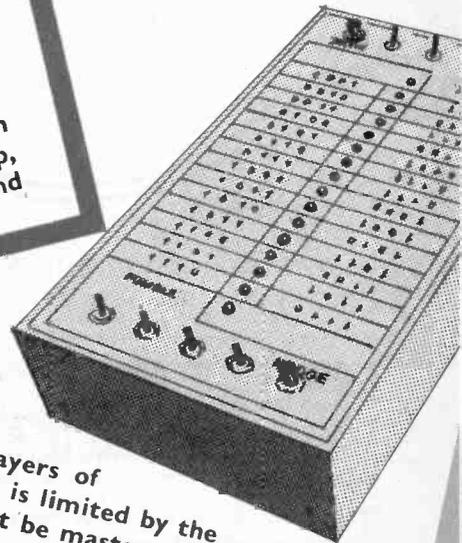
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40 Page
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This new spring '78 catalogue, which will cost other constructors 35p, contains 8000 line items, prices and data.

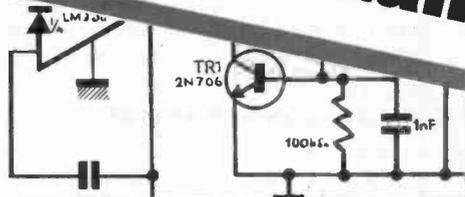


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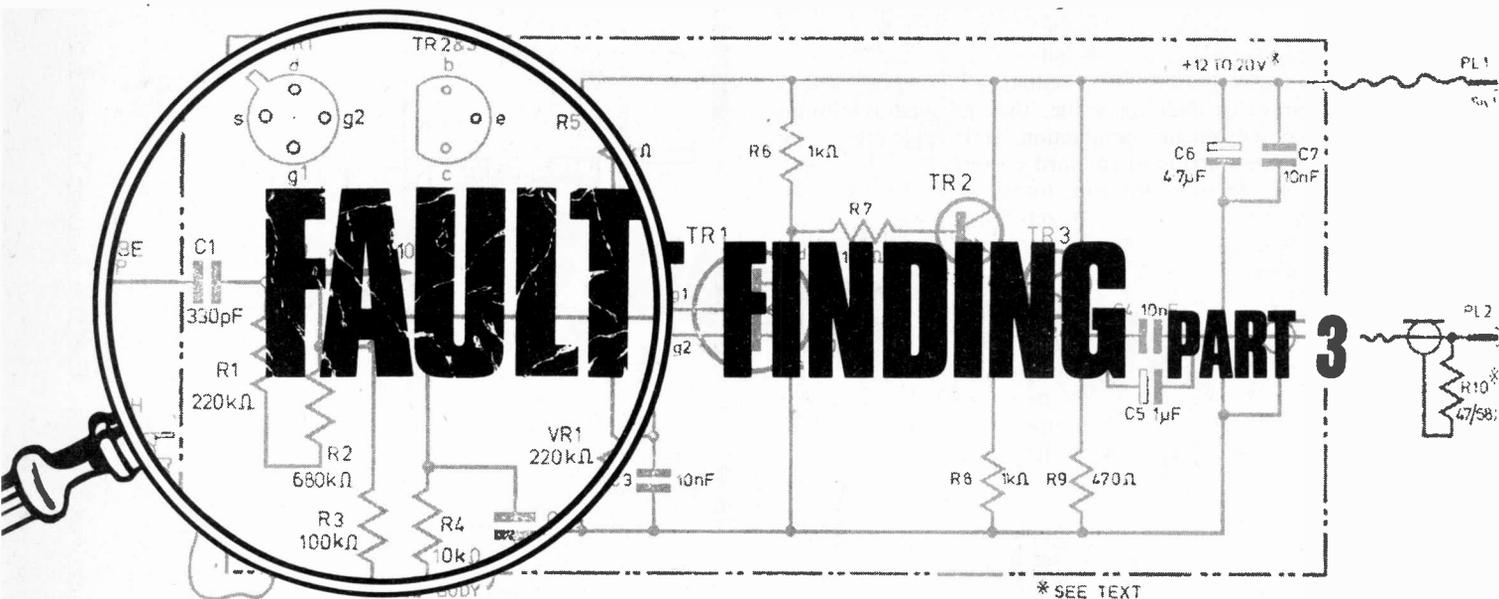
Electronic KEYSWITCH

Employing CMOS logic, this unit presents an unusual approach to the construction of an electronic lock.

PRACTICAL

ELECTRONICS

OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 10 MARCH, 1978



G. LOVEDAY

Fault finding on triac and thyristor circuits

THYRISTORS and triacs are semiconductor devices that are increasingly being used to replace conventional mechanical switches and relays, mainly because they offer faster switching speeds, high reliability and the ability to smoothly control the power dissipated in a load. They find many diverse applications such as lamp dimmers, sound-to-light units, power supplies, motor speed control etc., so an understanding of their operation, use, and fault diagnosis is important for anyone interested in electronics.

OPERATION AND CONSTRUCTION

Just like any other component it is important to appreciate how thyristors or triacs work before attempting to diagnose faults in typical circuits containing them, so a small amount of theory follows.

A typical thyristor structure is shown in Fig. 3.1a. It consists of a four layer *p-n-p-n* silicon sandwich, just like two rectifiers connected in series. The symbol is of a rectifier with an additional terminal called the gate (Fig. 3.1b).

It is the gate that enables the action of the rectifier to be controlled. As for an ordinary rectifier, when the anode is negative with respect to the cathode the device is reverse biased and no current flows. If the anode is made positive with respect to the cathode the device will still not conduct (provided that the forward breakover voltage is not exceeded) and it is said to be forward blocking (Fig. 3.1c).

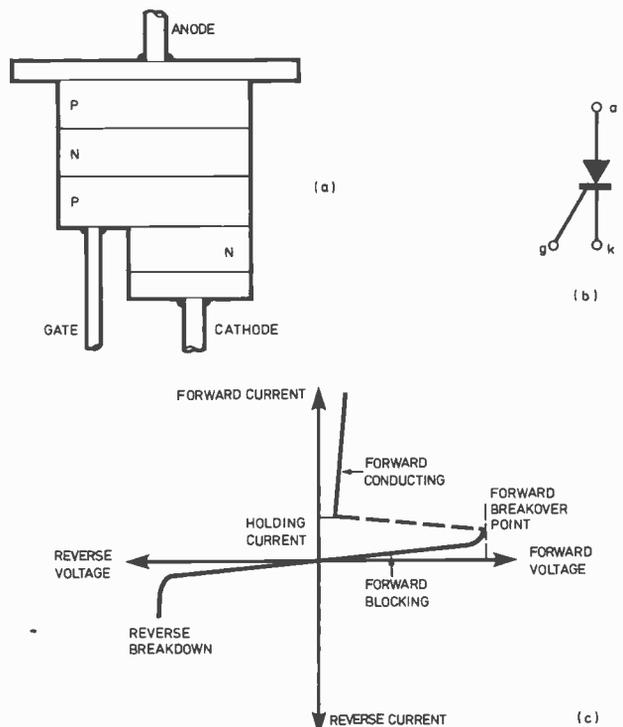


Fig. 3.1(a). Thyristor structure (b) symbol (c) characteristic

The thyristor can be triggered into a forward conducting state by applying a short pulse of relatively low power at the gate. Once switched on it will pass large values of current, limited only by the external load, with only a small voltage dropped between anode and cathode. Only a few milliwatts of gate power are required to switch hundreds of watts in the anode circuit and it remains conducting even if the gate signal is removed.

It can only be turned off by reducing the anode current to just below the holding value, the specified minimum current that will ensure conduction. It is typically a few per cent of the maximum forward current.

In a.c. circuits the thyristor turns off every time the supply voltage passes through zero, but in d.c. circuits special techniques must be used to reduce the anode current and achieve turn off.

THE TRIAC

The triac is similar to two thyristors connected in reverse parallel (Fig. 3.2a) but with a common gate connection. This means that the device can pass or block current in both directions. It is triggered into conduction in either direction by positive or negative gate signals. The symbol and operational characteristics are shown in Figs. 3.2b and c.

Both devices find their main application in power controllers. With an a.c. supply, power dissipation in the load can be made greater or smaller by controlling the time during the mains cycle at which the trigger pulse is applied to the gate. Triacs are used in full wave a.c. power control circuits in preference to two thyristors, because simpler heat sink and economical trigger circuits can be used.

FAILURES—THEIR CAUSES AND SYMPTOMS

As with most other electronic components, thyristors and triacs fail largely for thermal reasons. High temperatures in the relatively small volume, or a high rate of temperature cycling causes the device to slowly deteriorate and this ultimately leads to failure.

They can also be destroyed like fuses if the maximum ratings are exceeded, so don't expect them to withstand large overload surges. Make sure that an adequate heat sink is used.

Failure can also be caused by the rate of change of the anode current. At the instant of triggering, the gate current and also the anode current is constrained to flow in a small area. If the rate of rise of anode current exceeds a critical value the heat generated in this small area may be too large and the thyristor will fail. Normally the inductance of the load circuit limits the rate of rise to a safe value.

The faults that do occur in a thyristor are:

- Anode to cathode open circuit* — No current flow from anode to cathode.
- Anode to cathode short circuit* — Thyristor conducts in both forward and reverse directions. Measured voltage between anode and cathode will be zero.
- Gate to cathode open circuit* — Thyristor off and cannot be triggered into conduction. Measured gate signal will be high.
- Gate to cathode short circuit* — Thyristor off and cannot be triggered into conduction. Measured gate signal will be zero.

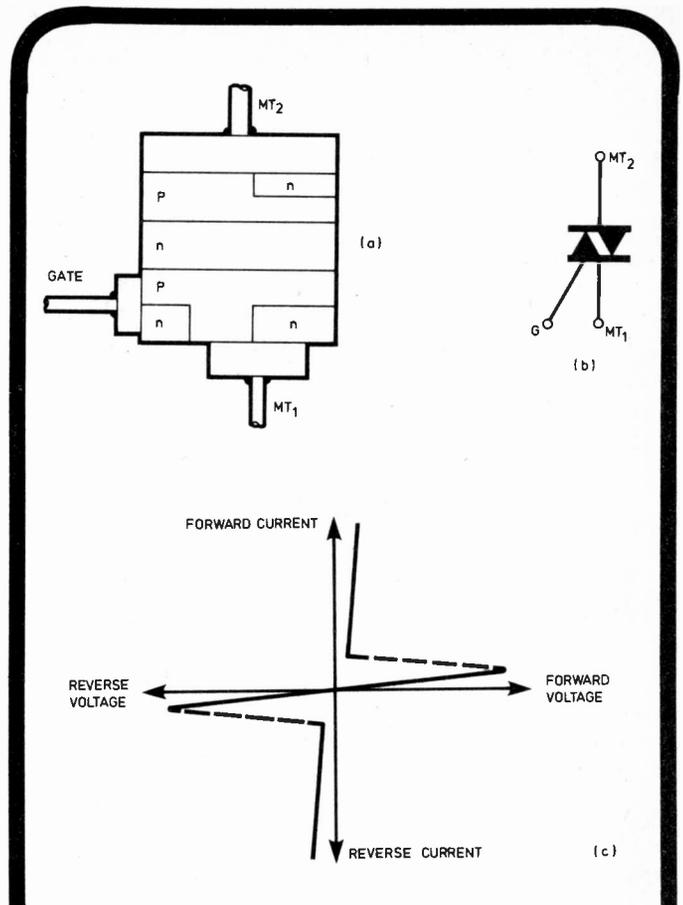


Fig. 3.2(a). Triac structure (b) symbol (c) characteristic

These are complete failures, but remember that partial failures such as poor gate sensitivity and low forward breakover voltage can also occur.

With some circuits it is possible to test the thyristor or triac while it remains in circuit. When switched on the voltage between anode and cathode should be approximately 1V and the voltage between gate and cathode about 0.7V.

With the power switched off you can measure for short circuit anode to cathode or for open or short gate to cathode with an ohmmeter. The gate cathode of a thyristor has similar characteristics to a diode. A low resistance (typically a few hundred ohms) should be indicated with the gate +ve with respect to cathode and a high resistance (greater than 100k Ω) with the gate -ve with respect to cathode. But remember that other components in parallel with the gate circuit will affect the readings. If in doubt unsolder and lift the gate lead before making the measurement. Now let's move on to some fault diagnosis in typical circuits.

TRIAC LAMP DIMMER

A common circuit for a lamp dimmer is shown in Fig. 3.3 using a RS134 triac and a phase shifting network of R1, VR1 and C2. In fact VR1 and C2 act as a variable potential divider and variable phase shift network. This feeds an attenuated and phase shifted signal to a slave network R2, C3. When the voltage across C3 exceeds about 35 volts the diac D1 triggers to partially discharge C3 into the triac gate. This then conducts and power is applied to the lamp.

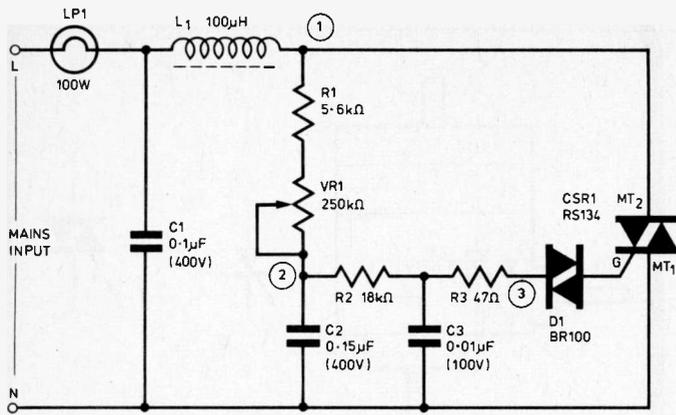


Fig. 3.3. Triac lamp dimmer circuit

The purpose of the slave network is to prevent any large change of voltage occurring across C2 when the diac triggers.

The conduction angle of the triac can be controlled up to nearly 170 degrees. This is when VR1 is set to near maximum value. Under these conditions very little power would be applied to the lamp and it would run at low brightness. Note that the triac switches off when the mains voltage goes through zero and is pulsed on in both the negative and positive half cycles of the mains.

L1 and C1 are filter components to prevent switching spikes being fed back from the triac into the mains supply.

FAULT CONDITIONS

Having looked at the way the unit works, let's consider some possible faults. Suppose that on switch on the lamp burned at maximum brightness and no control could be achieved with VR1. Without making any measurements we can see that the fault can be caused by only two components, either a short circuited triac (MT₂ to MT₁) or possibly C1 short. Lift one lead, say, MT₂, to determine which component is at fault. No other component fault could give these symptoms.

On the other hand if the lamp fails to light at all and assuming that we know the lamp is o.k. which components could cause this? In this case we are looking for an open circuit in components such as L1, R1, VR1, R2, R3, D1, and open junctions on the triac; either open gate to MT₁ or open circuit MT₁₋₂ to MT₂.

Another cause could be C2 or C3 short also. Measurements with a multirange meter (set to 250V a.c.) at the test points have to be made to narrow down the fault to one component. Suppose we obtain the following readings from the test points with respect to the neutral line:

Test point	1	2	3
A.c. voltage	235V	56V	43V

Lamp will not light.

These indicate that components L1, R1, VR1, C2, R2, C3 and R3 are o.k. and that the fault can only be an open circuit diac or an open circuit gate connection on the triac.

Which component fault would give the following symptoms?

(Answers are given at the end)

Test point	1	2	3
A.c. voltage	235V	0V	0V

Lamp will not light.

Test point	1	2	3
A.c. voltage	235V	53V	32V

Lamp will not light.

Test point	1	2	3
A.c. voltage	0V	0V	0V

Lamp will not light.

Test point	1	2	3
A.c. voltage	235V	36V	32V

Lamp very dim. No light increase can be obtained by varying VR1.

Finally what would be the symptoms for these conditions?

(e) R2 open circuit.

(f) C2 open circuit.

THYRISTOR LAMP FLASHER

This circuit is of a lamp flasher unit, the flashing of a lamp commencing if the ambient light falls below a selected level.

At first glance the circuit may look a little complicated, but if it is split up into sections the operation is more easily understood. A light dependent resistor (ORP12) is used to sense the ambient light level and the changes in resistance are detected by TR1 (Fig. 3.4). With sufficient light the l.d.r. has a fairly low resistance and TR1 is therefore forward biased with a low collector voltage so that D1 is reverse biased. C1 cannot charge and no pulses occur at R5.

If the light level falls, the resistance of the l.d.r. rises and TR1 turns off. D1 then conducts and C1 charges via R3. When the voltage across C1 exceeds the trigger point of TR3 the u.j.t. conducts and rapidly discharges C1 through R5 to give a positive pulse on b₁. This pulse is fed through C2, R6 to trigger on CSR2 and so the bulb lights. The anode voltage of this falls to about 1V and forward biases TR2. C1 is now charged via R3 and TR2 and the u.j.t. triggers again to give another pulse. CSR2 is already on so the pulse switches on CSR1 causing its anode voltage to fall sharply. C3 couples this negative step to CSR2 anode which reverse biases it and therefore turns it off, and the lamp goes out. Note that R7 is 10kΩ, a value that maintains the current through CSR1 below the holding current value so that it turns off automatically.

While the light level is low the lamp will flash at a rate determined primarily by R3 and C1 about 2 flashes per second.

Now we can consider some fault conditions.

FAULT CONDITIONS

Suppose we had the following fault conditions. With bright light falling on the l.d.r. as soon as the unit is

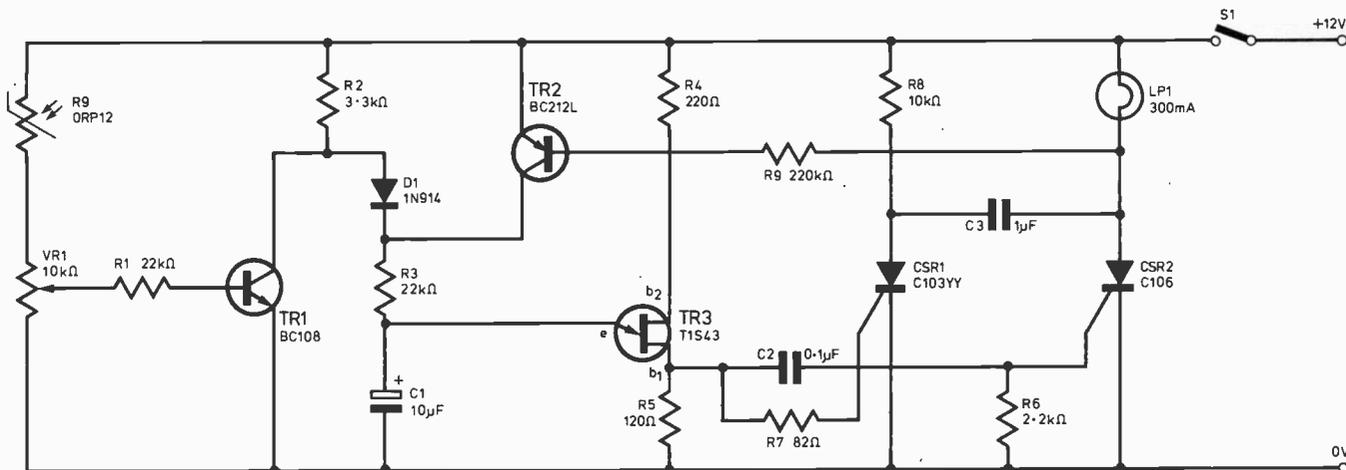


Fig. 3.4. Thyristor lamp flasher circuit

switched on the lamp lights and remains on without flashing. Before reaching for the meter we should study these symptoms because they are the guide to the faulty component. Unless we have a number of simultaneous faults the failure can only be caused by one component. You've probably worked out already that it is an anode to cathode short on CSR2.

If on the other hand we had the symptoms that the lamp would light when the l.d.r. was obscured but then remained on without flashing, we have the possibility of a failure in CSR1 and its associated components, R7, R8 and C3. An open circuit in any one of these would give these symptoms.

You can see that with this type of unit fault diagnosis is helped a lot by the visual indication given by the lamp. It's quite a simple matter to check bulb operation too by just shorting the anode to cathode of CSR2. Also a quick check can be made on each thyristor by momentarily connecting a 2.2kΩ resistor from gate to +12V.

Can you work out the symptoms for the following?

- (1) C3 short circuit.
- (2) TR1 base emitter short.
- (3) CSR2 gate to cathode short.

- (4) TR2 collector base short.
- (5) CSR1 anode to cathode short.

ANSWERS

Lamp dimmer faults:

- (a) R1 or VR1 open circuit or possibly C2 short.
- (b) Gate to MT₁ on triac short.
- (c) L1 open circuit.
- (d) VR1 wiper open circuit.

- (e) With R2 open
Lamp not on

Test Point	1	2	3
A.C.	235V	75V	0V

- (f) With C2 open the control over the lamp's brightness will become very limited. The lamp will burn at high brightness with VR1 at minimum but will only reduce slightly in intensity with VR1 at maximum.

Thyristor circuit:

- (1) C3 short circuit.
Assuming power is applied while ambient light is high then the lamp will be off. When the light level falls the lamp will be lit and will remain on.
- (2) TR1 base-emitter short.
Lamp will flash on and off irrespective of ambient light conditions.
- (3) CSR2 gate to cathode short.
Lamp will not light at all.
- (4) TR2 collector base short.
C1 will slowly charge via R9. So the lamp will flash at a very low rate even when ambient light conditions are high.
- (5) CSR1 anode to cathode short.
As soon as light level falls lamps will come on and remain on.

POINTS ARISING

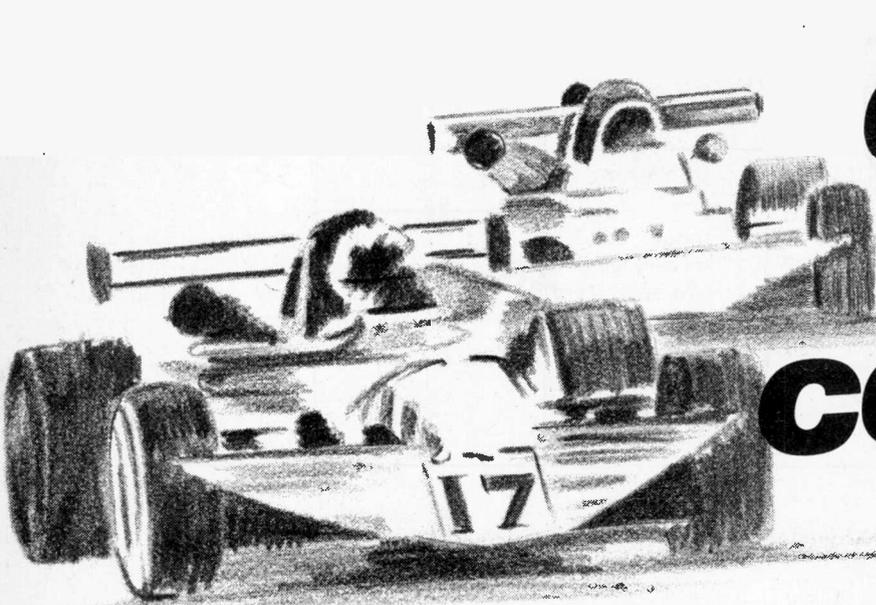
P.E. CHAMP (December 1977)

The use of wiring pens on the CHAMP board should be restricted to small signal connections and not supply lines. Pen wire may have maximum current ratings of as little as 30mA, thus introducing resistance which can cause poor localised supply regulation due to switching transients.

CAR BURGLAR ALARM (December 1977)

It seems that constructors are experiencing considerable difficulty in procuring the capacitors C1 and C4 (150μF/15V tantalum). They are, however, available from the Radio Resistor Co. Ltd., of Hitchin, Herts, part number SD-15-157K.

Next month: Fault finding i.c. circuits



digital LAP counter

S. MORGAN

THIS circuit is a very useful addition to any model car racing layout and has several advantages over the mechanical lap counter.

The mechanical counter is prone to either jamming or not working at all, whereas this digital method of recording the number of laps completed is not only reliable but has the added advantage that it can be cheaply constructed: the only two critical components are IC1 and IC2.

The number of laps can be preset so that after the winning car has crossed the finishing line the power to the track is automatically cut off.

THE CIRCUIT

The circuit diagram is shown in Fig. 1 and consists of an SN7490 binary counter and an SN7448 b.c.d. to 7 segment display decoder. The pulses for the 7490 counter are generated by a Light Dependent Resistor (R1) and lamp arrangement either side of the track. The lamp is set to shine directly onto the l.d.r., and whenever a car passes

between the lamp and the l.d.r. a pulse is sent to the counter. On receiving a pulse, the counter will count one, and on each subsequent lap it will add one more up to a maximum of nine, after which it will reset to zero.

When the automatic power shut-off is used, the preset number of laps can be set to either one, two, four or eight by means of S2. If S2 is set to position 5, the base of TR1 is connected to ground permanently so that the circuit will not turn off the power but just count the laps, resetting each time at nine.

When S2 is set to either one, two, four or eight laps it connects one of the four outputs from the 7490 to the base of TR1. If, for example, output C of the counter is connected to the base of TR1 it will count up to four and then the output C of 7490 will go high, turning on TR1 and consequently the relay, which in turn interrupts the power supplied to the track via its normally closed contacts (RLA1).

When the reset button is depressed the counter is automatically reset to zero.

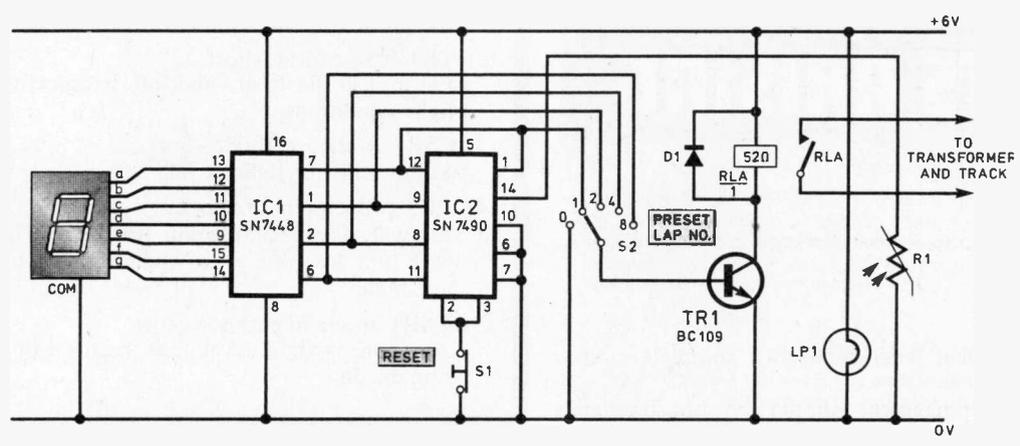


Fig. 1. Circuit diagram of the Digital Lap Counter

CONSTRUCTION

In the prototype the relay was mounted on the Veroboard, and a hole drilled through the relay case to take a fixing screw. The relay was then used to hold the Veroboard in position on the front panel; brackets could, however, be used. The i.c.'s were soldered directly onto the board but holders could be used if preferred. The Veroboard layout shown in Fig. 2 is slightly more expanded than that used in the prototype, and this is to make the wiring between the i.c.'s less congested. Hence the position of S2 must be altered to allow for the longer board.

The seven segment display used was of a sub-miniature type, but as this type does not now seem readily available,

one of the more common ones is specified. A suitable fixing arrangement is shown in Fig. 3 for this seven segment display. The Veroboard should be assembled first, the relay quoted can be directly mounted to the board without the need for a relay holder.

ALTERNATIVE HOUSING

If the unit is to be mounted in a case, the front panel should be drilled and cut so that the two switches and seven segment display can be mounted. R1 was fitted on two spare terminals of switch S2. It may be necessary to cover R1 with a piece of plastics tube in order to protect it from ambient light; a hole must be drilled in the side of the case for R1.

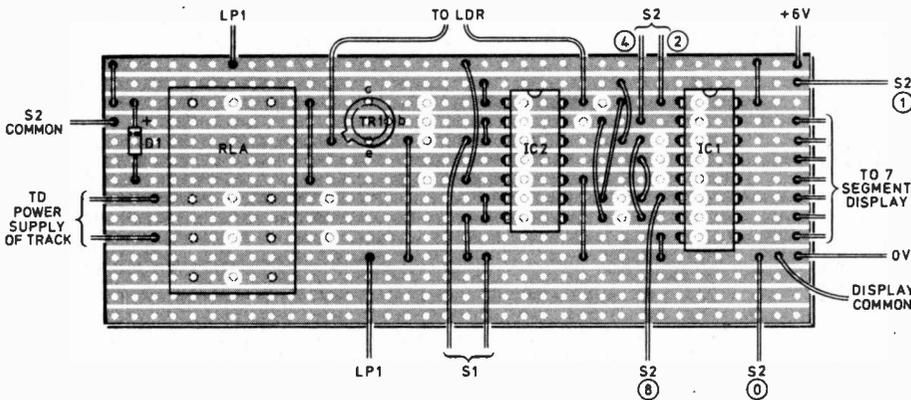


Fig. 2. Component layout and wiring of the lap counter

COMPONENTS . . .

Semiconductors

D1 IN4001 IC1 SN7448
TR1 BC109 IC2 SN7490
X1 DL707

Resistors

R1 ORP12 (l.d.r.)

Miscellaneous

LP1 M.E.S. Battenholder with 6V filament
RLA Sub-min 6V 2 pole 52Ω (Maplin)
B1 6V lantern battery
S1 Push button switch (normally closed)
S2 Single pole 5 way switch
Veroboard, 0.1" matrix, sockets for IC's (if req), aluminium case (see text).

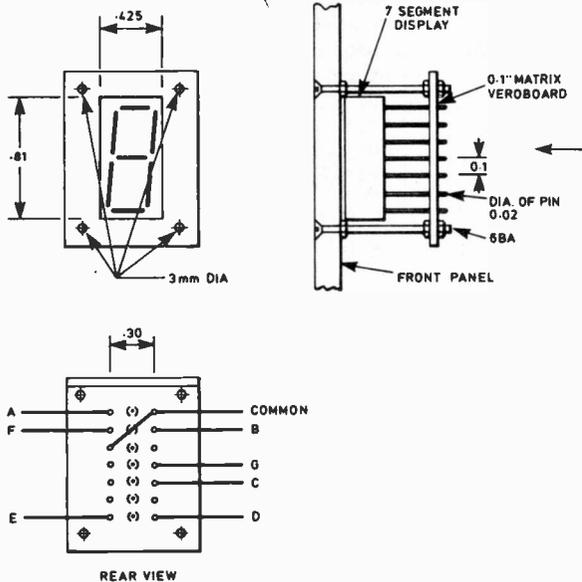
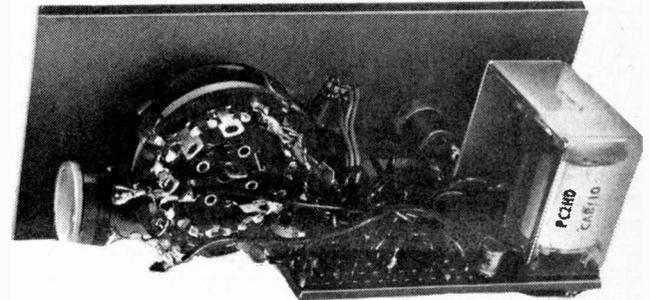
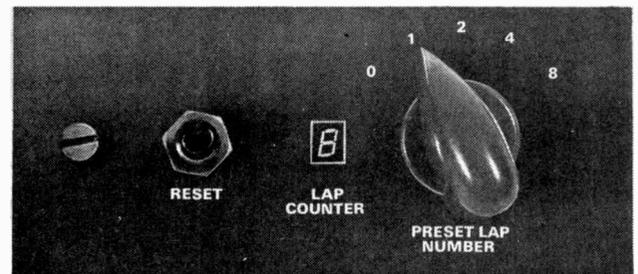


Fig. 3. Fixing arrangement for the seven segment display



Rear view of the chassis



Front panel marking

INSTALLATION

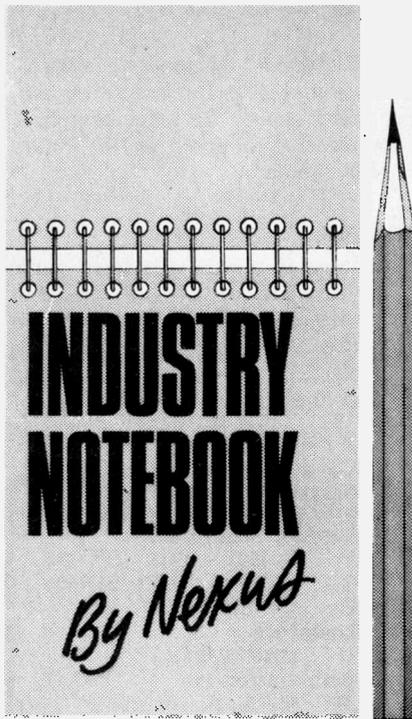
For the normal dual lane layout two complete circuits will be required.

The R1/lamp arrangement should be approximately one car's length behind the start/finish line because the completed lap is not recorded until the car actually passes completely through it.

POWER SUPPLY

The circuit can be supplied using a 6V lantern battery but the current drain is quite high (approximately 100mA) according to the type of relay used.

If preferred a power supply unit could be constructed using one of the many designs that have been previously published. ★



NEW BROOM

A prime minister's or a president's first hundred days in office are crucial. This is the period when the leader establishes style and example. There is a parallel in large commercial enterprises and Sir William Barlow, chairman of the Post Office, has just completed his first hundred days as leader of Britain's largest business.

Sir William arrived on the scene with a lot of old-fashioned virtues. So out-moded that they appeared almost revolutionary. Concepts like improved customer service and keeping prices down. He said: "Let us look at what we can give, not take away." He has views on aggressive marketing, on expansion of the services. He wants to run the Post Office for the benefit and convenience of the customer rather than for the Post Office, though it, too, will gain in the end because value for money always expands trade. In fact, quite like old times.

We must hope, too, that Sir William will devote some of his time to procurement policies and avoid such shambles as last year's mass cut-backs in orders to the telecommunications manufacturing industry which caused such chaos and real distress, the repercussions of which are still being felt today.

Sir William Barlow deserves every success.

STILL GOING WEST

The livelier European enterprises are still looking to the United States as the best market for expansion and have recognised that the quickest way

in is through acquisition. Latest British buy in the USA is Carterphone of Dallas, Texas, acquired by Cable & Wireless for £9.3 million. Carterphone rents, leases, sells and services data communications terminals through 40 branches throughout the nation.

Apart from the USA being the biggest individual market for electronics equipment in the world, the most significant business reason for investing there is political stability. As a C & W official points out, "— political risks are low." The disadvantage is that the USA is also the most competitive market in the world so you have to be smarter and work harder for every dollar earned. But with a market twice the size of the whole of Europe, even quite a small penetration can mean very big business by UK or European standards.

AVIONICS BOOST

British avionics companies have had a strong injection of orders for updates and new equipment. Nimrod maritime reconnaissance aircraft are now being progressively withdrawn from service for installation of improved sensor, navigational and tactical systems. A new tactical computer on the aircraft will process information from sonobuoys more than 50 times faster than on existing equipment. The new computer-assisted Searchwater radar can spot even smaller targets at greater range, and a new inertial navigation system will improve precision. Communications improvements include teleprinters with on-line encryption. The update programme is intended to meet all envisaged submarine threats through to the 1990s.

A parallel production line is being established for converting some of the Nimrods to the airborne early warning role, itself a multi-million pound programme. More than 100 avionic units are being developed for the communications system alone and the programme is providing 2,000 jobs for the main contractor (Marconi) and the subcontractors.

Plessey and Marconi also have huge contracts running for updating over 30 types of RAF aircraft with v.h.f. and u.h.f. radio equipment. The programme is said to be worth £10 million and involves building and fitting 2,000 sets of equipment. The technical requirement is to double the number of radio channels available from 360 to 720. This is achieved by reducing the channel spacing from 50kHz to 25kHz.

Ferranti have got the go-ahead for development of a new horizon gyro for the air defence variant of the Tornado (MRCA). Unusual feature is pitch and roll pick-offs feeding signals to the avionics systems.

Fly-by-wire, i.e. electrical control of aircraft which superseded push-pull

rods and mechanical cables and pulleys is now, in turn, being superseded by fly-by-light using optical fibres. Marconi-Elliott has five systems on trial in the US Boeing YC-14 STOL transport aircraft and expect orders for 300 more sets this year with a possible long-term sale of 3,000 sets. Optical fibre links have definitely arrived after years of experimentation and learning how to make the fibres and, equally important, how to connect them together. A trial installation over 100 yards long in the warship HMS Tiger has given over 6,500 hours service with no degradation in performance. American confidence in such systems is such that a fibre-optic data link between computers in the Cheyenne Mountain command post of the North American Air Defence System has been in operation since 1975, again with no failures reported.

HITACHI . . .

The Japanese company Hitachi has shelved but not cancelled plans for setting up a TV manufacturing plant in the UK. The news got a mixed reception, relief from UK manufacturers and frustration from those in favour of increased capital investment in the UK from whatever source.

. . . AND MULLARD

Meantime, Mullard is planning to invest another £4.5 million in the Southampton semiconductor plant to meet production demand for the upsurge in business expected from Teletext, Viewdata, digital tuning of TVs and TV games. The range of i.c.s and modules is based on technology drawn from the whole of the Philips Group including the US Signetics, based in Silicon Valley. Mullard currently claims 33 per cent of a UK market estimated at £12 million. By 1982 the market is expected to grow to £30 million with Mullard targeted on £18 million.

INDUSTRY NEWS

The bloom has faded from the medical scanner business. It was too much to hope that EMI's world lead could last forever. Now the going is much tougher, especially in the USA where domestic competition has increased. AB Electronics and Chloride have both been hit by strikes, now resolved but at great cost.

There are 108 distributors of electronics components in the UK in a recently published list. But according to some sources there are actually over 170 operating. Strange when you think that only a few years ago it was confidently predicted that the number, then approaching 100, would drop to three very large broad line distributors and half a dozen specialists.

Your

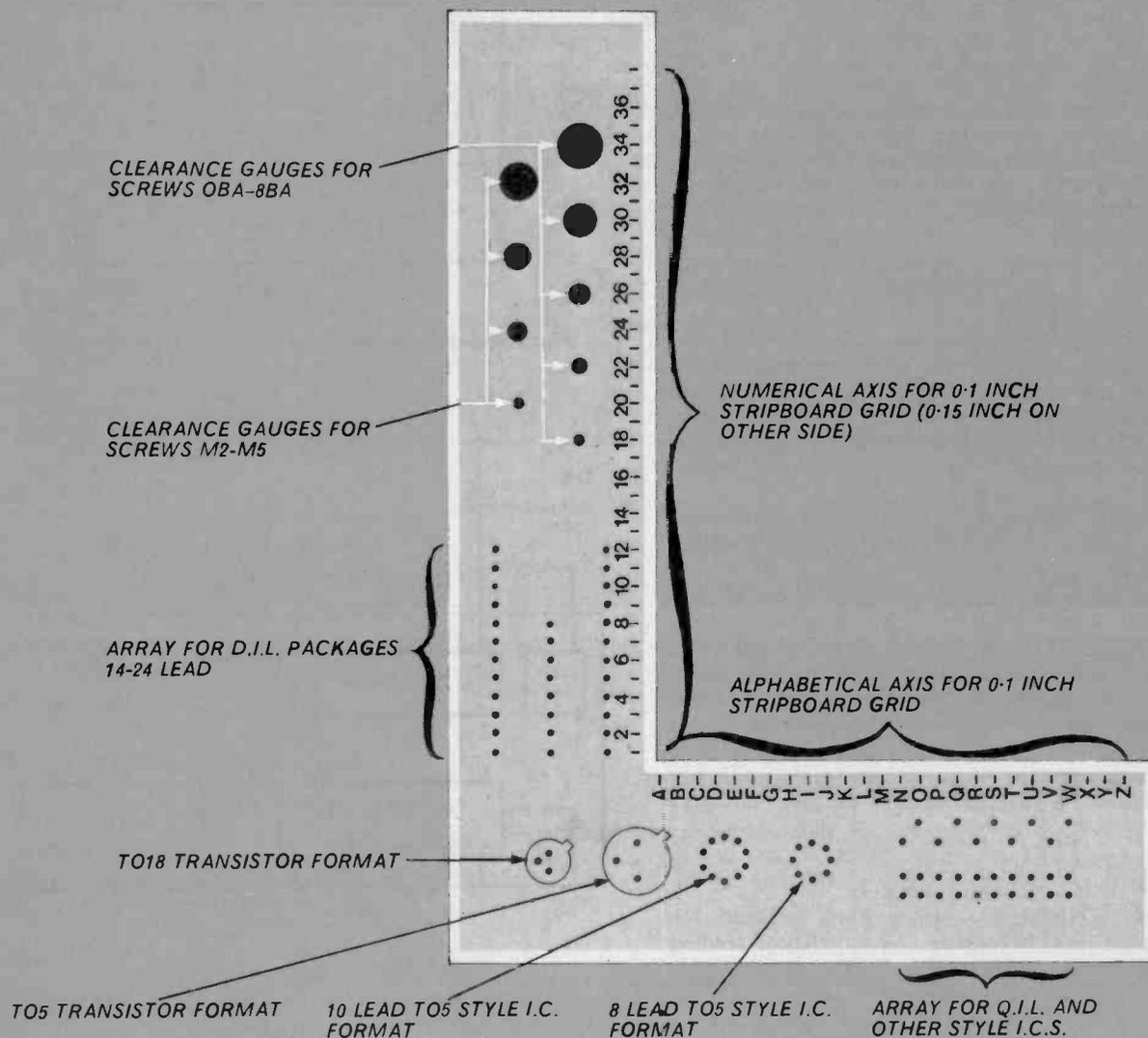
MATRIX MARKER

Explained

The Matrix Marker is a useful aid to the electronics constructor, and is marked on both sides to enable grid referencing of both 0.1 and 0.15 inch stripboard. By placing the marker against the corner of your stripboard, component and track cut positions can be identified instantly. The illustration below shows how the

Matrix Marker can be used for checking clearance drill and screw sizes for Metric and BA range screws. There are two ruled edges for inches and centimetres, and hole arrays to suit most i.c.s. and transistors. The first hole array is for up to 24 lead d.i.l. i.c.s., and the second array is for the quad in-line packages and

less usual ones often associated with audio i.c.s. Positions for 8 and 10 lead TO5 linear i.c.s., and TO5 and TO18 transistors are also included. These holes can be used for marking out copper clad board when making a p.c.b., or simply for aligning device pins prior to insertion. See below for Matrix Marker layout.



*A full charge
everytime with no
danger of overcharging*

NiCad BATTERY CHARGER

E.A.PARR B.Sc. C.Eng.

NiCAD battery chargers usually fall into one of two types. The first is the constant current charger, which charges the battery at a constant current for an indefinite period. The user has to note the state of charge of the battery by measuring the short circuit current and relating this to the charge required; note the start time and be back in time to take the battery off charge. In theory this works, in practice it does not. The author once maintained mobile radios on a steelworks and the battery chargers worked on this scheme. The number of batteries ruined by overcharging was surprising.

The second type of charger is the charge to a voltage type. In this type of charger the battery is charged until its terminal voltage rises to a set level. If the voltage is correctly set the battery cannot be ruined by overcharging. Unfortunately, the charge curve of a Nicad battery is very flat, see Fig. 1, and if the trip voltage is only slightly out you can end up with a 50 per cent charged battery or a battery ruined by overcharging. In addition, the trip voltage required will not be the same for all batteries, even those of the same nominal type.

The tendency is for people using this type of charger to set the trip voltage on the low side (for safety) and put up with partly charged batteries.

This article describes a charger which gives a fully charged battery every time, with no danger of overcharging. It uses the Ferranti ZN1034 timer to define the charging time, which in conjunction with a constant current, defines the charge put into the battery. To accept a battery in any state of charge, the battery is discharged before charging commences. This is perfectly alright since completely discharging a Nicad battery does no harm. The circuit will stand reversed battery or short circuited output.

TIMER CHIP

The Ferranti ZN1034 is a timer chip designed for long time applications. It consists of an oscillator feeding a twelve stage binary counter (Fig. 2). The control logic

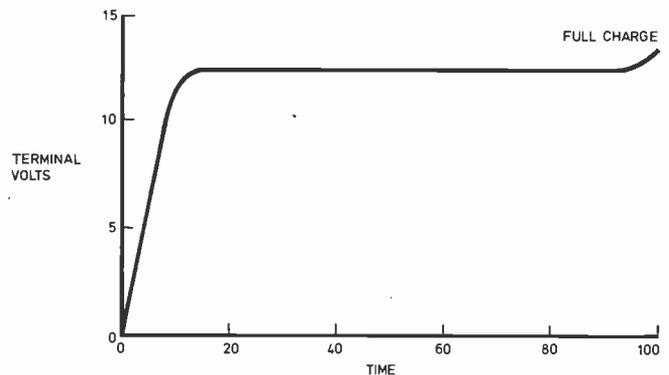


Fig. 1. Nicad battery charge curve at constant current

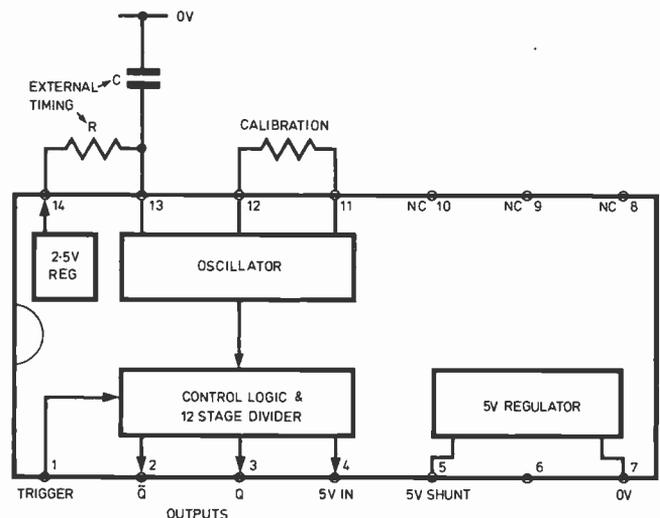


Fig. 2. Block diagram of ZN1034

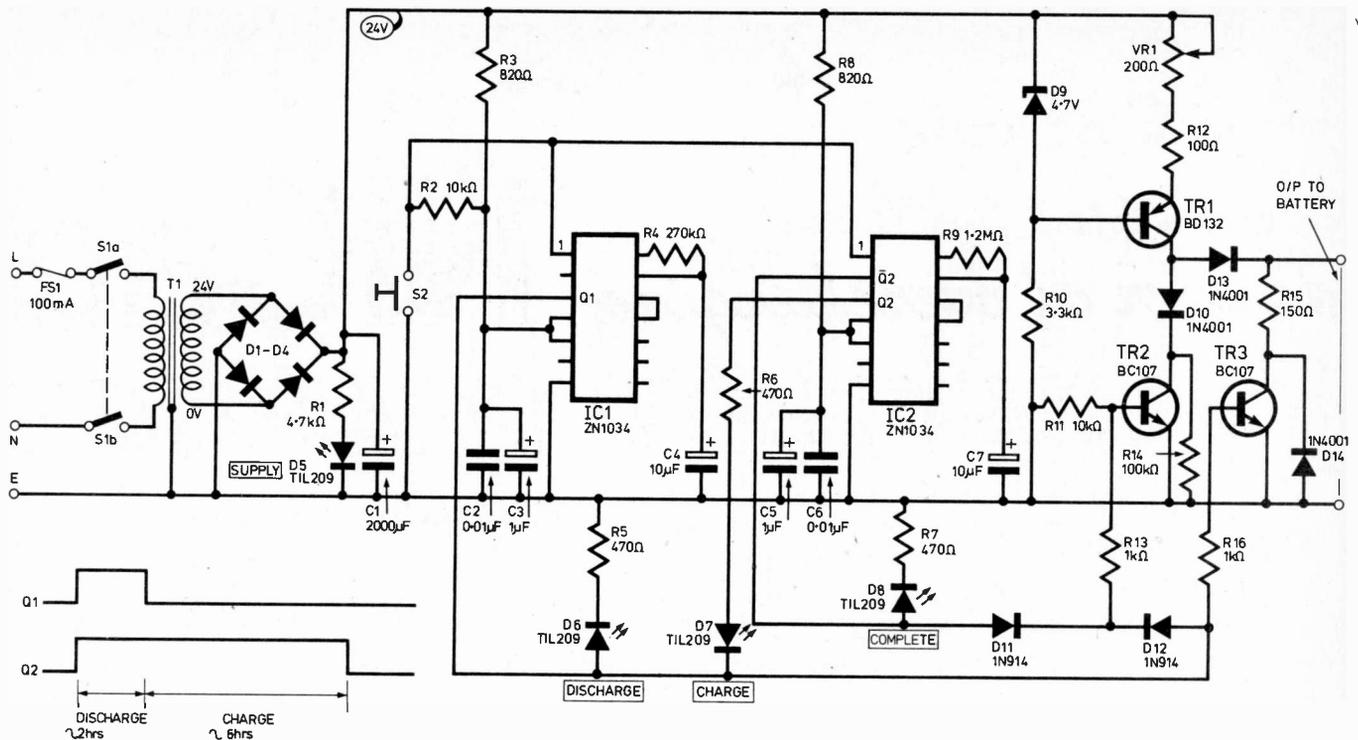


Fig. 3. Circuit of Nicad charger

times out after 4095 counts, giving a long period mono-stable with reasonable value components. The timed period is given by:

$$T = KRC \text{ seconds}$$

where K is a constant determined by an external resistor connected between pins 11 and 12. With pins 11 and 12 linked, $K = 2730$. With an external resistor connected between them, K increases up to $K = 7500$ for a resistance of 200 kilohms.

The ZN1034 has an internal 5V shunt regulator, allowing it to run off any voltage supply, with a suitable dropper resistor. True and complement outputs are available on pins 3 and 2 respectively and the device is triggered by 0V to pin 1.

CIRCUIT DESCRIPTION

The basic charger circuit diagram is shown on Fig. 3. IC1 controls the battery discharge, IC2 the battery charge. Both use their internal 5V regulators; R3 and R8 being the dropper resistors, decoupled by C3 and C2, C6 and C5.

IC1 is set for about 2 hours by R4, C4 and IC2 for about 8 hours by R9, C7. Both timers start together by S2, giving 2 hours discharge and 6 hours charge, a total of 8 hours.

Transistor TR1, Zener D9 and resistors R12, VR1 form a simple constant current source. This current can go to the battery, via D13, or be shunted to 0V by transistor TR2. TR3 is turned on by Q1 (IC1) or Q2 (IC2) via D11. The current is thus shunted during the discharge time and after the charging is complete.

TR3 discharges the battery by R15. This is simply turned on by Q1 output, hence the battery is discharged for the 2 hour period of IC1.

The charge period is thus the difference between the

periods of IC1 and IC2, nominally 6 hours. The charge/discharge cycle is summarised on the timing diagram in Fig. 3.

The operation is displayed by three l.e.d.s. D6 is driven direct off Q1 and hence indicates "Discharge". D7 is connected from Q2 to Q1 outputs and indicates "Charge". D8 is driven off Q2 and indicates "Cycle Complete".

The power supply is a simple unregulated 24V supply. The two i.c.s provide their own 5V rail from their internal regulators as described previously.

Resistor R14 and diodes D10, D14 provide protection against a reversed battery.

CONSTRUCTION AND USE

The prototype was built on Veroboard with the layout shown in Fig 4. Transistor TR1 has to dissipate about 1.5W in a reversed battery condition and should be mounted on a heat sink or onto the case. The unit was made to charge one battery, and fitted comfortably into an 8in x 5in box.

It is suggested that the circuit is first tested with R4 set at 5.6 kilohms and R9 at 6.8 kilohms to give three minutes discharge and one minute charge. Eight hours is a long time to wait to see if it all works.

A link somewhere in the battery leads where the charge/discharge currents can be monitored is also very useful.

Since the capacitors used have a tolerance of ± 20 per cent, it follows that the timed periods are not going to be exactly two hours and eight hours. There are two options, the aesthetically pleasing and the practical. In both cases it is essential that the capacity of the battery is known. The batteries used in the prototype were 225 mA/hr. In both cases, set up without the battery in, observing the l.e.d.s.

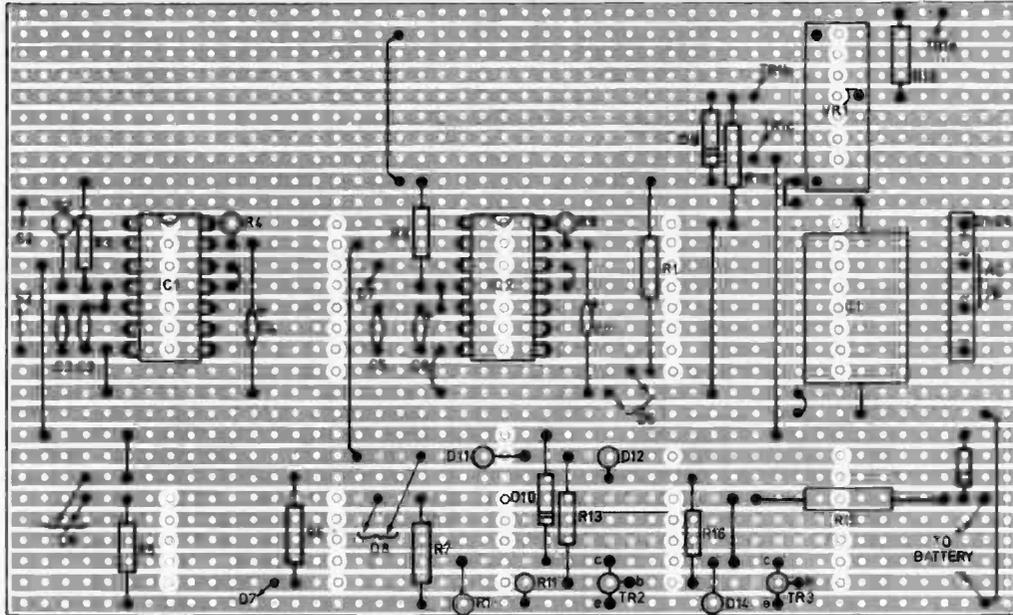


Fig. 4. Veroboard component layout and wiring diagram

The aesthetic first. The discharge and charge periods are made two hours and six hours exactly by calibration trim pots. The links between pins 11 and 12 on each i.c. are replaced by 200 kilohm trim pots, and R4 reduced to 180 kilohms and R9 to 820 kilohms.

Adjust the trim pots to set IC1 to two hours and IC2 to eight hours. If a scope with a high impedance probe is available, the oscillator period can be measured on pin 13 of each i.c. The total period is found by multiplying the period by 4095. The current is then set to the capacity divided by six.

The practical method is recommended, however. The discharge/charge times are measured, and the charging current changed to suit.

The prototype was found to have a discharge time of about 1.8 hours and a total time of about 8.6 hours. This gives a charge time of 6.8 hours. The charge current required, therefore, is $\text{capacity}/6.8$ ($225/6.8=33\text{mA}$) and the current set by VR1 accordingly.

In both cases the calibration should be checked if C4 or C7 is changed.

The eight hour cycle was chosen to give overnight charging. By doubling C4 and C7 a sixteen hour cycle can be made. The lower charging current would probably be better for battery life.

The sixteen hour cycle is suitable for equipment like mobile radios being used on a three shift system. The batteries spend two shifts on charge and one in use.

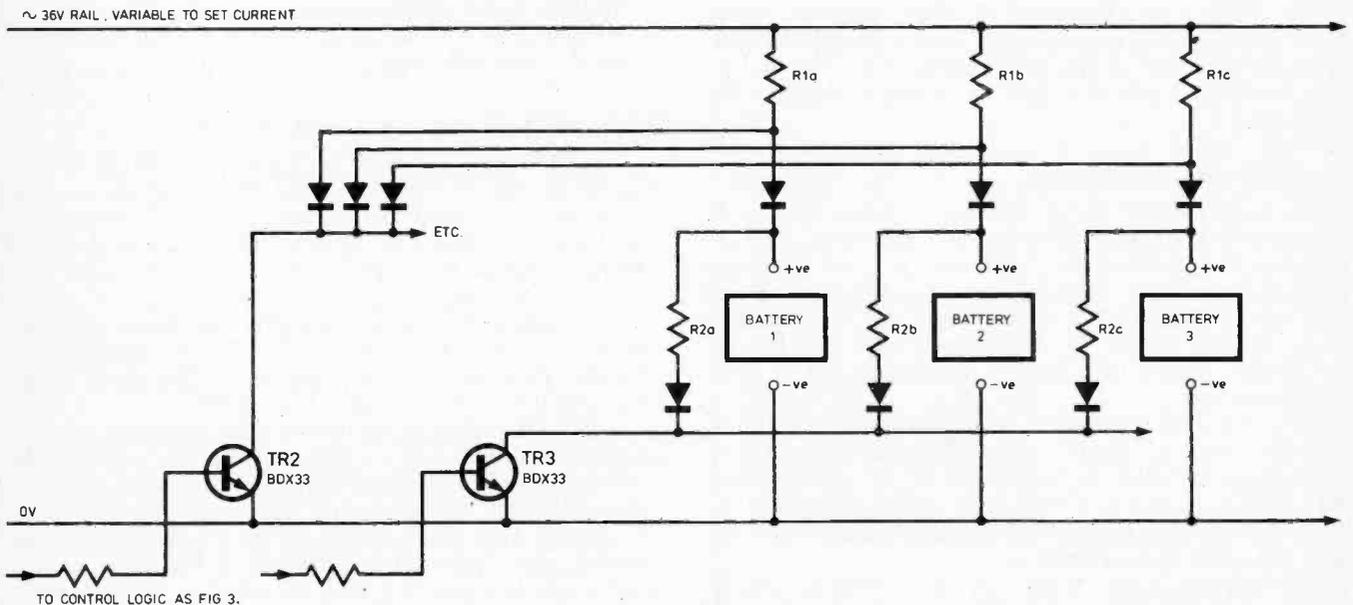


Fig. 5. Charging method for several batteries

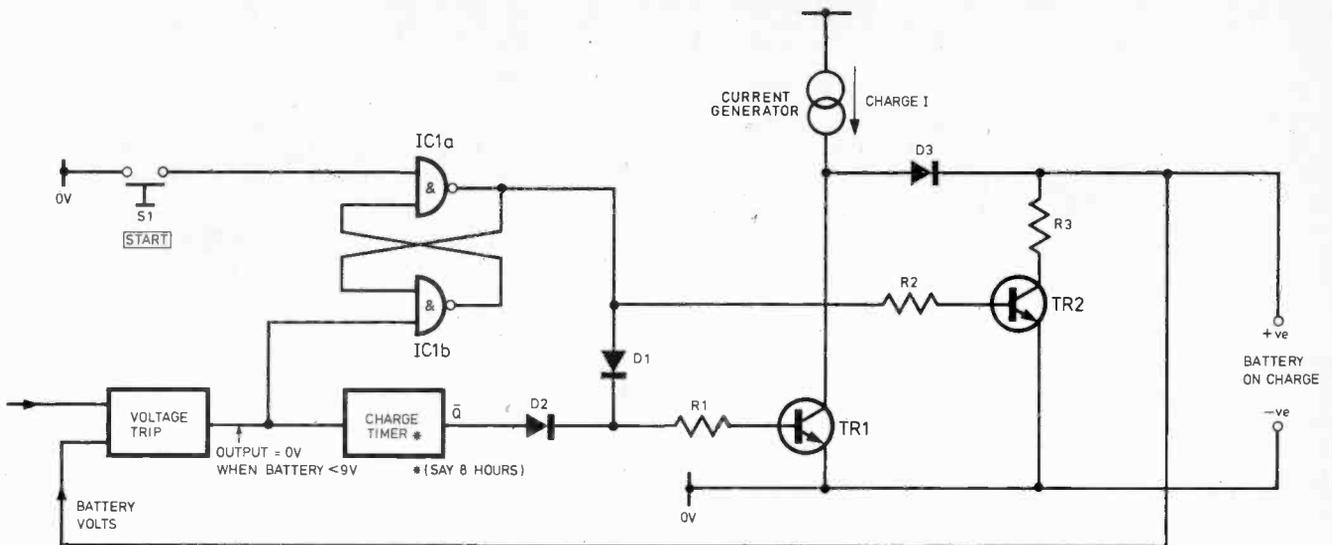


Fig. 6. Schematic for fully automatic charger

COMPONENTS . . .

Resistors

R1	4.7k Ω
R2	10k Ω
R3	820 Ω 1W
R4	270k Ω
R5-R7	470 Ω (3 off)
R8	820 Ω 1W
R9	1.2M Ω
R10	3.3k Ω
R11	10k Ω
R12	100 Ω
R13	1k Ω
R14	100k Ω
R15	150 Ω 2W

Potentiometer

VR1	200 Ω linear
-----	---------------------

Capacitors

C1	2000 μ F elect. 40V
C2	0.01 μ F ceramic
C3	1 μ F tantalum 6V
C4	10 μ F tantalum 6V
C5	1 μ F tantalum 6V
C6	0.01 μ F ceramic
C7	10 μ F tantalum 6V

Semiconductors

IC1-IC2	ZN1034 (2 off)
TR1	BD132
TR2-TR3	BC107 (2 off)
D1-D4	1A 50V Bridge Rectifier
D5-D8	T1L 209 i.e.d. (4 off)
D9	4.7V Zener 200mW
D10, D13, D14	1N4001 (3 off)
D11-D12	1N914 (2 off)

Switches

S1	Double-pole mains on/off switch
S2	Press switch

Transformer

T1	240V pri; 20V sec at 0.5A
----	---------------------------

VARIATIONS

The prototype was built to meet the author's requirement of a one battery overnight charge, with a battery of unknown charge state.

The control logic can be extended to charge several batteries at the same time by changing TR2 and TR3 as in Fig. 5.

For several batteries it is costly to provide a true constant current source for each, and a reasonable compromise would be to take the supply rail up to about 36V and utilise a single resistor (R1a-c).

This would approximate a constant current source over the voltage range and the battery would vary (12-14V).

With a 36V rail R3 and R8 should be increased to 1.8 kilohms with a 1W rating.

If it is certain that the batteries are already discharged, IC1 can be omitted, along with D12, R13, TR3, R15, etc.

D7 should be connected to 0V. Note that the battery charges for the whole period of IC2 now, and the period or the charging current should be adjusted to suit.

AUTOMATE

One further development that could be made is to automate the battery discharge along the lines of Fig. 6. The start button sets the memory IC1 which turns on the discharge transistor TR3, discharging the battery in the usual manner.

The battery terminal volts are measured by a voltage trip circuit. When the voltage goes below, say, 9V, the memory is reset and a charge timer, IC2, started to charge the now flat battery for the correct time.

This sets the discharge period correct for the battery, and shortens the whole cycle for the average, nearly discharged, battery.



NOMOGRAPHS for integrated circuit timers

E.A. PARR B.Sc.

THE integrated circuit timers that have become available in recent years have proved to be amongst the most useful devices for both the professional and the amateur electronics engineers. Unfortunately the choice of components for a desired result necessitates juggling with kilohms, megohms, microfarads and picofarads. It is very easy to end up with a period or frequency that is out by a factor of ten or a hundred.

The nomographs in this article were drawn up to make a selection of component values for all the common timers a quick and foolproof process.

555 MONOSTABLE

The nomographs for the 555 monostable are shown in Fig. 1. A line drawn between resistance, capacitance and

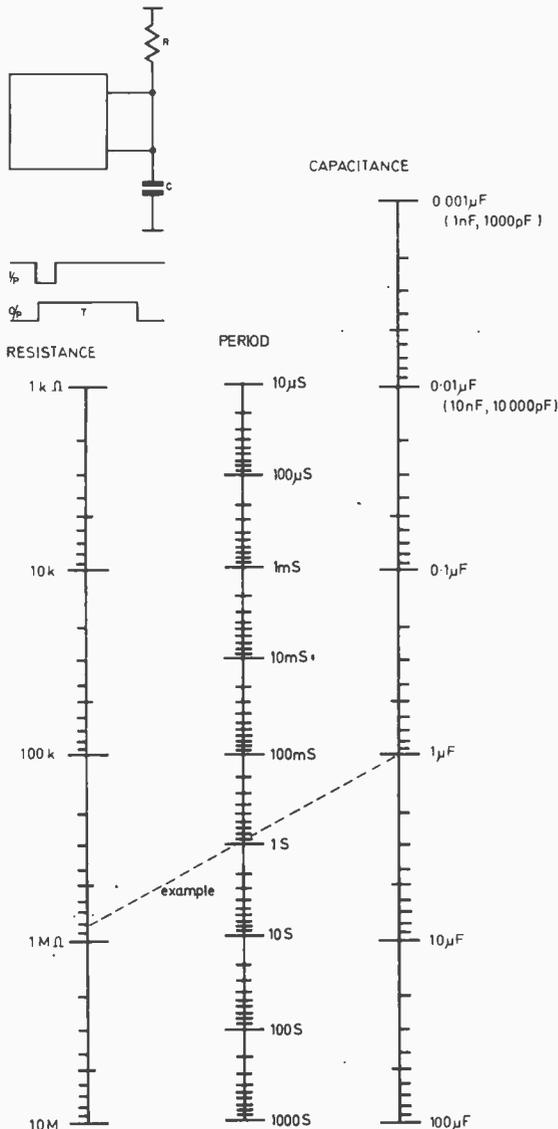


Fig. 1. Nomograph for the 555 monostable.

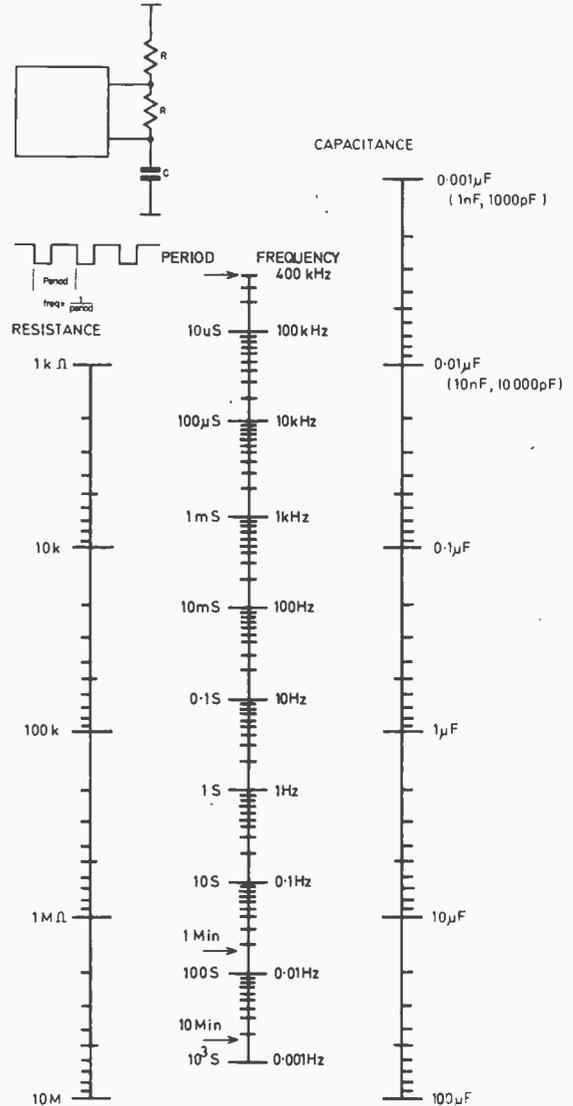


Fig. 2. Nomograph for the 555 astable (both resistors have value R).

time will give the third when two are known.

For example, suppose we have a $1\mu\text{F}$ capacitor and we want a one second period. The nomograph gives $800\text{k}\Omega$, so the nearest preferred value of $820\text{k}\Omega$ is chosen.

555 ASTABLE

There are three possible ways of using the 555 as an astable, making both timing resistors equal (giving 2:1 mark space), coupling pin 3 (output) to pins 2 and 6 with a timing resistor to give equal mark space or choosing different values for the two timing resistors to give a definite waveform. All are covered by the four 555 astable nomographs.

The simple case of both resistors equal is covered by Fig. 2. As can be seen, a typical result would be $50\text{k}\Omega$ and $0.1\mu\text{F}$ giving 100Hz .

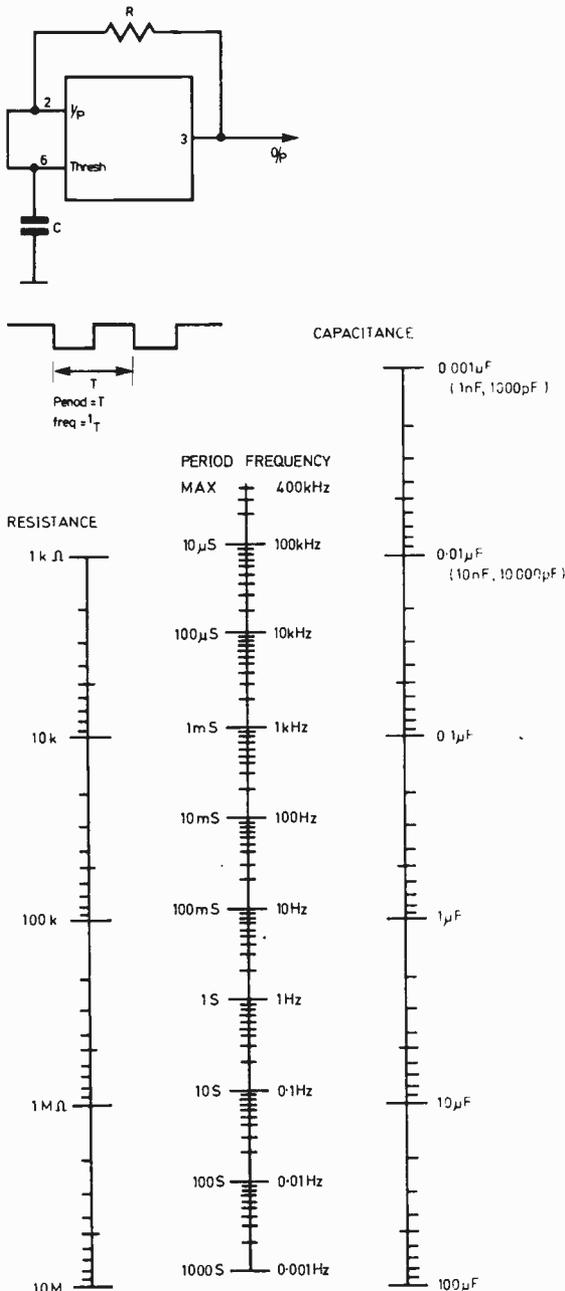


Fig. 3. Nomograph for equal mark/space 555 astable.

The equal mark space arrangement is shown by Fig. 3, a typical result being 1kHz ; approximately given by $4.7\text{k}\Omega$ and $0.15\mu\text{F}$.

To assemble a desired waveform use Figs. 4 and 5. The general equations for an astable are:

$$\text{Output high } T_a = 0.7(R_a + R_b) \times C$$

$$\text{Output low } T_b = 0.7R_b \times C$$

$$\text{Total period} = T_a + T_b = 0.7(R_a + 2R_b) \times C$$

A nomograph for R_b and C is given in Fig. 4 to select the output low time (which must be done first).

Given R_b and C , $(R_a + 2R_b)$ is now found from Fig. 5 for the desired period or frequency. Knowing R_b , R_a is easily found.

To demonstrate this, suppose we want a 0.1 second pulse occurring every second, then:

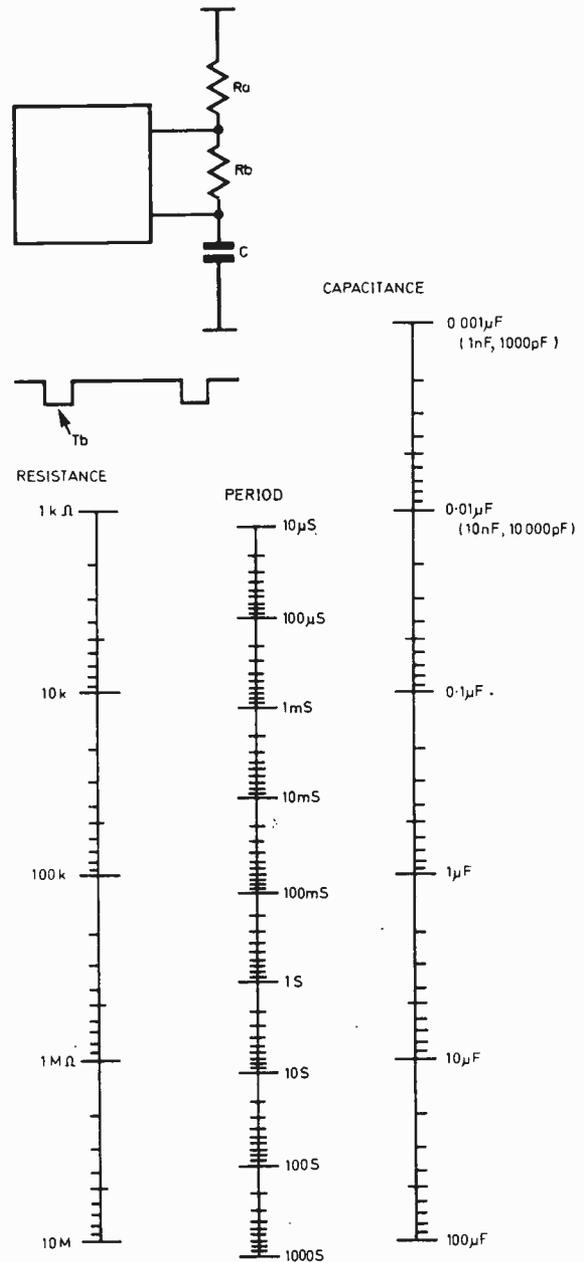


Fig. 4. 555 astable. Plot for selection of R_b to give output low time. Use in conjunction with Fig. 5 to give desired waveform.

$$T_a = 0.9S$$

$$T_b = 0.1S$$

$$T = 1S$$

frequency = 1Hz

First we select R_b and C using Fig. 4 to give 0.1 second. Typical values would be $33k\Omega$ and $4.7\mu F$ (to the nearest preferred values).

Now we use Fig. 5. We have C ($4.7\mu F$ from above) and the frequency is 1Hz. The nomograph gives ($R_a + 2R_b$) to be $280k\Omega$, hence R_a is $220k\Omega$ to the nearest preferred value. The values desired are thus $R_a = 230k\Omega$, $R_b = 33k\Omega$, $C = 4.7\mu F$.

ZN1034 TIMER

The ZN1034 is a very useful device for applications in

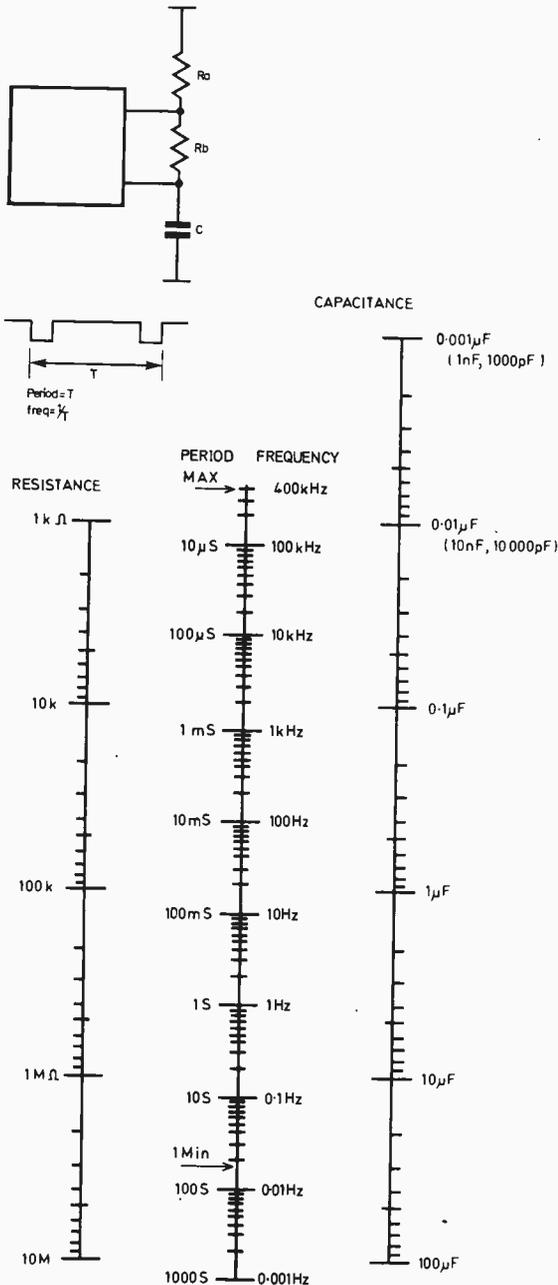


Fig. 5. Nomograph for 555 astable, plotted for $R_a + 2R_b$.

long delay circuits. It has been described elsewhere, but for people not familiar with it, it consists of an oscillator and a 12 bit binary counter. This allows very long delays to be obtained with reasonable value components.

The device has the facility for trimming the period. This is done by connecting a resistor between pins 11 and 12. With pins 11 and 12 linked, the calibration resistor is $100k\Omega$. With a $200k\Omega$ resistor between pins 11 and 12 the calibration resistor is $300k\Omega$.

The timed period given by:

$$T = K \times R \times C$$

Where K is a multiplier dependent on the calibration resistor. For a calibration resistor of $100k\Omega$, the multiplier is 2,700. For a calibration resistor of $300k\Omega$, the multiplier is 7,500.

Two nomographs are shown: Fig. 6 has a multiplier of 2,700 and Fig. 7 has a multiplier of 7,500. Between

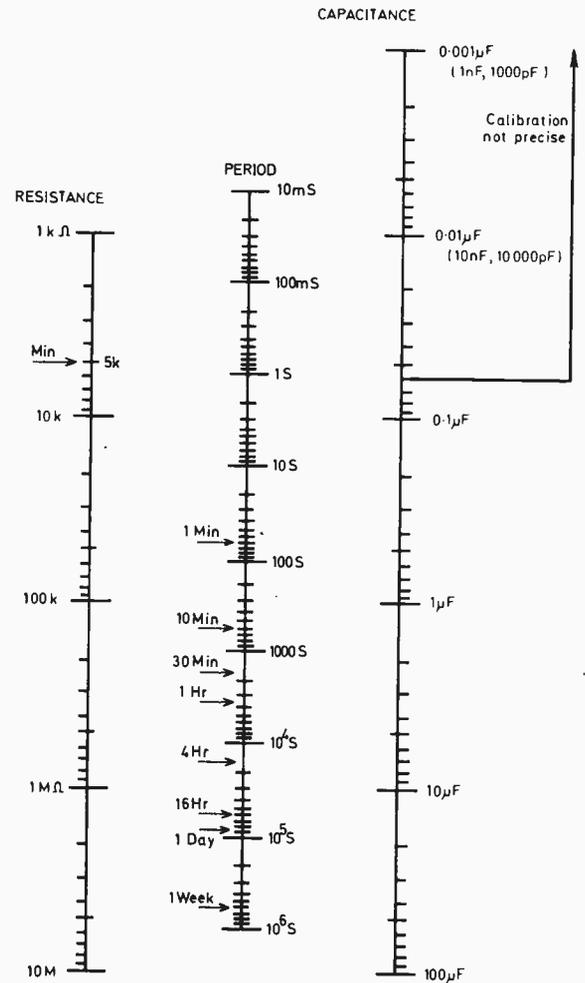


Fig. 6. Nomograph for ZN1034 timer. Pins 11 and 12 linked (internal calibration $100k\Omega$). Multiplier $K = 2,700$.

them the two nomographs show the limits attainable with a $250k\Omega$ potentiometer between pins 11 and 12. Note the small value components to give a specific value compared with the 555 monostable.

If it is desired to get a specific value choose a time $2/3$ of the desired time and use Fig. 6. The desired time can then be trimmed with the $250k\Omega$ pot between pins 11 and 12.

For example, assume we want one minute. We choose values for 40 seconds on Fig. 6. A typical choice would be $1\mu F$ and $15k\Omega$. Fig. 7 confirms the maximum attainable with this combination is 100 seconds. The desired value of 60 seconds is around the middle of the range and can be accurately set with the $250k\Omega$ pot.

Note that the calibration is not precise for values of C below $0.068\mu F$. Times up to 20 per cent away from the calculated value may be expected.

TTL MONOSTABLES

The nomographs Figs. 8 and 9 cover the 74121, 74122, 74123 and 96000 series monostables. The operation of these is similar to the 555 monostable.

In general TTL monostables are best suited to times below one second, above this it is probably easier to use the 555. For very short periods the stray capacitance will probably increase the calculated time.

GENERAL OBSERVATIONS

The accuracy of capacitors, particularly electrolytics, is not good, so do not be surprised if there is a difference between calculated and observed values. The nomographs have an accuracy of about 10 per cent which is better than most electrolytics.

Electrolytics also have a characteristic of exhibiting a

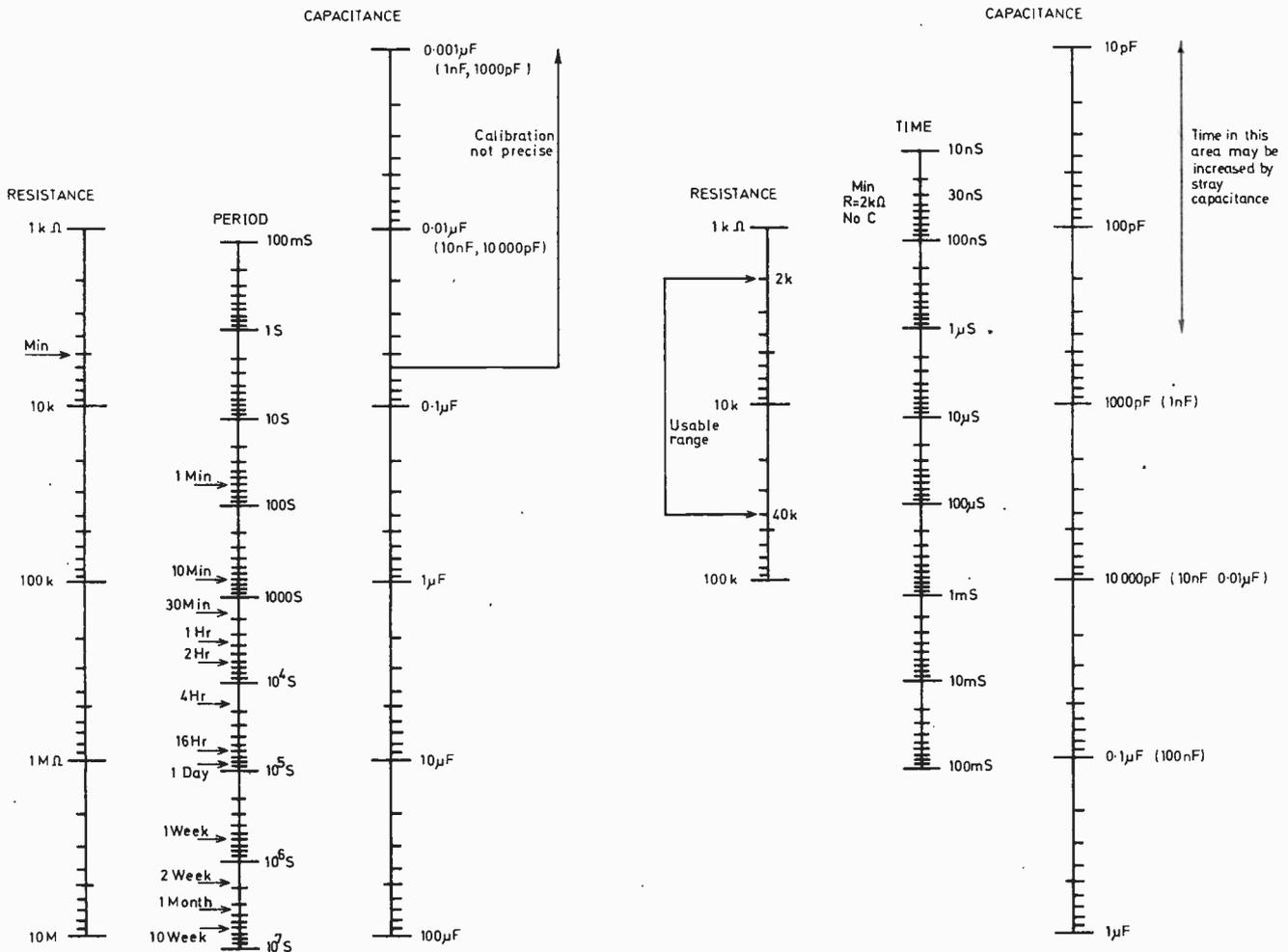


Fig. 7. Nomograph for ZN1034 timer with $200k\Omega$ between pins 11 and 12 (calibration $300k\Omega$). Multiplier $K = 7,500$.

Fig. 8. Nomograph for 74121 monostable. N.B. Capacitors up to $10\mu F$ allowed. For $1\mu F$ to $10\mu F$ use 0.1 to $1\mu F$ part of capacitor scale and multiply time by ten. For times above $100mS$, divide time by ten, and multiply capacitance found by ten, e.g. $25mS$: $25mS$ gives $0.8\mu F$ with $39k\Omega$, therefore $8\mu F$ with $39k\Omega$ will give $250mS$.

low value until about 10 per cent of their working voltage. If a 100V electrolytic was used in a 12V circuit, the observed times could be different from the calculated times by a factor of four. For best results the circuit volts should be only just below the working voltage of the timing capacitor.

For use in an electrically noisy environment, it is always preferable to use a large C and small R rather than vice versa. This is not, however, the cheapest way to give a specific time. The cheapest way is to use a small C and large R . For small values of C , however, remember that stray capacitance will increase the observed period. ★

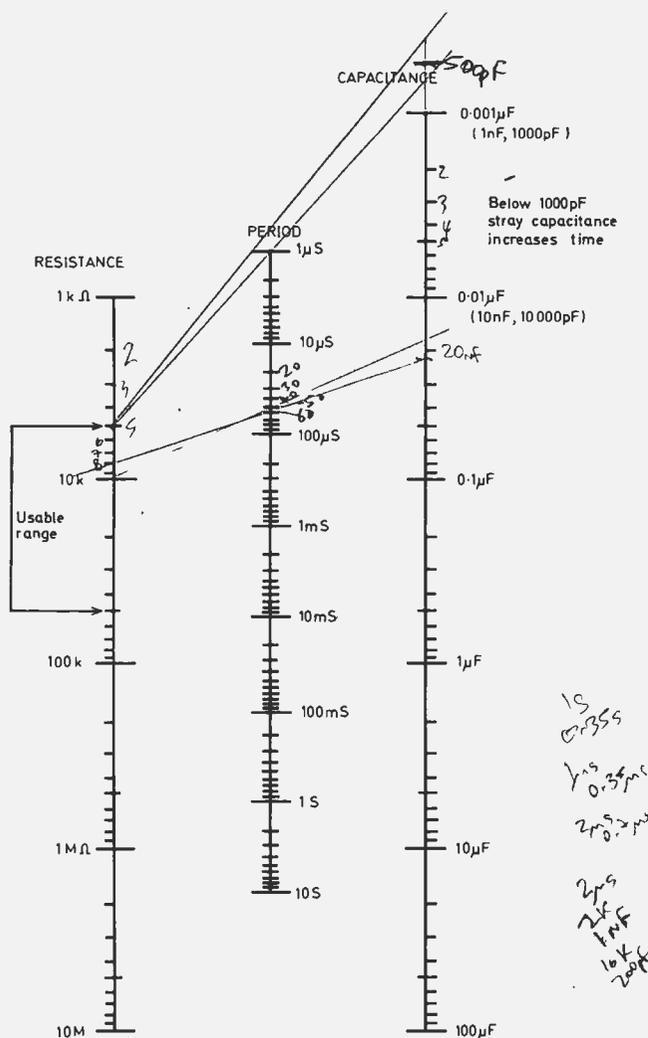


Fig. 9. Nomograph for 74122/3 monostables. Use also for 9600 monostables.

NEWS BRIEFS

Interference Between Systems

AS A result of the increase in electronic systems of all types in recent years, there is a greater possibility of interference between systems if proper precautions are not taken. An example of what can occur in the absence of such precautions was a ship's officer who could tune his radio telephone to a certain frequency, press the transmit button only to find that it provoked a sudden change in the ship's course. This potentially hazardous case highlights the problems of non-compatibility between separate but adjacent electronic systems, concerned respectively with communications and control.

The problems of preventing or controlling the generation of interference signals and the reduction of the sensitivity of equipment to interference between and within systems is the main theme of the conference on Electromagnetic Compatibility which is being organised by the Institute of Electronics and Radio Engineers at the University of Surrey, Guildford, in April.

Spring Hi Fi Show

THE 1978 International Spring High Fidelity Exhibition is to be staged at the Cunard International Hotel, Hammersmith, London. This decision was the result of a policy change by the Heathrow Hotel Management to limit their operations to classic hotel functions rather than large exhibitions.

The previous four Spring Exhibitions were held at the Heathrow Hotel, but because the 1977 Autumn Show logistics worked successfully at the Cunard, it was considered possible to introduce smoothly the 1978 Spring Exhibition into the same venue.

The Exhibition will run from May 2 to May 6 (10 am to 8 pm), with the first three days open to trade only.

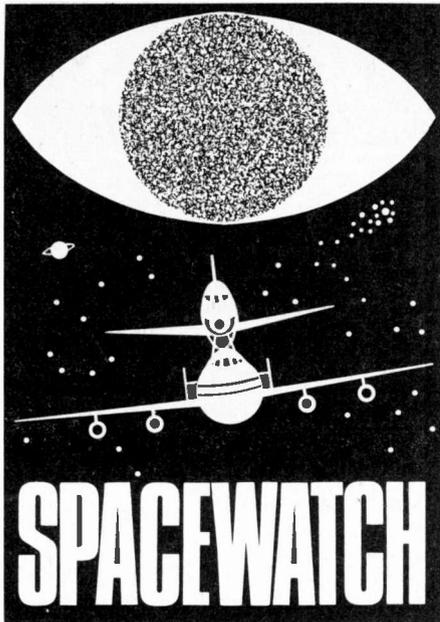
Microprocessor Courses

A MICROPROCESSOR consultancy and training company, Blesdale Computer Systems Ltd, regularly present two microprocessor courses. Both courses deal with the Motorola M6800 microprocessor. One is a five day introductory course costing over £200 and the other a ten day workshop course.

The introductory course assumes that the participants have little or no knowledge of computers and starting with the basic principles, the operation of a complete 6800 system is dealt with. There is also an introduction to the basic concepts associated with the programming of computers. This includes the aspect of defining the solutions to problems in the format of a flowchart. The rules regarding the design and development of good quality software are discussed. Course members are involved in the designing and writing of software solutions to set problems.

The ten day course is designed for people who have a basic knowledge of microprocessors and ideally who have attended the introductory five day course.

The objective of the course is to learn how to design and produce good quality, highly reliable microprocessor based systems. The participants have ample opportunity to get practical experience using Motorola development systems. They are also expected to design and build the software for one of several set problems, or design and produce the software for one of their own projects.



FRANK W. HYDE

TWO PIONEER SPACECRAFT TO VENUS

Two spacecraft will be launched to Venus this year. They are the Orbiter and a Multiprobe vehicle. The Orbiter will be launched in May and will be inserted in the planned orbit in December. The second vehicle will be launched in August and timed so that the probes enter the Venusian atmosphere five days after the arrival of the Orbiter. The probes will be launched from the Multiprobe vehicle 20 days before the rendezvous date. Each will have a different target point on the surface of Venus. There are four probes, one large and the others small.

The target areas are scattered so that one small probe will enter on the dark side of the planet high up to polar latitude and another just below the equator, also on the dark side. The large probe will land on the equator and the third small probe will land in the middle latitude below the equator, both on the sunlit side. The carrier vehicle, or 'bus', will enter the atmosphere of the planet at a low elevation, making measurements of the atmosphere by means of a spectrometer, before it burns up at an estimated height from the surface of 125 kilometres.

THE ORBITOR

The Orbiter mission is designed to cover the whole globe of the planet and map the atmosphere by remote sensing and radio occultation. The upper levels of the atmosphere will be directly measured as will the ionosphere and its reaction with the solar wind. The Orbiter will also study the planetary surface by remote sensing and radar mapping techniques. It is hoped that there will be

useful information on the surface craters and also perhaps an estimate of the global shape of the planet.

The Orbiter will be inserted in a highly inclined elliptical orbit. At its lowest point this orbit would bring the spacecraft 200 kilometres above the mid latitude. This would mean that the observations could go on for a period exceeding the Venusian day which is 247 Earth days. The spacecraft is about 250 centimetres in diameter and weighs 567 kilogrammes. It carries a payload of 43 kilogrammes. The launch trajectory will take the Orbiter more than 180 degrees round the solar system in eight months. With the apogee at a point some 60 thousand kilometres, perigee is at 200 kilometres. The spacecraft will make most of its measurements when at the perigee point. The useful time for data transmission will be about 1 hour each day.

THE MULTIPROBES

This spacecraft consists of the basic bus unit which has been modified to carry two scientific instruments and four probes. The whole assembly will be spin stabilised for the interplanetary flight and powered from solar cells. All trajectory movements and corrections will be made by the bus, as well as targeting the probes when they are launched. The four probes will be launched toward the planet 20 days before the target date.

The large probe and the small probes are each complete systems that provide the necessary subsystems to carry the instruments to the target. During this time communications links will be direct from the probes to the Earth based stations.

THE LARGE PROBE

The large probe is 145 centimetres in diameter and weighs about 291 kilogrammes. The data transmission will be at the rate of 256 bits per second. The instrument load is of the order of 28 kilogrammes. Like the small probes the front end is a heat shield of carbon phenol; it also serves to stabilise the vehicle aerodynamically when descending through the atmosphere of Venus with the parachute system.

The other probe subsystems, that is the data handling equipment, power, thermal protection, communications, are enclosed in the pressure vessel. The scientific payload is also inside the pressure vessel.

THE SMALL PROBES

Each of the three small probes are identical. They are 71 centimetres in diameter and weigh 86 kilogrammes. There are for each probe scientific instruments weighing 2.7 kilogrammes. Transmission of data is at the rate of 16 to 64 bits per second. The pressure vessel seals the instruments against the hostile atmosphere of Venus. Each probe has a conical shield of heat resistant

material at the forward end. No parachutes are used with these probes. The time of descent after entering the atmosphere is estimated to be about 70 minutes. During this period measurements will be made to give details of the winds and circulation patterns. The probes will not survive the impact. An instrument called the Nephelometer, developed by the Ames Research Centre, will measure the extent of the clouds, their density and altitude. A net flux radiometer will be included in the instruments in order to investigate the change of heat energy between the Sun and the atmosphere.

RADAR AND RADIO SYSTEMS

An interesting point about the communications on these vehicles is the fact that the communications equipment can be employed as a scientific instrument. This is accomplished by using the radio signals to assess the alterations in performance caused by the planet Venus and its atmosphere. As the radio signal passes through the atmosphere, the signal is changed and these changes can be measured. The type of change can reveal the characteristics of the atmosphere. The radio system will therefore be used to determine composition and density of the atmosphere, the cloud locations, atmospheric turbulence and wind velocities.

These radio experiments will be carried out with the Orbiter and the probe vehicle as well as the probes themselves. All the entry vehicles will be involved using the S-band equipment. Each entry vehicle transmits directly to the Earth-based stations in the Deep Space Network. The Orbiter will use the S-band telemetry and a specially designed X-band beacon system.

THE MISSION PHILOSOPHY

The study of weather patterns on other planets can help to solve some of the vital problems that exist regarding the weather patterns of the Earth which at the moment are of great concern. For example, no data is available to help decide the freakishness of the tornado and hurricane paths which occur. Study of the meteorology of Venus will be a great opportunity to solve such problems for the Earth. Many factors are involved on the Earth such as the mixing of the Oceanic and Continental air masses. Partial cloud cover too is involved. Many things are difficult in the study of the atmosphere of the Earth such as the axial tilt, and the rapid rotation. Venus is easier to study in depth. It has an atmosphere which contains 95 per cent carbon dioxide, very slow rotation, very little tilt of the axis and no oceans.

Many fundamental questions can be answered by the study of the vital conditions on slow and fast rotating planets. There will also be answers with regard to the different evolutionary paths that each planet has taken.

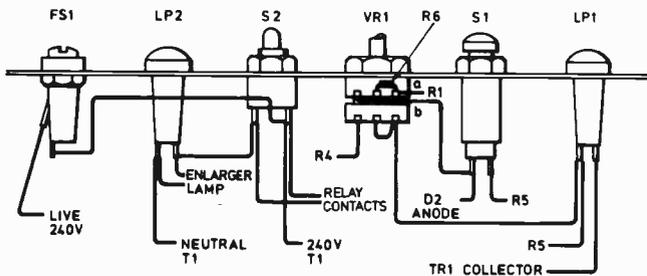
TIMER

The timer is based on the well proven circuit built around the versatile 555 i.c. Potentiometer VR1b acts as the variable element in the timer circuit and C3 the timing capacitor. Pushbutton S1 initiates the timer.

The output of IC2 drives a relay used to switch the enlarger lamp. Switch S2 is supplied to give the manual control required for balancing; LP2 is used to indicate enlarger lamp "live" condition for setting up or in case of enlarger lamp failure.

Layout and construction, etc. are not critical and the user can build the unit according to his/her requirements. The sensor can be made of anything that will house the ORP12 in a horizontal position under the diffuser.

Layout and wiring of the components mounted on the circuit board is shown in Fig. 2 whilst Fig. 3 shows wiring of the power supply unit and controls, etc.



Front panel wiring

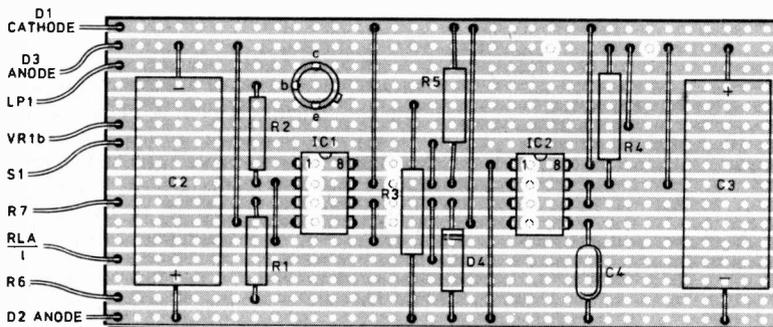


Fig. 2. Main circuit board

SETTING UP

The initial setting up procedure is very simple; one needs a multimeter and a "known" negative.

Assuming that the "known" negative's exposure time is, say, 5 seconds, all that is required is to expose the negative to the sensor in the usual way (explained later) and balance the unit, then switch off (plug out) the timer and measure the resistance (between track and wiper) of VR1b; then, using the formula:

$$C = \frac{t}{1.1R} \quad (\text{where } C = \text{Farads})$$

Calculate the value of the timing capacitor C3. So, if the resistance was found to be 25 kilohms then:

$$C3 = \frac{5 \text{ secs}}{1.1 \times 25,000\Omega}$$

$$C3 = 181.8\mu\text{F}$$

In this case, obviously some trouble has to be taken to select a component as close to this as possible, and, if an a.c. null voltmeter is not available then it requires trial and error methods of soldering in nearest preferred values, not moving the setting of VR1, depressing S1, and timing the "on" period of LP2, this being repeated until 5 seconds is achieved.

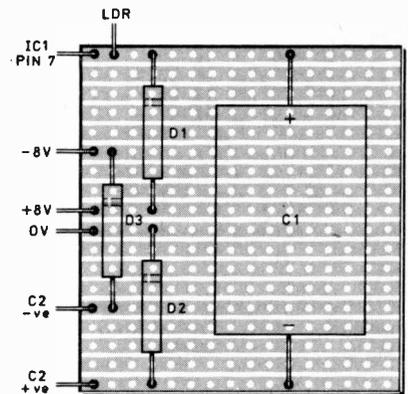


Fig. 3. Power supply board

Resistors

- R1 3.9k Ω
- R2 470 Ω
- R3 6.8 Ω
- R4 1k Ω
- R5 15k Ω
- R6 10k Ω
- R7 ORP12 light dependent resistor

Capacitors

- C1 1,000 μF elect. 25V
- C2 220 μF elect. 25V
- C3 see text (tantalum if possible)
- C4 0.1 μF

Semiconductors

- D1-D3 1N4001 (3 off)
- D4 1N4148
- TR1 BC107
- IC1 741 op. amp.
- IC2 555 timer

COMPONENTS . . .

Miscellaneous

- FS1 1 amp fuse and panel mounting holder
- T1 6-0-6V at 1A, 240V primary mains transformer
- VR1 50k Ω lin. ganged tandem potentiometer (VR1a and VR1b)
- RLA1 6V 400 Ω relay with normally open contacts capable of switching the enlarger lamp current
- LP1 6V 0.36W lilliput lamp
- LP2 main neon with built-in resistor
- S1 miniature push to make, release to break pushbutton
- S2 single pole on/off toggle switch
- Veroboard, connecting wire, case, mounting for R7, Perspex for diffuser, etc.

USE

Before use, two simple things must be arranged; they are, a method of easily switching off the darkroom safelight as this upsets the unit during measurement (the safelight can be used as normal during exposure, etc. but *must be off during the measurement procedure*) and a light dispersing filter made of finely sanded perspex sheet; this makes the light from the negative into a neutral grey and saves errors in judgement if looking for such an area on the negative.

So, having done this the procedure is as follows:

1. Switch S2 to turn on enlarger lamp.
2. Place and focus negative.
3. Swing diffuser into place (remove filter to fit diffuser).
4. Stand sensor roughly centrally on baseplate illuminated area.
5. Balance, using VR1, until display lamp LP1 is just out. (LP1 is fitted "naked" in a grommet so that in the dark even the dimmest glow of the filament can be seen.) One should try and keep the balance roughly in the centre (or above) of

the potentiometer span so that very short exposures of, say, 0.5 or 1 second are not produced; often this is achieved by "stopping down" on the enlarger lens.

6. Remove the sensor from the baseplate, cover it (use a small plastic cup—this prevents the safelight "lighting" LP1 during exposure) and swing the diffuser out of place.
7. Switch off the enlarger lamp with S2 and turn on the safelight.
8. Place the paper in the frame and depress S1; the lamp will light for the required time and go out automatically. The print can now be removed and processed in the usual way.

This may seem complex but it becomes automatic after a few sessions.

The instrument is very hardy and needs no special attention other than allowing the sensor a few seconds to settle after exposure to bright light. No on/off switch is provided because the instrument will be required all the time the other darkroom equipment is used, and therefore, can be plugged in with other units and controlled by one master switch. ★

Readout —

A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Tribute

Sir—As one of your "founder readers" and, in more recent years, a contributor may I say how sorry I am to hear that Fred Bennett has relinquished his post as Editor.

I would like to pay tribute to the way Fred has dedicated himself to the amateur electronics cause over the last dozen years and congratulate him on his expertise and far sightedness. I am privileged to have had the opportunity of working for him and to have shared private discussions with him. Above all things I think that Fred, through the pages of PE, inspired the amateur to get away from the "junk box" approach to amateur construction and over the years has elevated the standard of the magazine from "Camm's comic" to a periodical valued by amateur and professional alike.

He wasn't right all the time! I remember one occasion in 1967 when he expressed the sentiment that ICs would

"never catch on with the amateur". One only has to analyse the content of the magazine from that year onwards to see that he was quick to make up for this slanderous statement and bring the excitement and challenge of professional electronics into the dining room and kitchen.

I would like to thank him, on behalf of all readers and contributors, for all he has done for our hobby and in particular for all the help, advice and encouragement he has given to me personally. It is good to know that he is continuing with your sister magazine (*Everyday Electronics*). You had better "watch it" because, knowing Fred, he'll be out to steal your readership! With all his energy channelled in that direction your loss is going to be the gain of all young people keen to get started on one of the most exciting, challenging and satisfying hobbies.

M. Hughes,
Biggin Hill.
Kent.

Production method

Sir—Having tried various different methods for the production of printed circuit boards I have finally settled upon the following.

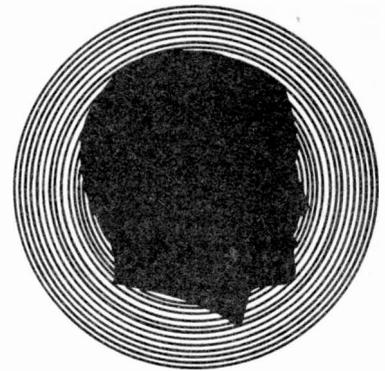
A piece of Shire Seal or similar clear self-adhesive plastic is cut slightly larger than the circuit, which is then traced on to the plastic film with a ballpoint, felt-tipped or ink pen (I use a Rotring 0.2mm drafting pen). Do not attempt to copy the circuit exactly, rather aim to include curves, component pads, etc., within straight lines, leaving as much copper as possible in the finished board. The backing is removed and the plastic film stuck carefully down on to the cleaned copper surface of the p.c.b., making sure that no air bubbles are trapped. The traced design is now cut around with a very sharp knife (e.g. a scalpel or craft knife with a scalpel type blade) and the plastic peeled off in the areas to be etched.

A wipe with a cloth slightly dampened with white spirit (to remove any adhesive) and straight into the etching solution, the plastic film protecting the copper areas which are to remain. When the board is etched peel off the plastic film, wipe with white spirit, then scrub the board with soap and water to remove any residual etching solution.

Although this system sounds time consuming it has proved itself admirably on some very complex boards. The greatest advantage, however, is the ability to produce professional looking switch plates, or keyboards for mini electronic organs, since it is possible to produce sharp edged "keys" separated by extremely small gaps.

Roger D Knight,
Sheffield.

CAR BRAKE LIGHT FAILURE INDICATOR



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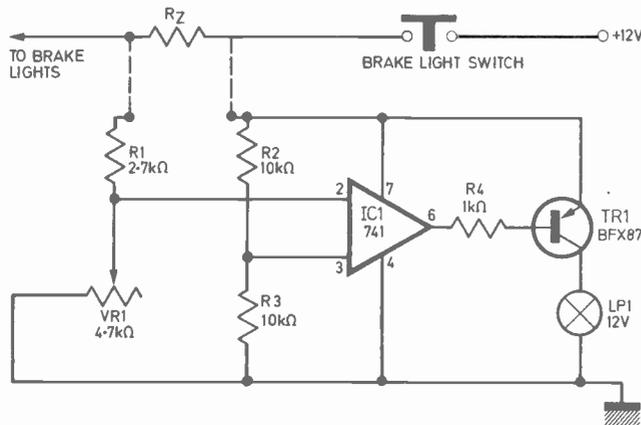


Fig. 1

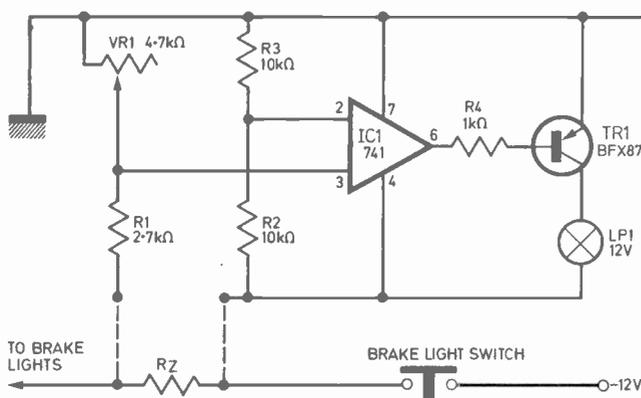


Fig. 2

THESE circuits (Figs. 1/2) were originally designed to monitor two 21W brake lights, but by changing the value of R_z , it could no doubt be used to monitor a wide variety of bulbs. Fig. 1 is for negative earth and Fig. 2 for positive earth vehicles. The monitoring of the brake lights depends on the potential difference across the resistor R_z . With a total brake light power of 42W, and R_z at 0.22Ω , the p.d. is 0.77V which will drop to 0.385V with one bulb extinguished.

VR1 is set to compensate for the 0.77V voltage drop and when the p.d. across R_z drops (i.e. one or both bulbs are extinguished) a higher voltage appears at the non-inverting input for positive earth, and at the inverting input for negative earth, which amplified by the op. amp, drives the base of TR1 and turns on the monitor bulb.

A light emitting diode may be used instead of a bulb and transistor, however, R_4 may need to be changed. R_z should be chosen to give a suitable voltage drop which will not greatly affect the brightness of the bulb being monitored.

R_z is connected directly to the brake light switch, and flying leads are taken from both sides of R_z to the appropriate positions on the circuit board, so no heavy current flows through the circuit board.

N. R. Garman,
Newhaven,
Sussex.

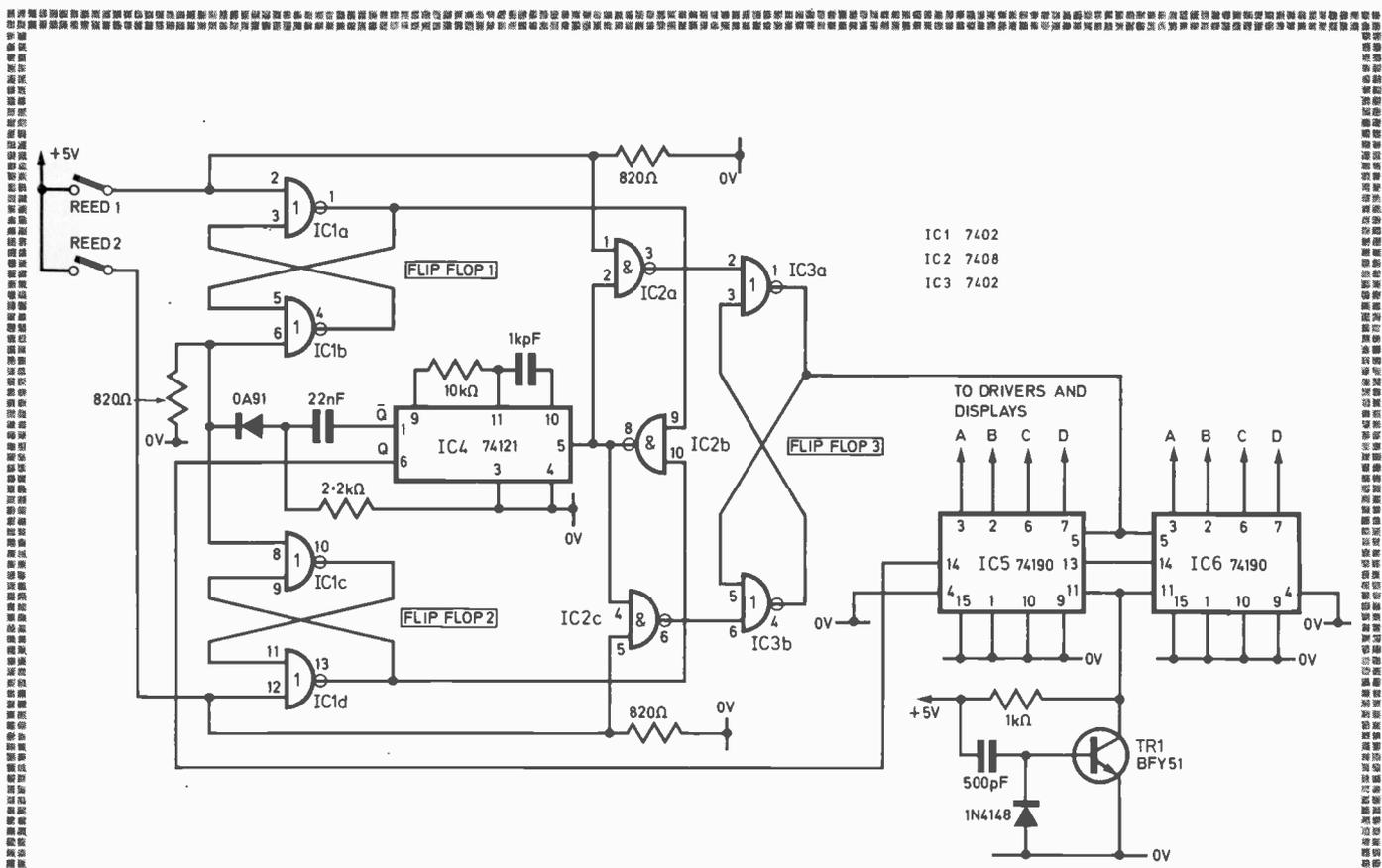


Fig. 1

UP-DOWN COUNTER

THIS circuit was originally designed for counting turns on a hand operated coil winding machine, and automatically subtracting any removed turns. The circuit is triggered by a magnet sequentially passing over two reeds, the order determining the direction of count. A clock pulse will only be delivered after both reeds have been energised, eliminating any miscount due to contact bounce. The circuit shown in Fig. 1 works as follows.

Energising the reeds momentarily will set flip-flops 1 and 2. IC2b detects that both flip-flops have been set, which fires the monostable IC4. The Q output (pin 1) resets the flip-flops, making them ready to accept further input pulses, and the Q output (pin 6) clocks the counter.

Only one reed is energised at any time, so only the output from the last reed to be activated will coincide with the output from IC2b.

This is detected by either IC2a or IC2c, setting flip-flop 3 output either high or low. This is fed to the up-down inputs of the counter thus determining the direction of the count. The counters are connected for asynchronous operation and further stages may be cascaded by taking the ripple through output to the next stage.

TR1 and associated components set the counter to zero when first switched on.

Philip R. Landau,
Southend-on-Sea,
Essex.

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

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

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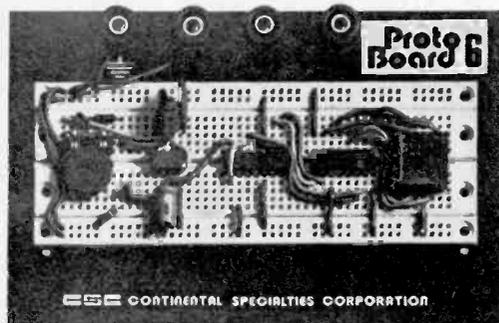
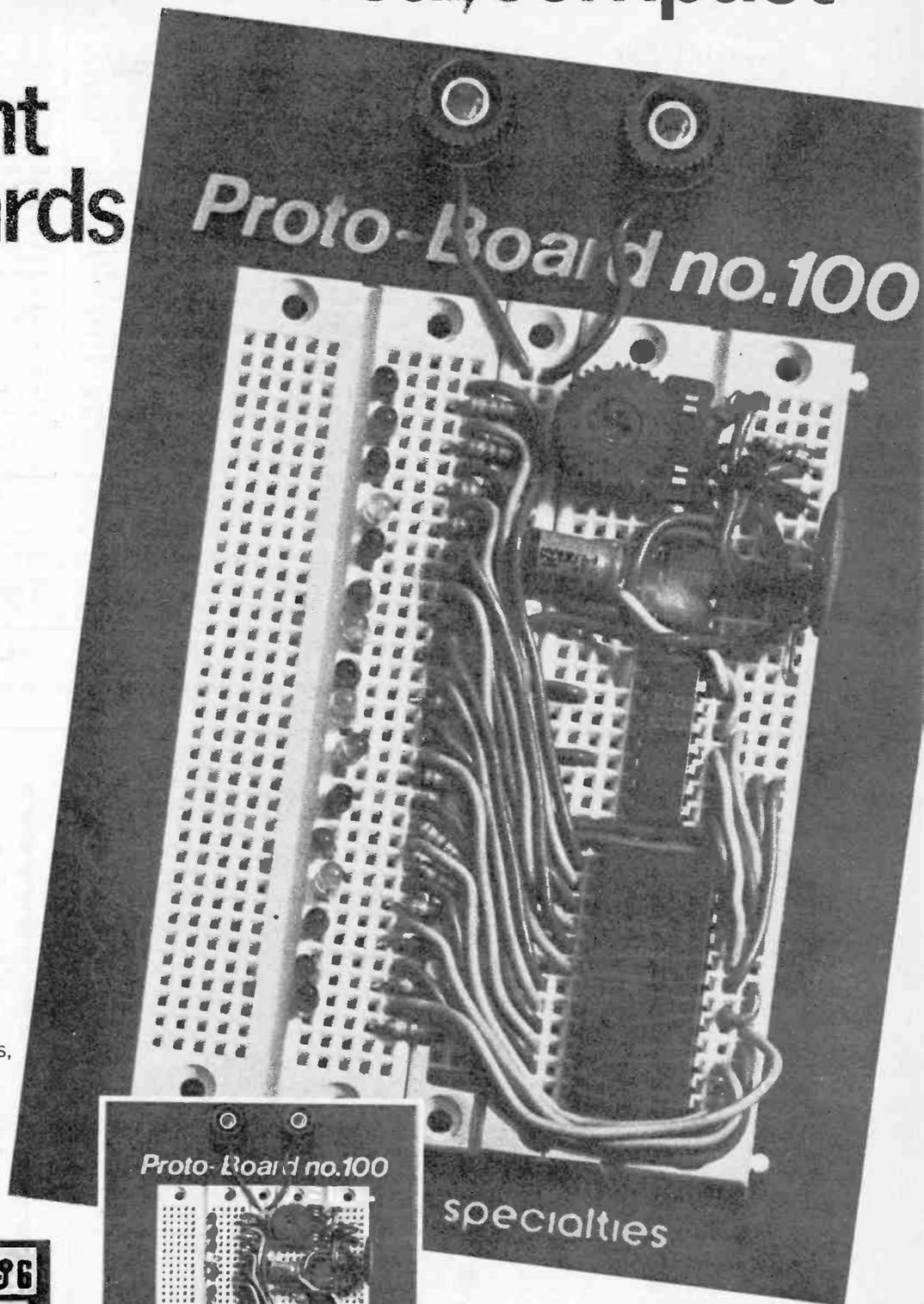
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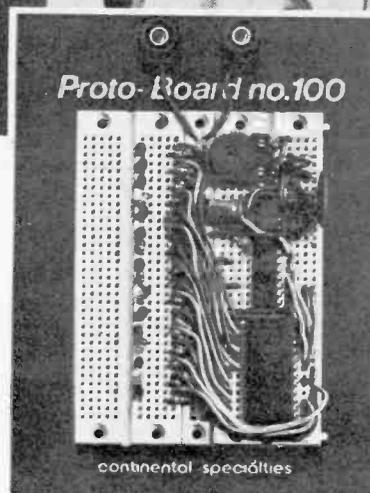
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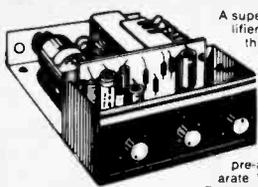
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Semiconductor UPDATE...

FEATURING : TL071 MC14412 UDN-6118A/6128A

R. W. Coles

BIFET UPGRADE

Until recently, if you needed an op-amp with a very high input impedance you were forced to use either a discrete f.e.t. input stage with a conventional op-amp i.c., or to use an i.c. which contained an op-amp chip and an f.e.t. chip already wired together, such as the NE536. Both solutions were expensive and involved compromises on other parameters such as input offset voltage, and this meant that high input impedance was something we learned to do without unless it was absolutely essential.

All this changed with the introduction of BIFET technology which for the first time allowed high quality matched junction f.e.t.s to be integrated on the same chip with other conventional bi-polar op-amp components. Since its introduction the BIFET process has mushroomed in popularity, and today there are several BIFET op-amps, with assorted characteristics, to choose from, all at knock down prices. One example which caught my eye because of its immediate practical applications, is the **TL071** from Texas Instruments.

The TL071 is optimised for use in hi-fi amplifiers, and has the advantage that it is a plug-in replacement for the 741 types which have been widely used in the past. Using the TL071 to replace 741's in past, present or future designs, will improve system noise figures, and gives the advantage of a very high input impedance where this is useful.

Texas have proved their point about plug-in replaceability by upgrading the performance of their own popular "Texan" amplifier with three TL071 devices in place of the original 741's, a substitution which required no other component changes, and which costs very little.

For newer designs Texas offer the TL072 dual and the TL074 and TL075 quads, all of which have identical performance characteristics to the TL071 but with higher circuit density.

The TL071 family are available in 8 or 14 pin plastic dual in line packages, and operate from standard op-amp supply rails. For the hi-fi buff, the typical noise

figure of the TL071 family is only 18 nanovolts per root Hertz, and when you consider that a 100 kilohm resistor can introduce 40 nanovolts per root Hertz, you can see that these chips are pretty quiet.

CMOS MODEM

When you want to send binary data to a distant terminal you have to resort either to radio or to telephone type lines. In either case sending your data in the form of an interrupted voltage or current is not such a good idea because such a simple communication link would have no protection against the inevitable build up of noise signals.

To prevent the corruption of transmitted binary data a more sophisticated scheme must be used, so that 0s and 1s on the line can be filtered out from all the other rubbish at the receive end.

One common way to improve matters is to employ Frequency Shift Keying (F.S.K.) where the link is modulated with two different audio tones; one for a logic 1 signal and another for a logic 0 signal. This system has the advantage that it is compatible with existing speech communication links such as Post Office telephone lines, regardless of whether the links employ wire, multichannel cables, microwave links, or satellites.

A further advantage of F.S.K. is that since audio frequency tones are used to transmit the data, it is not strictly necessary to make electrical connections to telephone lines at all, signals can be coupled acoustically by placing a speaker/microphone combination in intimate contact with a standard telephone handset.

Commercial equipment of this type is available and all you need to couple your microprocessor system to any remote location are a couple of boxes called "Modems", which will both send and receive F.S.K. data. Preset Modems are rather costly and are stuffed full of i.c.s, filters and discrete components, but this is all set to change with the introduction of the Motorola **MC14412** "Universal-

Low-Speed-Modem" chip.

The MC14412 is a CMOS 16 pin dil package, and yet it contains all the digital and analogue circuitry required to transmit serial binary data as a sine wave F.S.K. signal, and to turn similar received signals back into logic levels.

A typical use for this component is as an interface between the U.A.R.T. output of a microprocessor system and a wide variety of communication links, including acoustic couplers used with standard P.O. telephones. Data rates of up to 600 bits per second can be achieved, and transmitted carrier frequencies can be set to conform to either the U.S. standard or the European CCITT standard.

Under logic control this device will also send a special 100Hz tone to disable the line echo suppressors often used with long distance telephone systems so that they cannot corrupt the transmitted data.

The number of extra components required to complete a working system is small, the timing of the MC14412 being set by means of a 1MHz crystal.

FLUORESCENT DISPLAY DRIVER

If you like the distinctive green characters produced by those fluorescent displays often found on pocket calculators, you may be interested to hear that Sprague have just introduced a couple of chips to take care of all the display driving functions for this type of display. The two devices coded **UDN-6118A** and **UDN-6128A** can each act as either digit or segment drivers in a multiplexed display scheme. The UDN-6118A can be driven from TTL or 5 volt CMOS whereas the UDN-6128A is intended for use with PMOS or CMOS circuits operating from 6 to 12 volt supplies.

The new devices are housed in 18 pin plastic packages, and will operate from supplies of 25 to 85 volts. There are some very practical fluorescent display panels now available, and their continued use in calculators means that they have certainly not been made obsolete by l.e.d.s so if you do like them, you can now consider using them for one of your own pet projects!

PATENTS REVIEW...

Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 95p each

FILLER DRIVER

BP 1 487 176

There is currently much controversy in the hi-fi world over the relative merits of "linear phase" or "minimum phase" loudspeakers. In a linear phase loudspeaker, there is at least an approximation to phase coherence over the frequency range covered, so that low notes and high notes are reproduced in phase.

One of the first patents on linear phase systems to appear is BP 1 487 176 from Bang & Olufsen of Denmark. The patent covers the "filler driver" technique that is now an integral part of B & O loudspeakers.

Conventionally, a loudspeaker contains at least two transducers, with an electronic crossover routing high frequency signals to one transducer (the tweeter) and low frequency signals to the other (the woofer). If the crossover action is gradual, involving first order pass filters only, each transducer must operate well outside its normal frequency range without distortion or break-up. This is difficult to achieve. If the crossover filters are of higher order and cut off more sharply, there is a far greater signal disturbance unless the transducer transfer functions are corrected by meticulous and expensive design.

The B & O proposal, which demonstrations have shown to work well, is that a third and extra transducer unit (operating in the range between the woofer and the tweeter) should be employed to fill the acoustic gap left between the other two, and provide an overall transfer function which is constant.

Fig. 1 shows how a gap centring on crossover frequency f_0 is left between the curves a and b, representing the characteristics of the high and low pass filters of a crossover circuit. Curve c represents the transfer function of the auxiliary or filler driver, which fills in the gap.

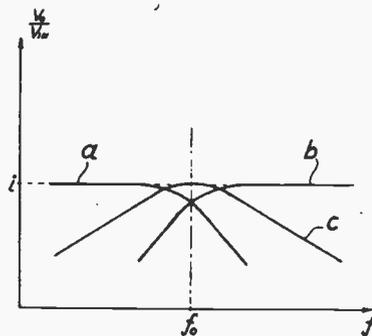


Fig. 1

BP 1 487 176
(Linear Phase System)

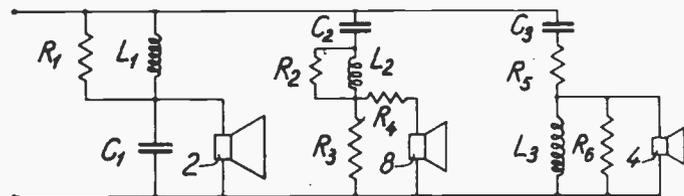


Fig. 2

Fig. 2 shows a three-way system, using three transducers or drivers of 4 ohms each and a crossover frequency of 2kHz. Woofer 2, tweeter 4, and filler driver 8 are associated with simple pass filters based on components for which representative values are given in the patent. It is suggested that adoption of the invention enables relatively inexpensive transducer units to be used, with minimal loss of quality, because the acoustic correction provided by the auxiliary driver throws far less demand on the design and performance of the woofer and tweeter. For a three-way system (woofer, tweeter and mid-range unit) filler drivers are used between each acoustically adjacent pair.

IN BRIEF

BP 1 487 360—Ito-Patent AG. Method of automatically orientating and controlling a vehicle. A self-positioning vehicle, for instance a highly sophisticated invalid carriage, which uses electro-optical distance sensing for long distances, and electro-acoustic or electromagnetic sensing for short distances. Computer evaluation of the long and short distance sensing enables the vehicle to position itself in a room and avoid stairs, etc.

BP 1 485 682—General Electric Co. Audio amplifier. Details of an i.e. to provide audio amplification with reduced idling current, achieved by a novel combination of feedback loops.

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AF239	0-45	BF179	0-45	OC29	1-95
AF211	2-25	BF180	0-45	OC35	1-50
AF212	2-75	BF181	0-45	OC36	1-50
AS226	0-45	BF182	0-45	OC41	0-50
AS227	0-50	BF183	0-45	OC42	0-45
AU113	1-70	BF184	0-39	OC43	1-50
AU110	1-70	BF185	0-37	OC44	1-50
BA145	0-10	*BF194	0-12	OC45	0-50
BA148	0-10	*BF195	0-11	OC71	0-45
BA154	0-10	*BF196	0-13	OC72	0-45
BA155	0-12	*BF197	0-14	OC73	1-00
BA156	0-13	BF200	0-32	OC74	0-75
BAW62	0-05	*BF224	0-20	OC75	0-75
BAK13	0-07	*BF244	0-35	OC76	0-50
BAK16	0-10	*BF257	0-37	OC77	1-20
BC107	0-12	BF258	0-42	OC81	0-75
BC108	0-12	BF259	0-45	OC82	1-00
BC109	0-13	*BF336	0-53	OC83	0-75
*BC113	0-15	*BF337	0-53	OC84	0-80
*BC114	0-18	*BF338	0-57	OC122	1-50
*BC115	0-19	*BF339	2-27	OC123	1-55
*BC116	0-19	BF341	1-38	OC139	2-25
*BC117	0-22	*BF361	0-25	OC140	1-95
*BC118	0-18	*BF368	0-48	OC141	2-25
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*BC126	0-15	BFW10	0-90	OC171	0-75
*BC127	0-15	BFW11	0-90	OC172	1-00
*BC128	0-15	BFX84	0-38	OC173	1-00
*BC129	0-15	BFX85	0-41	OC200	0-50
*BC130	0-15	BFX86	0-35	OC201	1-50
*BC131	0-15	BFY50	0-28	OC202	1-25
*BC132	0-15	BFY51	0-28	OC203	1-25
*BC133	0-15	BFY52	0-28	OC204	1-25
*BC134	0-15	BFY53	0-28	OC205	1-75
*BC135	0-15	BFY54	0-30	OC206	1-75
*BC136	0-16	BFY90	1-32	OC207	1-25
*BC137	0-16	BSK19	0-34	OC208	1-25
*BC138	0-16	BSK20	0-34	OC209	0-83
*BC139	0-16	BSK21	0-34	*R2008B	2-25
*BC140	0-16	BT106	1-19	*R2009	2-25
*BC141	0-16	BT107	1-19	*R2010B	2-25
*BC142	0-16	*BU205	2-25	T1C44	0-36
*BC143	0-16	*BU206	2-25	T1C226D	1-30
*BC144	0-16	*BU207	2-25	T1L209	0-25
*BC145	0-16	BY100	0-45	*T1P29A	0-50
*BC146	0-16	BY126	0-14	*T1P30A	0-60
*BC147	0-16	BY127	0-15	T1P31A	0-62
*BC148	0-16	BZX61	0-20	T1P32A	0-75
*BC149	0-20	Series		T1P33A	1-00
*BC150	0-11	EZY88	0-13	T1P34A	1-20
*BC151	0-11	Series		T1P41A	0-70
*BC152	0-12	CRS1/05	0-45	T1P42A	0-90
*BC153	0-12	CRS1/40	0-60	T1P2955	1-00
*BC154	0-12	CRS3/05	0-45	T1P3055	0-50
*BC155	0-17	CRS3/40	0-75	*T1S43	0-35
*BC156	0-17	MJE320	0-80	*ZS140	0-25
*BC157	0-12	GEX66	1-50	*ZS170	0-12
*BC158	0-15	GEX541	1-75	*ZS178	0-54
*BC159	0-15	GEX51	1-75	*ZS271	0-22
*BC160	0-20	GJ3M	0-75	*ZS278	0-56
*BC161	0-20	GJ5M	0-75	*ZTX107	0-11
*BC162	0-18	GMS378A	1-50	*ZTX108	0-11
*BC163	0-18	*KS100A	0-40	*ZTX109	0-12
*BC164	0-18	MJE340	0-56	*ZTX109	0-12
*BC165	0-18	MJE370	0-85	*ZTX300	0-12
*BC166	0-18	MJE371	0-81	*ZTX301	0-13
*BC167	0-18	MJE372	0-81	*ZTX302	0-17
*BC168	0-18	MJE373	0-81	*ZTX303	0-17
*BC169	1-00	MJE521	0-65	*ZTX304	0-18
*BC170	1-00	MJE2955	0-75	*ZTX311	0-12
*BC171	0-30	MJE3055	0-75	*ZTX314	0-20
*BC172	0-30	*MPP102	0-30	*ZTX500	0-13
*BC173	0-30	*MPP103	0-30	*ZTX501	0-14
*BC174	0-30	*MPP104	0-30	*ZTX502	0-16
*BC175	0-30	*MPP105	0-30	*ZTX503	0-17
*BC176	0-30	*MPSA06	0-25	*ZTX504	0-20
*BC177	0-30	*MPSA06	0-25	*ZTX505	0-20
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FEATURES: complete pre-amplifier in single pack multi-function equalisation, low noise, low distortion, high overload, two simply combined for stereo

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

SPECIFICATION: Inputs—magnetic pick-up 3mV, ceramic pick-up 30mV, tuner 100mV, microphone 10mV, auxiliary 3–100mV, input impedance 47k Ω at 1kHz Outputs—tape 100mV, main output 500mV R.M.S Active Tone Controls—treble \pm 12dB at 10kHz, bass \pm 12dB at 100Hz. Distortion—0.1% at 1kHz, signal/noise ratio 68dB. Overload—38dB on magnetic pick-up. Supply Voltage— \pm 16–50V

Price \pounds 5.22 + 65p VAT. P. & P. free

HY5 mounting board B.1. 48p + 6p VAT. P. & P. free



HY30 15W into 8 Ω

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

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

APPLICATIONS: updating audio equipment, guitar practice amplifier, test amplifier, audio oscillator

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

Price \pounds 5.22 + 65p VAT. P. & P. free

HY50 25W into 8 Ω

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

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

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

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

Price \pounds 6.82 + 85p VAT. P. & P. free



HY120 60W into 8 Ω

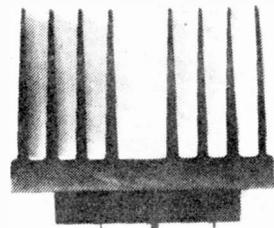
The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

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

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

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

Price \pounds 15.84 + \pounds 1.27 VAT. P. & P. free



HY200 120W into 8 Ω

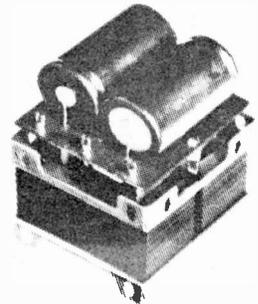
The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance.

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

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

SPECIFICATION: Input Sensitivity—500mV Output Power—120W R.M.S. into 8 Ω Load Impedance—4–16 Ω Distortion—0.05% at 100W at 1kHz Signal Noise Ratio—96dB Frequency Response—10Hz–45kHz –3dB Supply Voltage— \pm 45V Size—114 x 50 x 85mm

Price \pounds 23.32 + \pounds 1.87 VAT. P. & P. free



HY400 240W into 4 Ω

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

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

APPLICATIONS: public address, disco, power slave, industrial

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

Price \pounds 32.17 + \pounds 2.75 VAT. P. & P. free

POWER SUPPLIES: PSU36—suitable for two HY30s \pounds 5.22 + 65p VAT. P. & P. free. PSU50—suitable for two HY50s \pounds 6.82 + 85p VAT. P. & P. free. PSU70—suitable for two HY120s \pounds 13.75 + 1.10 VAT. P. & P. free. PSU90—suitable for one HY200 \pounds 12.65 + \pounds 1.01 VAT. P. & P. free. PSU180—suitable for two HY200s or one HY400 \pounds 23.10 + \pounds 1.85 VAT. P. & P. free.

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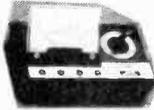
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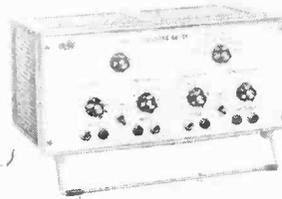
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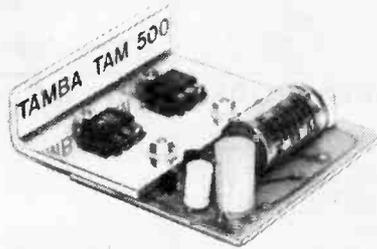
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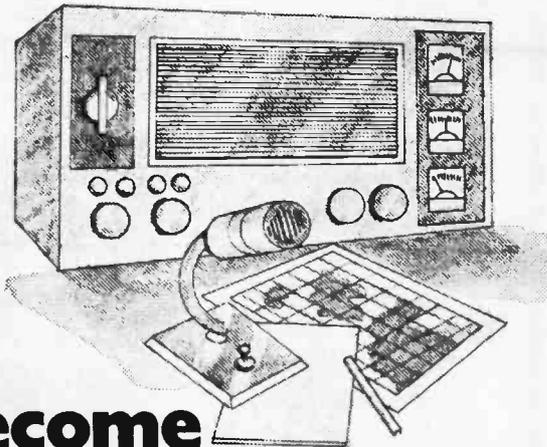
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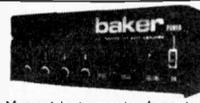
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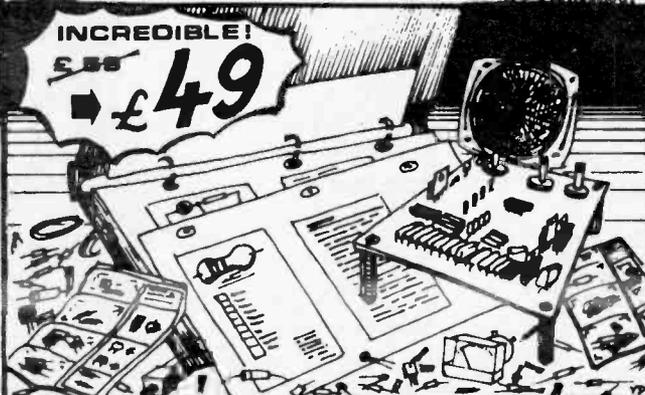
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2N2369A	0-25	2N4062	0-18	AF200	1-20	BC259B	0-18	BF178	0-35	MP102	0-30
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2N3441	1-81	2N6027	0-60	BC147	0-12	BC342	0-60	BFS21A	2-60	TIP41C	0-80
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CA3080A	1-88	MC1310	1-91	TBA530	2-21
CA3086	0-80	MC1327	1-54	TBA510Q	2-30
CA3088	1-10	MC1330	1-90	TBA520	2-21
CA3089	2-52	MC1350	0-90	TBA520Q	2-30
CA3090	4-00	MC1351	1-20	TBA530	1-98
CA3130	0-97	MC1352	1-10	TBA530Q	2-07
CA3130A	0-98	MC1458	1-91	TBA540	2-21
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7402	18p	74118	160p	108p	741	P4040	800p	1102A	400p	MJE3055	250p	2N3053	22p	OA81	15p	1A 100V 27p
7403	18p	74119	225p	4000	21p	P4021A	485p	2107	804p	MPSA06	37p	2N3702.3	14p	OA85	15p	2A 50V 40p
7404	24p	74120	130p	4001	21p	P4201A	450p	2112-2	300p	MPSA56	62p	2N3706.5	14p	OA90	9p	2A 100V 45p
7405	25p	74121	21p	74121	21p	P4265	410p	AVS-1013	810p	MPSU06	78p	2N3773	320p	OA91	9p	2A 200V 15p
7406	43p	74122	52p	4006	127p	MC1458P	75p	3900		MPSU55	90p	2N3819	27p	OA95	9p	3A 600V 80p
7407	43p	74123	75p	4007	21p	LINEAR I.Cs.				MPSU55	90p	2N3820	50p	OA200	9p	4A 100V 80p
7408	22p	74125	70p	4008	180p	NE543K	225p			MPSU55	90p	2N3820	50p	OA202	10p	4A 100V 80p
7409	22p	74126	85p	4009	180p	NE555	30p			MPSU55	90p	2N3820	50p	1N914	4p	6A 100V 100p
7410	18p	74128	85p	4010	87p	AY-1-0212	550p			OC23	140p	2N3820	50p	1N916	7p	10A 400V 120p
7411	25p	74132	81p	4011	21p	CA3028A	775p			OC35	140p	2N3820	50p	1N4003.2	6p	25A 400V 432p
7412	25p	74136	81p	4012	23p	CA3046	85p			OC71	22p	2N3903.4	22p	1N4003.7	8p	6A 100V 100p
7413	40p	74142	85p	4013	35p	LM301A	40p			R2008B	22p	2N3905.6	22p	1N4003.7	8p	6A 100V 100p
7414	85p	74145	95p	4014	80p	CA3028A	775p			R2010B	22p	2N3905.6	22p	1N4003.7	8p	6A 100V 100p
7415	40p	74146	95p	4015	90p	CA3053	75p			TIP29A	50p	2N4060	19p	1N4003.7	8p	6A 100V 100p
7416	40p	74147	205p	4016	54p	CA3053	75p			TIP29C	50p	2N4123.4	22p	1N4005.7	8p	6A 100V 100p
7417	40p	74148	160p	4017	120p	CA3065	700p			TIP30A	50p	2N4125.6	22p	1N4148	4p	6A 100V 100p
7418	40p	74149	300p	4018	110p	CA3080E	87p			TIP30C	50p	2N4401.3	34p	1N5401.3	15p	3A 400V 85p
7419	40p	74151	81p	4019	57p	CA3089E	250p			TIP31A	50p	2N4427	34p	1N5401.3	15p	3A 400V 85p
7420	18p	74150	160p	4020	120p	CA3090AQ	425p			TIP31C	50p	2N4871	80p	1N5401.3	15p	3A 400V 85p
7421	43p	74151	81p	4021	120p	ICL8038CC	425p			TIP32A	88p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7422	26p	74153	81p	4022	120p	LM339N	175p			TIP32C	88p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7423	36p	74154	160p	4023	140p	LM337N	175p			TIP33A	97p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7424	36p	74155	97p	4024	140p	LM380N	212p			TIP33C	120p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7425	43p	74156	97p	4025	23p	LM380N	212p			TIP34A	124p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7426	43p	74157	97p	4026	23p	LM380N	212p			TIP35A	124p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7427	40p	74159	250p	4027	23p	LM380N	212p			TIP35C	124p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7428	40p	74159	250p	4028	23p	LM380N	212p			TIP36A	290p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7429	18p	74161	130p	4029	110p	LM380N	212p			TIP36C	290p	2N6179	75p	1N5401.3	15p	3A 400V 85p
7430	18p	74162	130p	4030	110p	LM380N	212p			TIP37A	72p	2N6254	140p	10A 50V 160p		
7431	33p	74163	130p	4031	110p	LM380N	212p			TIP37C	72p	2N6254	140p	10A 50V 160p		
7432	33p	74164	130p	4032	110p	LM380N	212p			TIP38A	72p	2N6254	140p	10A 50V 160p		
7433	43p	74165	150p	4033	150p	LM380N	212p			TIP38B	72p	2N6254	140p	10A 50V 160p		
7434	43p	74166	150p	4034	150p	LM380N	212p			TIP38C	72p	2N6254	140p	10A 50V 160p		
7435	43p	74167	150p	4035	150p	LM380N	212p			TIP39A	72p	2N6254	140p	10A 50V 160p		
7436	37p	74168	150p	4036	150p	LM380N	212p			TIP39B	72p	2N6254	140p	10A 50V 160p		
7437	37p	74169	150p	4037	150p	LM380N	212p			TIP39C	72p	2N6254	140p	10A 50V 160p		
7438	37p	74170	260p	4038	150p	LM380N	212p			TIP39D	72p	2N6254	140p	10A 50V 160p		
7439	37p	74171	260p	4039	150p	LM380N	212p			TIP39E	72p	2N6254	140p	10A 50V 160p		
7440	18p	74172	320p	4040	84p	LM380N	212p			TIP39F	72p	2N6254	140p	10A 50V 160p		
7441	85p	74173	130p	4041	84p	LM380N	212p			TIP39G	72p	2N6254	140p	10A 50V 160p		
7442	75p	74174	130p	4042	84p	LM380N	212p			TIP39H	72p	2N6254	140p	10A 50V 160p		
7443	120p	74175	97p	4043	58p	LM380N	212p			TIP39I	72p	2N6254	140p	10A 50V 160p		
7444	120p	74176	320p	4044	58p	LM380N	212p			TIP39J	72p	2N6254	140p	10A 50V 160p		
7445	108p	74177	130p	4045	58p	LM380N	212p			TIP39K	72p	2N6254	140p	10A 50V 160p		
7446	108p	74178	130p	4046	58p	LM380N	212p			TIP39L	72p	2N6254	140p	10A 50V 160p		
7447	75p	74179	97p	4047	58p	LM380N	212p			TIP39M	72p	2N6254	140p	10A 50V 160p		
7448	85p	74176	130p	4048	58p	LM380N	212p			TIP39N	72p	2N6254	140p	10A 50V 160p		
7449	18p	74177	130p	4049	58p	LM380N	212p			TIP39P	72p	2N6254	140p	10A 50V 160p		
7450	18p	74178	130p	4050	58p	LM380N	212p			TIP39Q	72p	2N6254	140p	10A 50V 160p		
7451	18p	74180	160p	4051	130p	LM380N	212p			TIP39R	72p	2N6254	140p	10A 50V 160p		
7452	18p	74181	324p	4052	30p	LM380N	212p			TIP39S	72p	2N6254	140p	10A 50V 160p		
7453	18p	74182	150p	4053	30p	LM380N	212p			TIP39T	72p	2N6254	140p	10A 50V 160p		
7454	18p	74183	150p	4054	30p	LM380N	212p			TIP39U	72p	2N6254	140p	10A 50V 160p		
7455	18p	74184	250p	4055	30p	LM380N	212p			TIP39V	72p	2N6254	140p	10A 50V 160p		
7456	16p	74185	130p	4056	30p	LM380N	212p			TIP39W	72p	2N6254	140p	10A 50V 160p		
7457	32p	74186	320p	4057	30p	LM380N	212p			TIP39X	72p	2N6254	140p	10A 50V 160p		
7458	36p	74190	140p	4058	30p	LM380N	212p			TIP39Y	72p	2N6254	140p	10A 50V 160p		
7459	36p	74191	140p	4059	30p	LM380N	212p			TIP39Z	72p	2N6254	140p	10A 50V 160p		
7460	36p	74192	120p	4060	30p	LM380N	212p			TIP39AA	72p	2N6254	140p	10A 50V 160p		
7461	36p	74193	120p	4061	30p	LM380N	212p			TIP39AB	72p	2N6254	140p	10A 50V 160p		
7462	43p	74194	160p	4062	30p	LM380N	212p			TIP39AC	72p	2N6254	140p	10A 50V 160p		
7463	43p	74195	160p	4063	30p	LM380N	212p			TIP39AD	72p	2N6254	140p	10A 50V 160p		
7464	43p	74196	160p	4064	30p	LM380N	212p			TIP39AE	72p	2N6254	140p	10A 50V 160p		
7465	43p	74197	160p	4065	30p	LM380N	212p			TIP39AF	72p	2N6254	140p	10A 50V 160p		
7466	43p	74198	160p	4066	30p	LM380N	212p			TIP39AG	72p	2N6254	140p	10A 50V 160p		
7467	43p	74199	160p	4067	30p	LM380N	212p			TIP39AH	72p	2N6254	140p	10A 50V 160p		
7468	43p	74200	160p	4068	30p	LM380N	212p			TIP39AI	72p	2N6254	140p	10A 50V 160p		
7469	340p	74251	150p	4069	540p	LM380N	212p			TIP39AJ	72p	2N6254	140p	10A 50V 160p		
7470	140p	74298	220p	4070	215p	LM380N	212p			TIP39AK	72p	2N6254	140p	10A 50V 160p		
7471	140p	74299	160p	4071	215p	LM380N	212p			TIP39AL	72p	2N6254	140p	10A 50V 160p		
7472	140p	74300	160p	4072	215p	LM380N	212p			TIP39AM	72p	2N6254	140p	10A 50V 160p		
7473	140p	74301	160p	4073	215p	LM380N	212p			TIP39AN	72p	2N6254	140p	10A		

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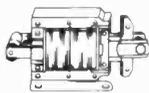
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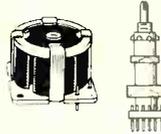
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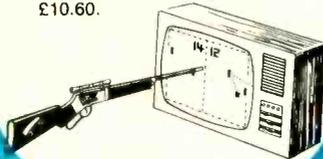
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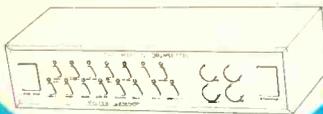
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