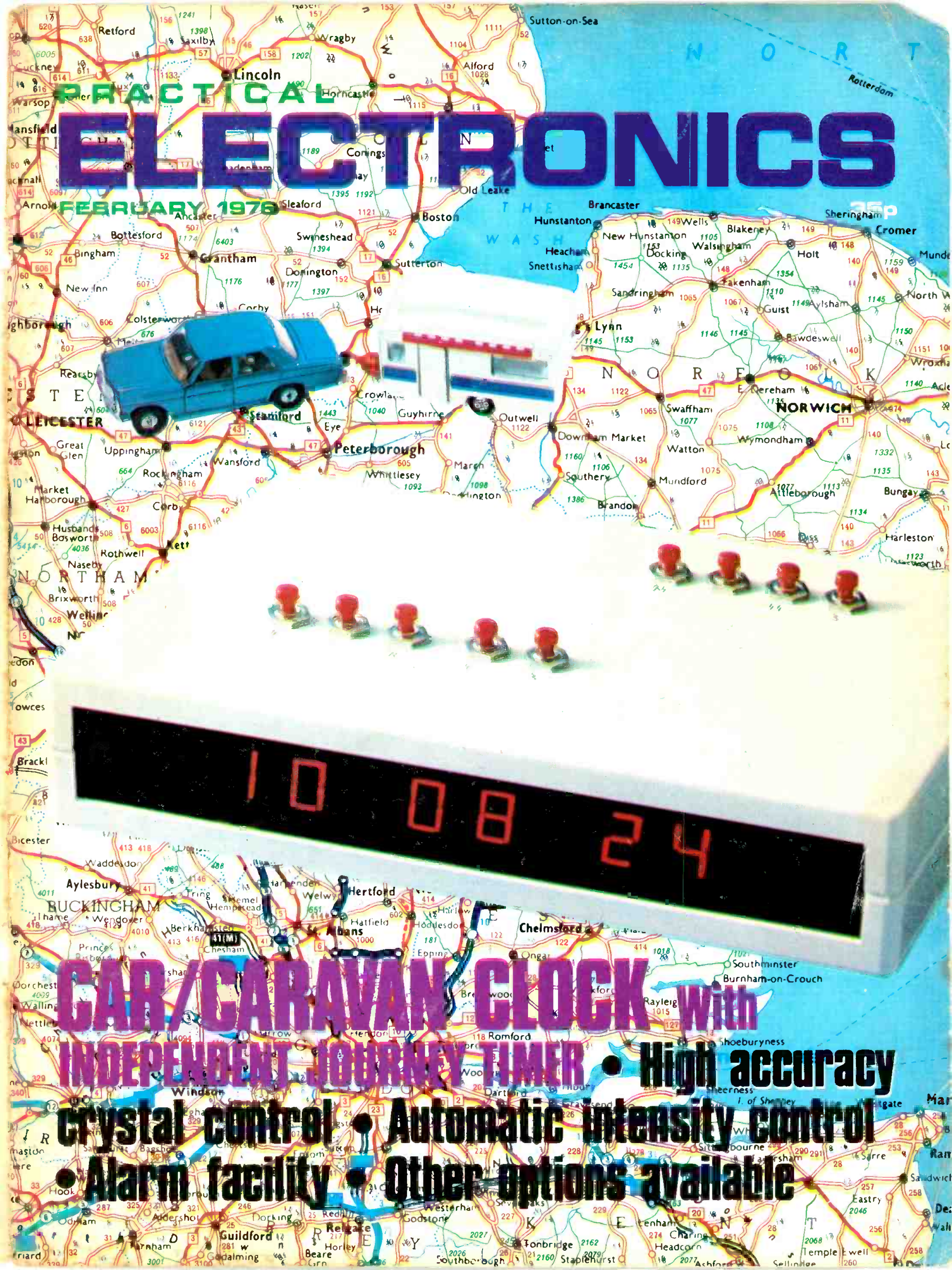
PRACTICAL ELECTRONICS

FEBRUARY 1976

25p



CAR/CARAVAN CLOCK With INDEPENDENT JOURNEY TIMER

- High accuracy crystal control
- Automatic intensity control
- Alarm facility
- Other options available

CHROMASONIC electronics

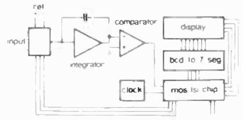
Dept.2, 56, Fortis Green Road,
Muswell Hill, London, N10 3HN.
telephone: 01-883 3705

C-MOS

mix prices

	1-24	25-99	100up
CD4000AE	19p *	17p *	14p *
CD4001AE	19p *	17p *	14p *
CD4002AE	19p *	17p*	14p *
CD4006AE	£1.59 *	£1.33 *	£1.06 *
CD4007AE	23p *	19p*	15p *
CD4008AE	£1.75 *	£1.46 *	£1.17 *
CD4009AE	Use	CD4049*	
CD4010AE	Use	CD4050*	
CD4011AE	19p *	17p*	14p *
CD4012AE	19p *	17p*	14p *
CD4013AE	59p *	50p*	46p *
CD4014AE	£1.75 *	£1.46 *	£1.17 *
CD4015AE	£1.75 *	£1.46 *	£1.17 *
CD4016AE	55p *	48p*	44p *
CD4017AE	£1 29 *	£1.07 *	93p *
CD4018AE	£1.89 *	£1.56 *	£1.25 *
CD4019AE	80p *	66p*	53p *
CD4020AE	£1 97 *	£1.64 *	£1.31 *
CD4021AE	£1.75 *	£1.46 *	£1.17p *
CD4023AE	19p *	17p*	14p *
CD4022AE	£1.83 *	£1.53 *	£1.22 *
CD4024AE	£1.26 *	£1.05 *	84p *
CD4025AE	19p *	17p*	14p *
CD4026AE	£2.79 *	£2.33 *	£1.86 *
CD4027AE	98p *	82p*	65p *
CD4028AE	£1.53 *	£1.28 *	£1.02 *
CD4029AE	£1.89 *	£1.56 *	£1.15 *
CD4030AE	71p *	59p*	47p *
CD4035AE	£1.75 *	£1.46 *	£1.17 *
CD4040AE	£2.01 *	£1.69 *	£1.34 *
CD4042AE	£1.49 *	£1.24 *	99p *
CD4046AE	£2.15 *	£1.79 *	£1.44 *
CD4049AE	69p *	58p*	46p *
CD4050AE	69p *	58p*	46p *
CD4051AE	£2.78 *	£2.32 *	£1.85 *
CD4052AE	£2.78 *	£2.32 *	£1.85 *
CD4056AE	£2.12 *	£1.76 *	£1.41 *
CD4060AE	£2.39 *	£1.99 *	£1.55 *
CD4066AE	£1.13 *	94p*	75p *
CD4068AE	28p *	24p*	19p *
CD4069AE	28p *	24p*	19p *
CD4070AE	28p *	24p*	19p *
CD4071AE	28p *	24p*	19p *
CD4077AE	71p *	59p*	47p *
CD4081AE	28p *	24p*	19p *
CD4082AE	28p *	24p*	19p *
CD4085AE	£1.28 *	£1 06 *	85p *
CD4086AE	£1.28 *	£1.06 *	85p *
CD4093AE	£1.56 *	£1.20 *	£1.04 *
CD4099AE	£2.95 *	£2.46 *	£1.96 *
CD4511AE	£2.36 *	£1.79 *	£1.44 *
CD4528AE	£1.30 *	£1.08 *	87p *

3½ DECADE DVM I.C.



This state-of-the-art MOS LSI chip contains all the logic necessary for a 3½ decade, dual slope integrating, automatic polarity detecting DVM. Supplied with free data and circuit booklet. AY-5-3507

OUR PRICE ONLY £6.59.*

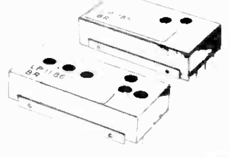
(Data and Circuit Booklets alone 20p.)

The AY-5-1224 tick-tock

Another marvel from G.I. A 16 pin 12-24 hr. Clock I.C. with 25 pin capability and low external parts count. Supplied with manufacturers detailed leaflet £3.95p*(inc VAT) (Leaflet alone 20p.) Full Kit (excluding case) available towards end of 1975. Phone Clive for details.

MULLARD MODULES

Still make the simplest, highly reliable F.M. tuner



LP1186 Varactor front end	£8·60
LP1185 I.F. Strip	£6·95
LP1400 Muliplex decoder	£9·02

I.C. SOCKETS

Pin Sockets, pins in strips of 100. Just snip off what you need. 65p per strip *

Dual in line

8 pin 13p.	24 pin 26p.	TO5
14 pin 15p	28 pin 30p.	8 pin 31p.
16 pin 15p	36 pin 39 p.	10 pin 35p.

FREE CIRCUITS

Our 8 Page A4 Audio I.C. Booklet is supplied FREE with purchases of Linear I.C.'s worth £1. or more (35p. if sold alone) Contains circuits and pin connections

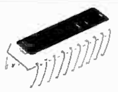
- 15 Amplifiers 250 mW to 20 watts
- 5 Audio Pre-Amplifiers
- 1 Tape Pre-Amplifier
- 1 Power Driver
- 1 Instrument Amplifier (Bifet)
- 1 General Purpose Mini Amplifier
- 1 D.C. Controlled Gain Control
- 1 Micro-mini radio (2 I.C's)

PHOTO-DARLINGTON

Vceo 25v 2N5777
Vcbo 25v
Vebo 8v
I1 250 mA
Pd 200 mW
Hfe 2500

35p.

LINE-O-LIGHT



NEW LED Linear Cursors each device contains 10 light emitting diodes in a 20 pin dual-in-line package. Ideal for solid state analogue meters or dials Type 101 RED £2.26.* Complete with leaflet.

74 TTL

mix prices

	1-24	25-99	100
7400	14p*	12p *	10p *
7401	14p*	12p *	10p *
7402	14p*	12p *	10p *
7403	15p*	12½p*	10p *
7404	16p*	13p *	11p *
7408	16p*	13p*	11p *
7409	16p*	13p*	11p *
7410	16p*	13p*	11p *
7413	29p*	24p*	20p *
7417	27p*	22½p*	20p *
7420	16p*	13p*	11p *
7427	27p*	22½p*	18p *
7430	16p*	13p *	11p *
7432	27p*	22½p*	18p *
7437	27p*	22½p*	18p *
7441	75p*	62p*	50p *
7442	65p*	55p*	43p *
7445	85p*	71p*	57p *
7447	81p*	75p*	65p *
7448	75p*	62p*	50p *
7447A	95p*	83p*	67p *
7470	30p*	25p*	20p *
7472	25p*	21p*	17p *
7473	30p*	25p*	20p *
7474	32p*	26p*	21p *
7475	47p*	39p*	31p *
7476	32p*	26p*	21p *
7482	75p*	62p*	50p *
7485	£1.30 *	£1.09 *	87p *
7486	32p*	26p*	21p *
7489	£2.92 *	£2.80 *	£2.10 *
7490	49p*	40p*	32p *
7491	65p*	55p*	45p *
7492	57p*	46p*	36p *
7493	45p*	40p*	32p *
7495	67p*	55p*	45p *
74100	£1.08 *	89p*	72p *
74107	35p*	28p*	22p *
74121	34p*	28p*	23p *
74122	47p*	39p*	31p *
74141	78p*	63p*	53p *
74145	68p*	58p*	48p *
74154	£1.62 *	£1.48 *	86p *
74174	£1.00 *	83p*	67p *
74180	£1.06 *	88p*	71p *
74181	£3.20 *	£2.50 *	£1.90 *
74192	£1.35 *	£1.14 *	90p *
74193	£1.35 *	£1.14 *	90p *
74196	£1.64 *	£1.34 *	99p *

LINEAR I.C.'s

555 (8 pin dip)V	55p *
555 (TO-99)T	81p *
556 (14 pin dip)	£1.29 *
703 (RF/IF Amp)	68p
709 (8 pin dip)	38p
709 (TO-99)	45p
709 (14 pin dip)	39p
710 (8 pin dip)	39p
710 (TO-99	45p
710 (14 pin dip)	44p
711 (TO-99)	51p
711 (14 pin dip)	44p
720 (A M. Radio)	£1·76
723 (TO-99)	£1 09
723 (14 pin dip	55p
741 (8 pin dip)	30p
741 (TO-99)	43p
741 (14 pin dip)	36p
747 (14 pin dip)	£1·04
748 (8 pin dip)	42p
748 (TO-99)	46p
748 (14 pin dip)	49p
753 (F.M. 1st. I.F.)	£1·08
75491	88p *
75492	£1·10 *

Regulators 100 mA

78105WC (T0-92)	60p *
78L12WC (T0-92)	60p *
78L15WC (T0-92)	60p *

Regulators 100mA

78L05AWC (TBA625A)	90p *
78L12AWC (TBA625B)	90p *
78L15AWC (TBA625C)	90p *

Regulators 500mA

78M05HC	£1.35 *
78M12HC	£1.35 *
78M15HC	£1.35 *
78M18HC	£1.35 *
78M24HC	£1.35 *

Regulators 1A

7805KC (T0-3)	£2.09 *
7812KC (T0-3)	£2 09 *
7815KC (T0-3)	£2.09 *
7818KC (T0-3)	£2.09 *
7824KC (T0-3)	£2.09 *

Regulators 1A

7805UC (T0-220)	£1.72 *
7812UC (T0-220)	£1.72 *
7815UC (T0-220)	£1.72 *
7818UC (T0-220)	£1.72 *
7824UC (T0-220)	£1.72 *
ICL8030	£3.52 *

AY-1-0212	£6.93
AY-1-5051	£1.44
AY-5-1224	£3.95 *
AY-5-3500	£6.59 *
AY-5-3507	£6.59 *
AY-5-4007	£7.94 *
BHA0002	£3.01
CA2111	£1.19
CA3045	£1.69
CA3046	88p
CA3053	59p
CA3065	£1.60
CA3075	£1.64
CA3078	£1.26
CA3080	59p
CA3081	£1.86
CA3082	£1.86
CA3089E (TDA1200)	£2.43
CA3097E	£1.67 *
CA3123E	£1.76
CA3130	84p
CA3401E (LM3900)	68p
CA3600E	£1.44
L005T1 (T0.3)	£1.46 *
L036T1 (T0.3)	£1.46 *
L037T1 (T0-3)	£1.46 *
L129 (SOT-32)	85p *
L130 (SOT-32)	85p *
L131 (SOT-32)	85p *
LM301T (T0-99)	65p
LM301S (8 pin dip)	59p
LM301A T(T0-99)	67p
LM301A S(8 pin dip)	59p
LM307 T (T0-99)	59p
LM307 S (8 pin dip)	57p
LM308 T (T0-99)	£1 96
LM308 S (8 pin dip)	98p
LM308A T (T0-99)	£7.92
LM308A S (8 pin dip)	£6.90
LM309K	£2.34 *
LM339	£2.25
LM370N	£2.85
LM371	£2.08
LM372N	£1.99
LM373N	£2.99
LM377N	£2.71
LM380	£1.25
LM381	£1.85
LM382	£1.66
LM703	68p
LM1820	£1.03

LM2111	£1·12
LM3900	69p
LM3909	66p *
MC1303L	£1·94
MC1306P	85p
MC1310P	£2·10
MC1312P	£2·52
MC1314P	£4·34
MC1315P	£4·85
MC1327P	£1·48
MC1330P	89p
MC1339P	£1 60
MC1350	68p
MC1351	92p
MC1352	92p
MC1357	£1·60
MC1358 (CA3065)	£1·23
MC1375	£1·56
MC1455 (555T)	65p *
MC1456CG	£1 77
MC1458CP1	89p
MC1468G	£2·30 *
MC1495L	£4·48
MC1496G	£1·01
MC3302P	£1 65
MC3401P	81p
MFC4000B	87p
MFC4060A	85p *
MFC6030A	85p *
MFC6040	£1·01
MM5314	£4·80 *
MM5316	£9·99 *
MVRSV (TO-3)	£1 45 *
MVR12V (TO-3)	£1 45 *
MVR15V (TO-3)	£1·45 *
NE540L	£1·25
NE546A	£1·16
NE555V	69p *
NE556	£1·29 *
NE560B	£5 06
NE561B	£5·06
NE562B	£5·06
NE563	£2·96
NE565N	£2·63
NE566V	£1·87
NE567V	£2 63
SD6000	£1·22
SL414A	£2·09
SL415A	£2·75
SL437D	£7·05
SL440	£2 84 *
SN75491N	88p *
SN75492N	£1 10 *

ZN414 Leaflet free with devices (10p alone)

MC1310; 2, 4 & 5 Leaflet free with devices (10p alone)

SN76001N (TAA611)	£1.82 *
SN76003N	£3.30
SN76013N	£1.98
SN76023N	£1.98
SN76 227N(MC1327)	£1.89
SN76532N	£1.86
SN76544N	£1.81
SN76550-2(TAA550)	89p
SN76552-2	81p
SN76660N(TBA120)	75p
SN76666N (CA3065)	£1.12
TAA263	£1.50
TAA300	£2.16
TAA310A	£1.87
TAA320	£1.44
TAA350	£2.43
TAA370	£3.45
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TAA570	£2.75
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TBA120S	£1.25
TBA231	£1.02
TBA281 (723)	£2.59
TBA500Q	£3.16
TBA520Q	£3.85
TBA530Q	£3.27
TBA540Q	£3.72
TBA550Q	£5 29
TBA560CQ	£5.29
TBA625A	£1.03 *
TBA625B	£1.03 *
TBA625C	£1.03 *
TBA651	£1.87
TBA720Q	£2.79
TBA750Q	£2.79
TBA800	£1.11
TBA810S	£1.24
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TBA820	86p
TBA920Q	£4.71
TBA990Q	£4.71
TCA270Q	£5.24
TCA760	£2.16
TCA800Q	£7.24
TCA830S	£1.04
TCA940	£2.25
TDA1054	£1.50
TDA1200	£2.43
TDA1405	80p *
TDA1412	80p *
TDA1415	80p *
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LED DISPLAYS

Litronix Double Digit Displays 0.5" Common Anode; 2 R/H Decimal Points
DL721 ± 1.9
DL727 0.0 to 9.9
Suitable for Clocks, Meters, Instruments, Channel Indicators
Our price £4.75 * each

NEW

Low cost Red GaAsP Motorola MLED 500 in a T092 package

15p.*

		C.Anode R/H Dec. pt.	C.Anode, L/H Dec.pt.	C.Anode	C.Cathode R/H Dec. Pt.	
0.33"	Litronix DL 707 Series	✓	✓	✓	✓	all £1.82* each (Red only)
0.33"	Monsanto MAN 50/70/80/3600	✓	✓	✓	✓	all £1.82* Each (Red, green, yellow, Orange)
0.33"	Xciton XAN 70 Series	✓		✓	✓	all £1.49* Each (Red Green, yellow)
0.43"	Monsanto MAN 4000 Series	✓	✓	✓	✓	all £2.32* Each (Red, Green, Yellow, Orange)
0.63	Litronix DL747 'Jumbo' Series		✓	✓		all £2·42* Each (Red only)

Common Cathode as Common Anode (Red only)

NOTE: MAN 4000 Series pin outs are 14 pin dil the same as MAN 50; 70 and 80 series.

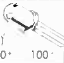
DIGITAL SWITCH

BCD encoded digital switch Reading 0 to 9. Suitable for digital clock alarm setting DVM input Scaling etc.

1 to 9. £1.49 each *

LIGHT EMITTING DIODES

Free snap-on plastic retainer



	0.125" dia lens (TIL209)			0.16" dia. lens			0.2" dia. lens (MLED 650)		
	1	10	100	1	10	100	1	10	100
Red	16p	15p	13p *	27p	24p	22p*	18p	16p	14p *
Green	27p	24p	22p *	33p	30p	27p*	30p	27p	25p *
Orange	27p	24p	22p*	33p	30p	27p*	30p	27p	25p *
Yellow	34p	31p	29p *	35p	32p	29p*	35p	33p	30p *

.......Cont'd

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0.33" (LIT 707) 90p.*(inc. VAT)
0.63" (LIT 747) £1.99 .*(inc. VAT)

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TIL 4N25 or TIL116
6 pin industry standard package
2.5KV isolation £1.00.*

MAINS TRANSFORMERS

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6-0-6V	100 mA	97p. *
9-0-9V	100 mA	97p *
12-0-12V	100 mA	97p *
20-0-20V	1 A	£4.55 *
24-0-24V	500 mA	£2.48 *
28-0-28V	1 A	£6.18 *

	½A	1A	2A	4A
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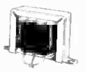
0-12-15-20-24-30 V	-	£2.48. *	£4.15.	- *
0-24-30-40-48-60 V	-	£5.18 *	£7 02	- *
0-19-25-33-40-50 V	£2.70 *	£3.40 *	£4.53	- *



p.p. on transformers 10% of price min 20p

VAT INC

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Overseas Customers deduct 2/27 from * items. 1/5 from others

postage & packing 20p. Orders for over £6. post free. Except transformers

Data Sheet and photocopy service available 10p. per page

Advert No. 1A of Series B

CALLERS WELCOMED

PRACTICAL
ELECTRONICS

VOLUME 12 No. 2 FEBRUARY 1976

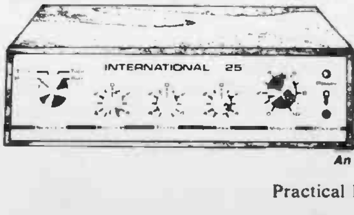
CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our March issue will be published on Friday, February 13, 1976
(for details of contents see page 119)


MINOR MULTITESTER
Operating instructions
SENSITIVITY
20 KΩ/V= 4 KΩ/V~
MINOR
Chinaglia


INTERNATIONAL 25

WILMSLOW AUDIO

THE Firm for speakers!

SPEAKERS

Baker Group 25, 3, 8 or 15 ohm	£8·64
Baker Group 35, 3, 8 or 15 ohm	£10·25
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Baker Group 50/15 8 or 15 ohm	£18·62
Baker Deluxe 124 8 or 15 ohm	£13·75
Baker Major 3, 8 or 15 ohm	£11·87
Baker Superb 8 or 15 ohm	£18·12
Baker Regent 12in 8 or 15 ohm	£10·00
Baker Auditorium 12in 8 or 15 ohm	£16·25
Baker Auditorium 15in 8 or 15 ohm	£21·56
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Celestion G12H 8 or 15 ohm	£15·95
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Celestion G12/50TC 8 or 15 ohm	£18·00
Celestion G15C 8 or 15 ohm	£26·95
Celestion G18C 8 or 15 ohm	£34·50
Celestion HF1300 8 or 15 ohm	£7·75
Celestion HF2000 8 ohm	£9·50
Celestion MH1000 8 or 15 ohm	£13·50
Celestion C03K	£4·95
Decca London ribbon horn	£32·00
Decca London CO/1000/8 crossover	£7·50
Decca DK30 ribbon horn	£19·06
Decca CO/1/8 crossover (DK30)	£5·00
EMI 150 13 × 8in d/cone 8 ohm	£2·94
EMI 13 × 8in 20W bass 8 ohm	£9·00
EMI 14 × 9in bass 8 ohms, 14A770	£13·25
EMI 8 × 5in, 10W, d/cone, roll surr.	£3·95
EMI 6½in d/cone, roll surr., 8 ohm	£4·37
EMI 8in roll surr. bass	£6·37
EMI 5in mid range	£3·50
Elac 59RM109 (15 ohm), 59RM114 (8 ohm)	£3·44
Elac 6½in d/cone, roll surr., 8 ohm	£4·06
Elac 10in 10RM239, 8 ohm	£3·95
Eagle Crossover 3000Hz 3, 8 or 15 ohm	£1·75
Eagle FR4	£6·12
Eagle FR65	£9·62
Eagle FR8	£12·31
Eagle FR10	£15·62
Eagle HT15	£4·40
Eagle HT21	£6·81
Eagle MHT10	£4·44
Eagle FF28 Multicell, horn	£9·00
Fane Pop 15, 8 or 16 ohm	£5·25
Fane Pop 25T, 8 or 16 ohm	£7·50
Fane Pop 33T, 8 or 16 ohm	£8·75
Fane Pop 50, 8 or 16 ohm	£12·00
Fane Pop 55, 8 or 16 ohm	£13·95
Fane Pop 60, 8 or 16 ohm	£17·25
Fane Pop 70, 8 or 16 ohm	£18·75
Fane Pop 100, 8 or 16 ohm	£25·95
Fane Crescendo 12A, 8 or 16 ohm	£34·50
Fane Crescendo 12BL, 8 or 16 ohm	£36·50
Fane Crescendo 15/100A, 8 or 16 ohm	£47·50
Fane Crescendo 15/125, 8 or 16 ohm	£57·95

SPEAKERS

Fane Crescendo 18, 8 or 16 ohm	£62·95
Fane 910 Mk II horn	£14·95
Fane 920 Mk II horn	£33·95
Fane HPX1 crossover 200W	£2·50
Fane 13 × 8in, 15W dual cone	£5·50
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Gauss 15in 200W	£83·00
Gauss 18in 200W	£110·00
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Goodmans Audiom 100 15 ohm	£13·90
Goodmans Audiom 200 8 ohm	£13·90
Goodmans Axiom 402 8 or 15 ohm	£20·00
Goodmans Twinaxiom 8, 8 or 15 ohm	£10·14
Goodmans Twinaxiom 10, 8 or 15 ohm	£10·75
Goodmans 8P 8 or 15 ohm	£5·50
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Goodmans 12P 8 or 15 ohm	£13·95
Goodmans 12PG 8 or 15 ohm	£15·95
Goodmans 12PD 8 or 15 ohm	£16·95
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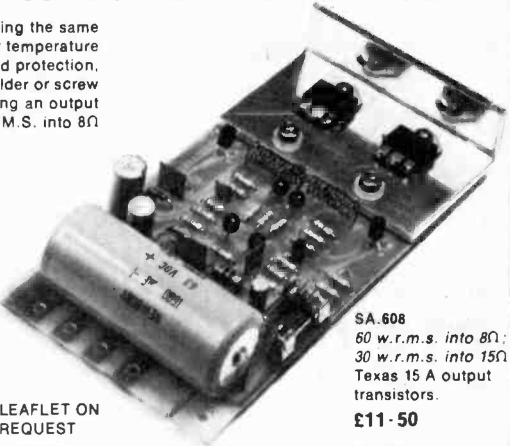

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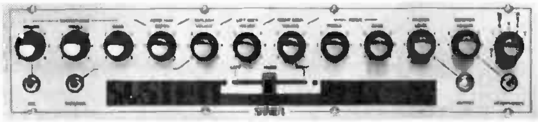

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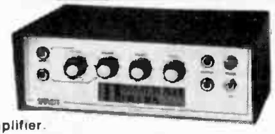

100W r.m.s. into 8Ω.

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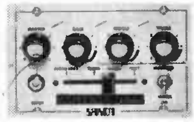

- ★ 1000 watts per channel. Sound light *and* SEQUENTIAL *and* OVERRIDE.
- ★ Individual control of bass middle and treble.
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- ★ Plug/socket terminations throughout.
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Stereo separation 30dB
Supply required 20–30V at 90mA max.

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£19.95

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
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The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

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25 WATTS (RMS)

● Max Heat Sink temp. 90°C. ● Frequency response 20Hz to 100kHz. ● Distortion better than 0·1 at 1kHz. ● Supply voltage 15–50V. ● Thermal feedback. ● Latest design improvements. ● Load: 3, 4, 5 or 16 ohms. ● Signal to noise ratio 80dB. ● Overall size 63mm, 105mm, 13mm.
Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

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SPM80 is especially designed to power two of the AL60 Amplifiers, up to 15W (r.m.s.) per channel simultaneously. With the addition of the mains transformer BMT80, the unit will provide outputs of up to 1·5A at 35V. Size 63mm × 105mm × 30mm. Incorporating short circuit protection.

Input voltage 33–40V a.c.
Output voltage 33V d.c. nominal
Output current 10mA–1·5A
Overload current 1·7A approx.
Dimensions 105mm × 63mm × 30mm
Transformer BMT80 £2·60 plus 62p postage

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STEREO PRE-AMPLIFIER PA 100

Frequency Response + 1dB 20Hz–20kHz
sensitivity of inputs:
1. *Tape input 100mV into 100k ohms*
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3. *Magnetic P.U. 3mV into 50k ohms*

P.U. input equalises to R1AA curve within 1dB from 20Hz–20kHz. Supply—20–35V at 20mA
Dimensions—299mm × 89mm × 35mm

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

OUR PRICE

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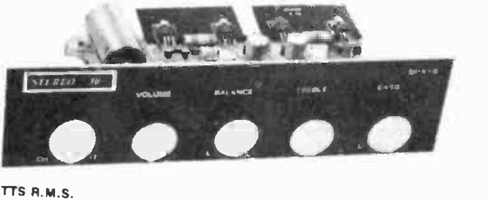
***MK60 AUDIO KIT.** Comprising: 2 × SPM80, 1 × BTM80, 1 × PA100, 1 front panel and knobs. 1 kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £27·55** plus 62p postage. **TEAK 60 AUDIO KIT.** Comprising: Teak veneered cabinet size 16¾in × 11¼in × 3¾in, other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets, etc. **KIT PRICE £9·20** plus 62p postage.*

STEREO 30

COMPLETE AUDIO CHASSIS



7 + 7 WATTS R.M.S.
The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs, i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

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P. & P. 45p

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7402	0·10	0·09	7451	0·12	0·10	74141	0·62	0·60
7403	0·12	0·09	7453	0·12	0·10	74145	0·70	0·65
7404	0·10	0·09	7454	0·12	0·10	74150	1·30	1·25
7405	0·10	0·09	7460	0·12	0·10	74151	0·65	0·60
7406	0·28	0·25	7470	0·26	0·24	74153	0·65	0·60
7407	0·28	0·25	7472	0·22	0·20	74154	1·30	1·25
7408	0·14	0·10	7473	0·26	0·22	74155	0·65	0·60
7409	0·14	0·10	7474	0·27	0·23	74156	0·65	0·60
7410	0·08	0·07	7475	0·44	0·40	74157	0·90	0·80
7411	0·20	0·18	7476	0·28	0·25	74160	0·95	0·85
7412	0·20	0·18	7480	0·40	0·35	74161	0·95	0·85
7413	0·26	0·25	7481	0·95	0·90	74162	0·95	0·85
7416	0·28	0·25	7482	0·72	0·62	74163	0·95	0·85
7417	0·27	0·24	7483	0·80	0·68	74164	1·20	1·10
7420	0·10	0·09	7484	0·85	0·80	74165	1·20	1·10
7422	0·25	0·23	7485	1·20	0·95	74166	1·20	1·10
7423	0·26	0·24	7486	0·30	0·25	74174	1·00	0·90
7425	0·26	0·24	7489	2·70	2·50	74175	0·95	0·85
7426	0·26	0·24	7490	0·38	0·32	74176	1·00	0·95
7427	0·26	0·24	7491	0·60	0·50	74177	1·00	0·95
7428	0·36	0·34	7492	0·43	0·35	74180	1·00	0·95
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7432	0·25	0·22	7494	0·45	0·40	74182	1·00	0·90
7433	0·35	0·32	7495	0·58	0·50	74184	1·50	1·40
7437	0·25	0·22	7496	0·68	0·63	74190	1·40	1·30
7438	0·25	0·22	74100	1·00	0·90	74191	1·40	1·30
7440	0·12	0·10	74101	0·30	0·25	74192	1·10	1·00
7441	0·64	0·58	74105	0·30	0·25	74193	1·10	1·00
7442	0·60	0·52	74107	0·30	0·25	74194	1·00	0·95
7443	0·95	0·90	74110	0·50	0·45	74195	0·75	0·70
7444	0·95	0·90	74111	0·80	0·75	74196	1·00	0·95
7445	0·75	0·55	74118	0·90	0·82	74197	1·00	0·95
7446	0·95	0·85	74119	1·30	1·20	74198	1·90	1·80
7447	0·68	0·65	74121	0·26	0·25	74199	1·80	1·70

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

IC SOCKETS

BPS8 **9p** BPS14 **10p** BPS16 **11p**

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741P 8 PIN D.I.L. **20p**

TIMERS

NE555 **42p** DUAL NE556 **85p**

TRANSISTORS

TYPE	PRICE
AC128	10p
AC153K	18p
AC176K	20p
AC153/ 176K MP	38p
AC187K	20p
AC188K	18p
AC187K/ 188K MP	38p
OC71	9p
BC107	6p
BC108	6p
BC109	6p
BC118	8p
BC154	20p
BC147	8p
BC148	8p
BC149	10p
BC157	12p
BC158	10p
BC159	10p
BC169C	7p
BC170	5p
BC171	5p
BC172	5p
BC182 L & K	10p
BC183	10p
BC184	12p
BC212 L & K	10p
BC213	10p
BC214	12p
BC251	6p
BC327	12p
BC328	12p
BC337	11p
BC338	11p
BF115	10p
BF167	10p
BF173	10p
BF198	12p
BF199	12p

TYPE	PRICE
BF194	9p
BF195	9p
BF196	11p
BF197	11p
BF257	22p
BF258	26p
BF259	30p
BFX29	18p
BFX84	15p
BFX85	20p
BFX86	16p
BFY50	15p
BFY51	15p
BFY52	15p
BFY53	14p
2N696	10p
2N697	11p
2N706	6p
2N706A	6p
2N708	7p
2N1613	15p
2N1711	15p
2N1893	18p
2N2217	15p
2N2218	14p
2N2218A	15p
2N2219	14p
2N2219A	15p
2N2221	14p
2N2221A	15p
2N2222	14p
2N2222A	15p
2N2369	12p
2N2369A	12p
2N2904	12p
2N2904A	13p
2N2905	13p
2N2905A	13p
2N2906	10p
2N2906A	12p
2N2907	11p
2N2907A	13p
2N2926G	9p

TYPE	PRICE
2N2926Y	8p
2N3053	15p
2N3055	40p
2N3702	8p
2N3703	8p
2N3704	9p
2N3705	8p
2N3706	8p
2N3707	7p
2N3708	7p
2N3709	7p
2N3710	7p
2N3711	7p

F.E.T.

2N3819	12p

2N3903	8p
2N3904	8p
2N3905	9p
2N3906	9p
2N4058	8p
2N4059	8p
2N4060	9p
2N4061	9p
2N4062	9p
2N5172	9p

UNI-JUNCTION

UT46 = TIS43	20p

ZTX300	5p
ZTX500	8p
ZTX107	5p
ZTX108	5p
ZTX109	5p

DIODES

TYPE	PRICE
OA10	15p
OA47	5p
OA85–OA81	5p
OA91	5p
OA200/ BAX13	5p
OA200/ BAX16	5p
IN914	4p
IN4148	4p
IN4001	3p
IN4002	4p
IN4003	4p
IN4004	5p
IN4005	5p
IN4006	6p
IN4007	7p

S.C.R.'s

1A/50V TO5	15p
1A/400V TO5	25p
5A/50V TO66	25p
5A/400V TO66	40p

VOLTAGE REGS.

L129 (UA7805)	85p
L130 (UA7812)	85p
L131 (UA7815)	85p

L.E.D.

TIL209/ FLV117 RED 5 for	50p

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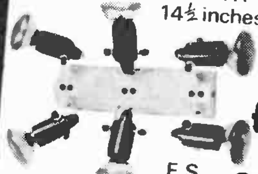

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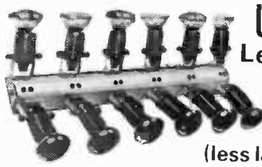

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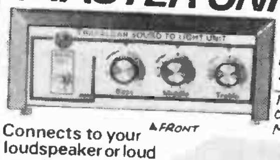

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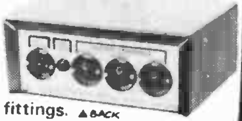

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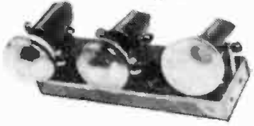

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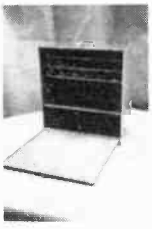

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7401	11	7453	13	74156	71
7402	11	7454	14	74157	71
7403	11	7460	11	74161	95
7404	13	7464	21	74163	90
7405	13	7465	21	74164	1-10
7406	22	7472	22	74165	1-25
7407	22	7473	26	74166	1-15
7408	14	7474	26	74173	95
7409	14	7475	41	74175	95
7410	11	7476	26	74176	95
7411	16	7483	70	74177	85
7413	29	7485	80	74180	80
7416	22	7486	24	74181	2-50
7417	22	7489	1-50	74182	80
7420	11	7490	40	74184	1-55
7422	22	7491	71	74185	1-30
7423	22	7492	44	74190	95
7425	22	7493	44	74191	95
7426	23	7494	49	74192	90
7427	22	7495	49	74193	85
7430	12	7496	55	74194	95
7432	22	74100	1-00	74195	72
7437	25	74105	60	74196	1-00
7438	21	74107	27	74197	75
7440	11	74121	28	74198	1-70
7441	60	74122	50	74199	1-70
7442	55	74123	55	74200	3-90
7443	55	74125	50		
7444	60	74126	50		
7445	75	74141	68		
7446	85	74145	75		
7447	73	74150	75		
7448	80	74151	60		
7450	12	74153	71		

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74L02	16	74L55	18	74L91	80
74L03	16	74L71	18	74L93	89
74L04	18	74L72	27	74L95	89
74L06	18	74L73	38	74L98	1-53
74L10	16	74L74	38	74L164	1-53
74L20	16	74L78	44	74L165	1-53
74L30	16	74L85	85		
74L42	89	74L86	38		

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74H00	£0-16	74H21	£0-16	74H55	£0-20
74H01	16	74H22	18	74H60	21
74H04	16	74H30	18	74H61	21
74H08	16	74H40	16	74H62	20
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8123	88	8551	91	8831	1-42
8130	1-20	8552	1-37	8836	27
8200	1-42	8554	1-37	8880	73
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74C02	30	74C76	93	74C163	1-78
74C04	41	74C107	82	74C164	1-92
74C08	41	74C151	1-59	74C173	1-59
74C10	36	74C154	1-92	74C195	1-65
74C20	36	74C157	1-20	80C95	82
74C42	1-18	74C160	1-78	80C97	82
74C73	.85	74C161	1-78		

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4010A	38	4022A	78	4050A	42
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4069A	£ 31	4073A	28	4082A	25
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	Jumbo Vis. Red (Clear Dome)	18
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MAN2	Red alpha num .32"	2-72
MAN3	Red 7 seg. .127" straight pins	16
MAN4	Red 7 seg. .190"	1-18
MAN5	Green 7 seg. .270"	1-62
MAN6	.6" high solid seg.	3-81
MAN7	Red 7 seg. .270"	74
MAN8	Yellow 7 seg. .270"	2-17
MAN66	.6" high spaced seg.	2-55
MCT2	Opto-iso transistor	38

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SL5-4025	QUAD 25 bit	95

DTL

930	10	937	10	949	10
932	10	944	10	962	10
936	10	946	10	963	10

MEMORIES

1101	256 bit RAM MOS	96
1103	1024 bit RAM MOS	2-72
2102-2	1024 bit static RAM	2-00
5260	1024 bit RAM	1-20
5261	1024 bit RAM	1-20
5262	2048 bit RAM	2-00
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MM5738	8 DIG 5 funct K & mem	2-42
MM5739	9 DIG 4 funct (btry sur)	2-92
MM5311	28 pin BCD 6 dig mux	2-42
MM5312	24 pin 1 pps BCD 4 dig mux	1-94
MM5313	28 pin 1 pps BCD 6 dig mux	2-42
MM5314	24 pin 6 dig mux	2-42
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302	Volt follower TO-5	43
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308	Mciro Pwr Op Amp mDIP TO-5	60
309K	5V 1A regulator TO-3	91
310	V Follower Op Amp mDIP	65
311	Hi perf V Comp mDIP TO-5	58
319	Hi Speed Dual Comp DIP	71
320	Neg Reg 5.2, 12, TO-3	74
322	Precision Timer DIP	60
324	Quad Op Amp DIP	1-07
339	Quad Comparator DIP	92
340K	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-3	1-20
340T	Pos V reg (5V, 6V, 8V, 12V, 15V, 18V, 24V) TO-220	1-07
372	AF-IF Strip detector DIP	44
373	AM/FM/SSB Strip DIP	30
376	Pos V Reg mDIP	33
380	2w Audio Amp DIP	81
380-8	.6w Audio Amp mDIP	69
381	Lo Noise Dual preamp DIP	98
382	Lo Noise Dual preamp DIP	98
550	Prec V Reg DIP	54
555	Timer mDIP	44
556A	Dual 555 Timer DIP	89
560	Phase Locked Loop DIP	1-94
562	Phase Locked Loop DIP	1-94
565	Phase Locked Loop DIP TO-5	1-20
566	Function Gen mDIP TO-5	1-20
567	Tone Decoder mDIP	1-20
709	Operational AMP TO-5 or DIP	27
710	Hi Speed Volt Comp DIP	21
711	Dual Difference Compar DIP	44
723	V Reg DIP	38
739	Dual Hi Perf Op Amp DIP	65
741	Comp Op Amp mDIP TO-5	25
747	741 Dual Op Amp DIP or TO-5	44
748	Freq Adj 741 mDIP	27
1304	FM Mulpx Stereo Demod DIP	65
1307	FM Mulpx Stereo Demod DIP	45
1458	Dual Comp Op Amp mDIP	38
1800	Stereo multiplexer DIP	1-50
LH2111	Dual LM 211 V Comp DIP	1-07
3900	Quad Amplifier DIP	33
7524	Core Mem Sense AMPL DIP	1-04
8038	Voltage contr. osc. DIP	3-20
8864	9 DIG Led Cath Drvr DIP	1-37
75150	Dual Line Driver DIP	1-10
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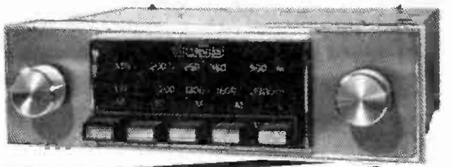

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INPUT SENSITIVITIES – Input – 1). Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity.) – Inputs – 2), 3), 4). Medium output equipment – ceramic cartridge, tuner, tape recorder, organs, etc. – all 250mV sensitivity. AC Mains, 240V operation. Size approx: 12½"×6"×3½". **£20.00** +£1.35 p & p.

8 TRACK HOME CARTRIDGE PLAYER

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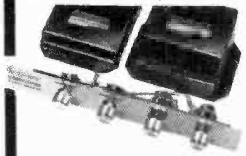
BUILD YOUR OWN STEREO AMPLIFIER*



For the man who wants to design his own stereo – here's your chance to start, with Unisound – pre-amp, power amplifier and control panel. No soldering – just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

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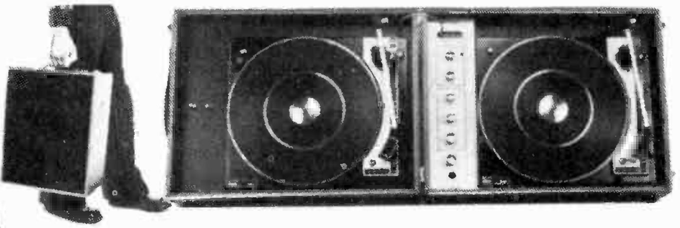
Also available with the 'Compact' (see opposite page) easy build speaker kit £13.50 + £2 p & p

PORTABLE DISCO CONSOLE*

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables. Two B.S.R. MP60 type single play professional series decks, fitted with crystal cartridges.



TECHNICAL SPECIFICATION:

Pre amp – Output – 200mV. Auxiliary inputs – 200mV and 750mV into 1 meg. Mic input – 6mV into 100K 240 volt operation. **Turntables capacity** – 7", 10" or 12" records. **Rumble, wow and flutter** Rumble Better than –35dB. Wow Better than 0.2%. Flutter Better than 0.06% (Gaumont kalee meter). **Finish** – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size –

Unit Closed – 17¾"×13¾"×8¾"(app.)

Unit Open – 35¾"×13¾"×4¾" (app.)

This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.

The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

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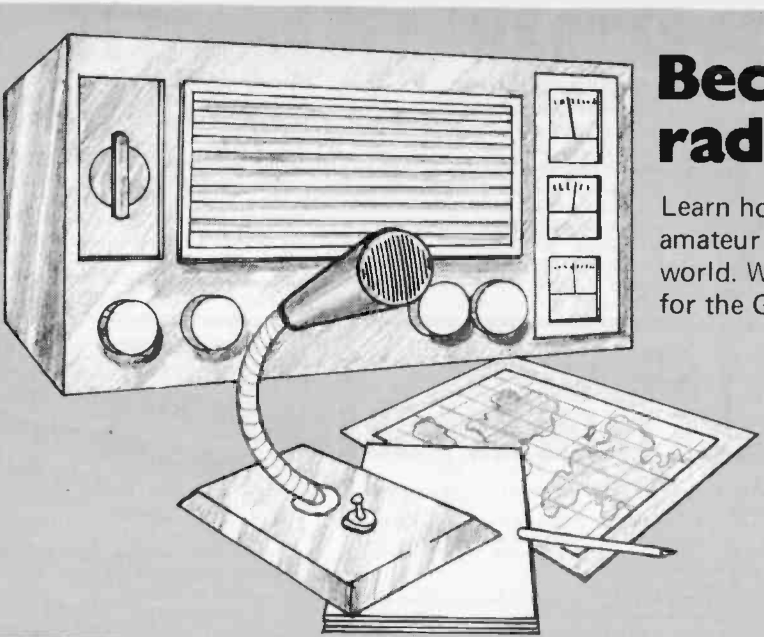

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AC153	0·27	BF200	0·25	2N2222	0·17½
AC176	0·14	BF194	0·09	2N2646	0·30
AC187K	0·27	BF195	0·09	2N2904	0·18
AC188K	0·27	BF198	0·12	2N2905	0·18
AD161	0·35	BF199	0·12	2N2906	0·18
AD162	0·35	BF257	0·24	2N2907	0·18
BA102	0·10	BF258	0·24	2N2926G	0·09
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BAX16	0·04	BFX29	0·22	2N3054	0·40
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BC108	0·09	BFX84	0·20	2N3393	0·12
BC109	0·09	BFX85	0·27	2N3441	0·56
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BC183	0·09	OA91	0·04	2N3771	1·25
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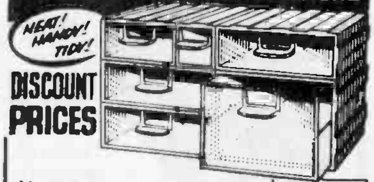

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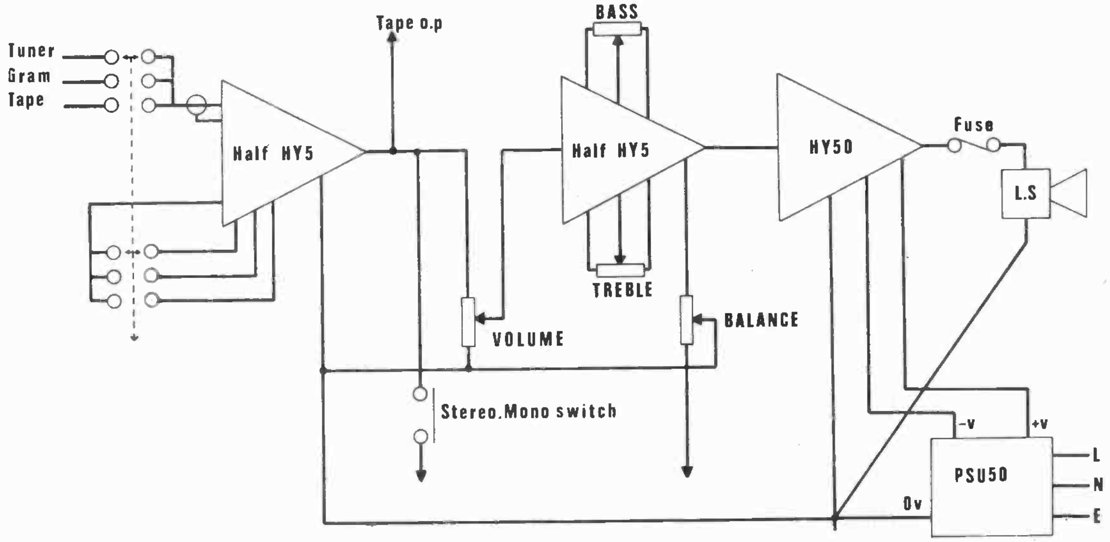
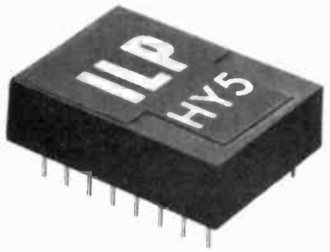
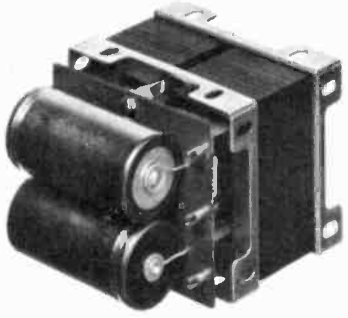


MONO ELECTRICAL CIRCUIT DIAGRAM WITH INTERCONNECTIONS FOR STEREO SHOWN





The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

TECHNICAL SPECIFICATION
Inputs: Magnetic Pick-up 3mV RIAA; Ceramic Pick-up 30mV; Microphone 10mV; Tuner 100mV; Auxillary 3–100mV; Input/impedance 47kΩ at 1kHz. **Outputs:** Tape 100mV; Main output 0db (0·775V RMS). **Active Tone Controls:** Treble ± 12db at 10kHz; Bass ± 12db at 100Hz. **Distortion:** 0·5% at 1kHz. **Signal/Noise Ratio:** 68db. **Overload Capability:** 40db on most sensitive input. **Supply Voltage:** ± 16–25V.

The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided, input, output, power lines and earth.

TECHNICAL SPECIFICATION
Output Power: 25W RMS into 8Ω. **Load Impedance:** 4–16Ω. **Input Sensitivity:** 0db (0–775V RMS). **Input Impedance:** 47kΩ. **Distortion:** Less than 0·1% at 25W typically 0·05%. **Signal/Noise Ratio:** Better than 75db. **Frequency Response:** 10Hz–50kHz ± 3db. **Supply Voltage:** ± 25V. **Size:** 105 × 50 × 25mm.

The PSU50 incorporates a specially designed transformer and can be used for either mono or stereo systems.

TECHNICAL SPECIFICATIONS
Output voltage: ± 25V. **Input voltage:** 210–240V. **Size:** L.70, D.90, H.60mm.

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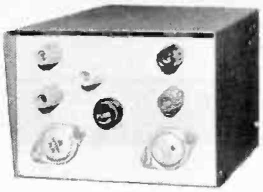

240v–50Hz from your 12v car battery.

25 watt—£4·20	150 watt—£19·10
40 watt—£7·35	300 watt (12v)—£29·85
75 watt—£10·71	300 watt (24v)—£23·75

All above invertors are in kit form but may be purchased built up in metal case & ready for use. Price list sent on receipt of s.a.e. Prices include post & packing.

P.W. AUTOMATIC EMERGENCY SUPPLY

240v–50Hz–150 watt invertor with built in battery charger. In event of power failure switches over automatically from battery charging to invertor operation. Cct. as appeared in Dec. 72 P.W. Complete kit of parts (excluding meter) £22·50 + £1·10 p. & p.

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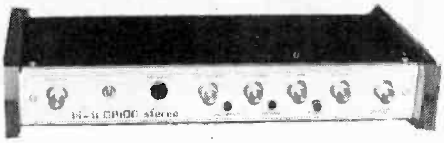

20 + 20 Watts r.m.s. into 8 ohm load. Distortion less than 0·01% 100Hz–10kHz. Frequency response ± 1dB 20 Hz to 20 kHz. Hum level virtually nil with vol. full on.

This is a power amplifier of superb quality incorporating the very latest design features. Professional hi-fi enthusiasts have classed it as fantastic and real value for money. The CCT incorporates a low flux transformer and inputs for disc. tape, tuner, etc.

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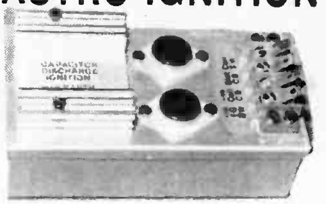
The bookend case, I.C.s & semiconductors, P.C. board, Transformer, etc. may be purchased separately if desired. Send S.A.E. for further information

ASTRO IGNITION



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230 VOLT RELAY
3 h.d. c/o contacts. Price **75p.** Post 20p. Octal plug in base 15p extra.
230/240 VOLT A.C. RELAY. Mfg. by Arrow 2 h.d. 15 amp c/o contacts. Amp connectors. Price **£1.** Post 20p.
220/240 VOLT A.C. RELAY
3 c/o 5 amp contacts. Sealed. Mfg. ISKRA. **£1·25.** Post 20p. Base 15p extra.
CLARE-ELLIOTT TYPE RP7641 G8
Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o. **70p** post paid.
110V. 2 c/o. 20 amp contacts. **£1·25.** Post 10p.
Many others from stock—phone for details.

LATCHING RELAY

Twin latching relay, "flip-flop" 2 c/o each relay. Mains contacts. 115V A.C. or 50V D.C. operation. 240V A.C. with 2·5K resistor. **85p.** Post 20p.

C/O MICRO SWITCH

VERY SPECIAL OFFER. Mfg. by C.E.M. 3 amp 250 volt. 10 amp 125 volt. 50 for **£3.** Post 36p. 100 for **£5.** Post 50p. 1,000 for **£45.** Post paid.
Bulk purchase means LOW! LOW! prices.
DOUBLE POLE C/O or 2 make/2 break micro switch. 10 amp 250v a.c. With detachable roller assembly. 10 for **£2·50.** Post 50p (min. order 10).

230/250 VOLT A.C. SOLENOID

Approximately 1½lb pull. Size of feet 1⅜" × 1⅞". Price **£1·00.** Post 20p.

HEAVY DUTY TYPE. 10 lb. (approx.) pull. **£2·50.** Post 50p.

24 VOLT DC SOLENOIDS

UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two × approx. 1lb pull ½ inch travel. 6 × approx. 4oz. pull ½ inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price **£2·50.** Post £1. **ABSOLUTE BARGAIN.**

600 WATT DIMMER SWITCH
Easily fitted. Fully guaranteed by makers. Will control up to 600W of lighting except fluorescent at mains voltage. Complete with simple instructions. **£2·75.** Post 25p.
1,000 watt model, **£4.** Post 25p.
2,000 watt model, **£8.** Post 40p.

CENTRIFUGAL BLOWER

Mfg by Smiths Industries. 230/240V a.c. Miniature Model. Series SE/200. Size 95mm × 82mm × 82mm. Aperture 38mm × 31mm. 12 c.f.m., **£2·75.** Post 50p.

Mfg. by Airflow Developments Ltd.
Precision made, continuously rated, smooth running. 230/240V a.c. motor, 80 c.f.m. As illustrated but with round aperture. **£6·50.** Post 75p.

Mfg. by Woods.
Extremely powerful. 220/250V a.c. 0·3A 2,700 r.p.m. continuously rated. Capacitor start. Cast construction. Aperture 66mm × 50mm, O/A 200mm. **£12.** Post £1.

INSULATION TESTERS *NEW!*

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. **500V,** 500 megohms, **£30.** Post 80p. 1,000V, 1,000 MΩ, **£36.** Post 80p.

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Phone 01-995 1560
Showroom open Mon.-Fri.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230/240V a.c. 50/60 OUTPUT
VARIABLE 0–260V **All Types**
SHROUDED TYPE
200 watt (1 amp) **£10·00**
0·5 KVA (2½ amp) (MAX) **£11·50**
1 KVA (5 amp) (MAX) **£16·50**
2 KVA (10 amp) (MAX) **£30·00**
3 KVA (15 amp) (MAX) **£33·00**
4 KVA (20 amp) (MAX) **£60·00**
37·5 amp (MAX) **£102·50**
CARRIAGE AND PACKING EXTRA

L.T. TRANSFORMERS

0, 6, 12 Volt at 10 amp.	**£5·60.**	Post 70p.
0, 10, 17, 18 Volt at 10 amp.	**£7·90.**	Post £1·00
0, 4, 6, 24, 32 Volt at 12 amp.	**£9·90.**	Post £1·00
0, 6, 12 Volt at 20 amp.	**£9.**	Post £1·00
0, 12, 24 Volt at 10 amp.	**£9·20.**	Post £1·00
0, 6, 12, 17, 18, 20 Volt at 20 amp.	**£10·40.**	Post £1·00

Other types to order at short notice—Phone your enquiries.

STROBE! STROBE! STROBE!

Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation.

HY-LYGHT STROBE MK III
For use in large rooms, halls and utilises a silica tube, printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes **£15·40.** Post 75p.
RANGE OF THREE OTHER STROBE KITS FROM STOCK. FROM £6·30 to £22.
S.A.E. (Foolscap) for details.

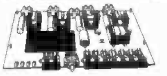
BIG BLACK LIGHT

400 Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. P.F. ballast is essential. Price of matched ballast and bulb **£21.** Post £1·50. Spare bulb **£8.** Post 65p.

BLACK LIGHT FLUORESCENT U.V. TUBES

4ft 40 watt, £5·50 (callers only).
2ft 20 watt, £4·25. Post 60p. (For use in standard bi-pin. MINI. **12in 8 watt, £1·60.** Post 25p. **9in 6 watt, £1·30.** Post 25p. Complete ballast unit and holders for 9in and 12in tube, **£1·70.** Post 30p. (9in and 12in measures approx.)

SQUAD LIGHT

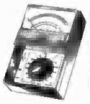


A new conception in light control. Four channels each capable of handling 750 watts of spot lights, flood lights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free. Can be used on same circuit as radio mikes or sensitive amplifiers. A whole new range of lighting effects possible with astounding results. Already in use in London's foremost theatres, night clubs and discos. Conforms to all R.F.I. tests, including Common Market regulations. Supplied in tough, well designed case with embossed front panel. Price only **£60.** Post 75p. S.A.E. (Foolscap) for further details.

U.D.I. SINGLE CHANNEL
750 WATT MANUAL/AUTO DIMMER
750W Solid State Fader, with three functions. Manual fade; Auto fade-up; Auto fade-down. Automatic cycling up and down. Functions selected with 'three-position' rocker switch. Two ranges of cycling for 'Flashing' or 'Slow blending'. Ready built module 6" × 3" glass fibre board incorporating 10 amp TRIAC. Two or more modules for top quality colour blending and flashing effects. PRICE **£15.** Post 30p.

WIDE RANGE OF DISCO LIGHTING EQUIPMENT
6" colour wheels, 3½" cassettes. S.A.E. (Foolscap) for details.

WHY PAY MORE?



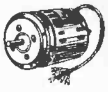
MULTI RANGE METER. A.C. volts 2·5–500, D.C. volts 2·5–500 (Sensitivity 2000 Ω/V d.c. and a.c.). D.c. current 0/1/10/100 mA, Ohms range. Sturdy compact moving coil instrument with 21 ranges. Dimensions 120 × 80 × 44mm. Weight 0·32kg.
SERVICE TRADING CO. Price **£5·00.** Post 50p. (Total price inc. VAT and post **£5·94**). Incl. leads and battery.

VAT

VAT AT 8% MUST BE ADDED TO ALL ORDERS FOR THE TOTAL VALUE OF GOODS INCLUDING POSTAGE UNLESS OTHERWISE STATED

SERVICE TRADING CO.

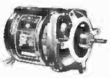
REVERSIBLE MOTOR



General Electric, 230V a.c. 1,600 r.p.m. 0·25A. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm × 95mm. Spindle 3/16in. dia. 20mm long. Ex. equipment tested, £3. Post 50p.

230/240 VOLT A.C. MINIATURE MOTOR. 20 R.P.M. Price £1. Post 20p.

BODINE TYPE N.C.I. GEARED MOTOR



(Type J) 71 r.p.m. torque 10 lb. in. **Reversible** 1/70th h.p. cycle 0·38 amp. **(Type 2) 28 r.p.m.** torque 20 lb. in **Reversible** 1/80th h.p. 50 cycle 0·28 amp. The above two precision made U.S.A. motors are offered in 'as new' condition. Input voltage of motor 115V A.C. Supplied complete with transformer for **230/240V A.C. input.**
Price, either type **£6·25.** Post 75p or less transformer **£3·75.** Post 65p.

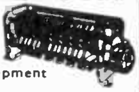
GEARED MOTOR

Type SD48 15 r.p.m. 80 lb. ins. Input 100/200 volt A.C. Length incl. gearbox 270 mm. Height 135 mm. Width 150 mm. Shaft drive 16 mm. Weight 8·5 Kilos. BRAND NEW. Price **£10.** Carr. £1.
Suitable transformer for use on 220/240 volt A.C. **£3·85.** Post 50p.

ROTARY VACUUM AIR PUMP AND COMPRESSOR

Carbon vane, oilless, 100/115V a.c., 1½h.p. motor, 50/60 cycle, 2875/3450 r.p.m., 20 in vacuum, comp. 1·25 c.f.m., 10 p.s.i. (approx. figures). New unused surplus stock. Supplied with electrical connection data. FRACTION OF MAKERS' PRICE **£12.** Post £1·00. Suitable 110/240V, 150 watt auto transformer **£3·50.** Post 50p. (Both items together Post £1·25).

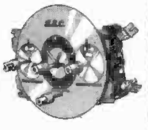
PROGRAMME TIMERS



230/240V a.c. 15 r.p.m. Motors. Each cam operates a c/o micro switch. Ideal for lighting effects, animated displays, etc. Ex equipment tested.

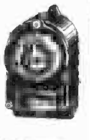
2 cam model.	15 r.p.m.	**£2·00** post 35p.
4 cam model.	15 r.p.m.	**£2·50** post 40p.
8 cam model.	20 r.p.m.	**£4·75** post 60p.

A.C. MAINS TIMER UNIT



Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135mm × 130mm × 60mm. Price **£2·25.** Post 40p. (Total incl. VAT and Post £2·87).

TIME SWITCH



'Horstmann' Type V Mk. II Time switch. 200/250 volt A.C. Two on/two off every 24 hours, at any manually pre-set time. 30 amp contacts. 36 hour spring reserve in case of power failure. Day omitting device. Fitted in heavy high impact case, with glass observation window. Built to highest Electricity Board Spec. individually tested. Price **£7·75.** Post 50p. (Total inc. VAT **£8·91**).

TRIAC

Raytheon Tag symmetrical Triac. Type TAG. 250/500V, 10 amp, 500 p.i.v. Glass passivated plastic triac. Swiss precision product for long term reliability **£1·00.** Post 10p. (Inclusive of Data and application sheet.) Suitable Diac **18p.**

POWER RHEOSTATS ! ! !

Superior Quality Precision Made
NEW POWER RHEOSTATS

New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.
25 WATT 10/25/50/100/150/250/500/1k/1·5k ohm. **£1·70.** Post 20p.
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100 WATT 1/5/10/25/50/100/250/500/1k/1·5k/2·5k/3·5k/5k ohm **£3·30.** Post 35p.
Black Silver, Skirted knob calibrated in Nos. 1–9 1½in. dia. brass bush. Ideal for above **22p** each.

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TUAC

TRANSISTOR UNIVERSAL AMPLIFICATION CO.LTD
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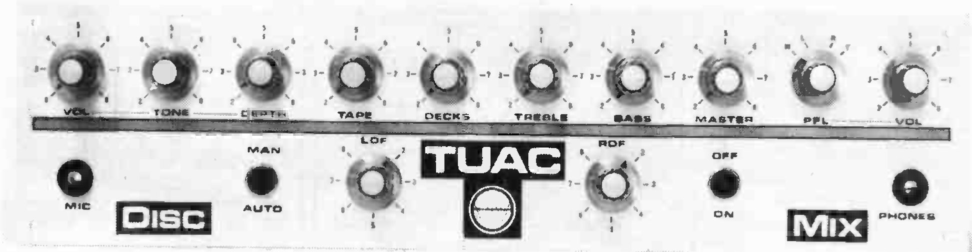
TUAC DISCOTHEQUE MIXER WITH AUTO FADE



Designed for the discerning D.J. of professional standard. Offering a vast variety of functions. Controls: Mic Vol; Tone, over-ride depth; auto/Manual Sw; Tape Vol; L & R Deck Faders; Deck Volume; Treble and Bass; H. Phon Vol Selector; Master Vol On/Off Sw. Max output 1V RMS.

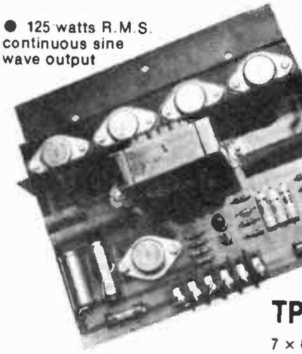
Specification: Deck Inputs—50mV into 1MΩ; Deck Tone Controls—treble +20 −10dB at 12kHz, Bass +22 −15dB at 40Hz; Mic Input—200 ohms upwards, 2mV into 10kΩ; Mic Tone Control—Total Variation Treble 15dB, Total Variation Bass 10dB; Tape Input—30mV into 47kΩ; Power Requirements—30–50 volts at 50mA.

£31·50

PANEL SIZE
18 × 4½in
DEPTH 3in

★ TUAC AMPLIFIER MODULES ★ POWER AND QUALITY ★

- 125 watts R.M.S. continuous sine wave output



TP125

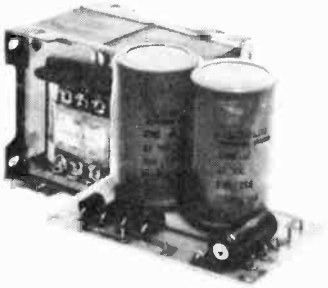
7 × 6½ × 3in

£19·50

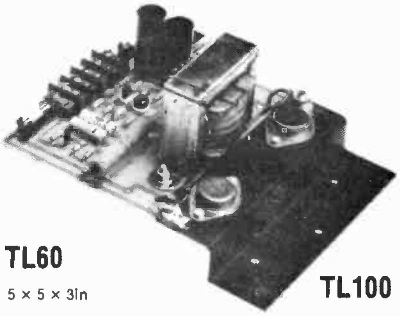
- 4 R.C.A. 150 watt 15 amp output transistors

- Rugged layer wound driver transformer
- Short—Open—and Thermal overload protection
- Only 6 connections

Power supplies vacuum impregnated. Transformers with supply board incorporating pre-amp supply:



PS 125 ± 45 volts for TP125	£12·25
PS 100 ± 43 volts for TL100	£11·25
PS 60 ± 38 volts for TL60	£10·00
PS 30 ± 25 volts for TL30	£5·90
PSU 2 for supplying disco mixer	£4·75



TL60

5 × 5 × 3in

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

£12·50

TL100

5 × 5 × 3in

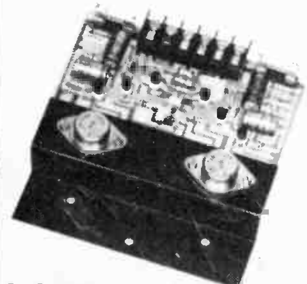
- 100 watts R.M.S. continuous sine wave output
- 2 R.C.A. 150 watt 15 amp transistors

£15·00

Specification on all power modules: All output power ratings ±0·5dB; Output impedance 8–15 ohms; THD at full power 2% typically 1%; Input sensitivity 60mV into 10kΩ; Frequency response 20Hz–20kHz ±2dB; Hum and noise better than −70dB.

STOCKISTS—CALLERS ONLY

Geo Mathews, 85/87 Hurst Street, Birmingham (Tel. 021-622 1941)
Arthur Sallis Ltd., 28 Gardner Street (Tel. Brighton 65806)
Bristol Disco Centre, 86 Stokes Croft (Tel. Bristol 41666)
Socodi, 9 The Friars (Tel. Canterbury 60948)
Cookies, 132 West Street (Tel. Crewe 4739)
Calbarrie Audio, 88 Wellington Street (Tel. Luton 411733)
A1 Music Centre, 88 Oxford Street, Manchester (Tel. 061-236 0340)
Damon Electronics, 99 Carrington Street (Tel. Nottingham 53880)
Electra Centre, 58 Lancaster Road (Tel. Preston 58488)
Mitchell Electronics, 64 Winchester Street (Tel. Salisbury 23689)
Mitchell Electronics for Southampton area



5 × 5 × 1½in

TL30

NEW FROM TUAC TL30 D.C. COUPLED POWER AMPLIFIER MODULE.

- Output power 30 watts R.M.S. continuous sine wave
- Output impedance 8–15 ohms
- T.H.D. at full power 0·5%
- Signal to noise ratio −85dB
- Input sensitivity 60mV into 50k ohms
- Frequency response 25Hz–50kHz
- 8 transistors
- 4 diodes
- Only six connections

£8·00

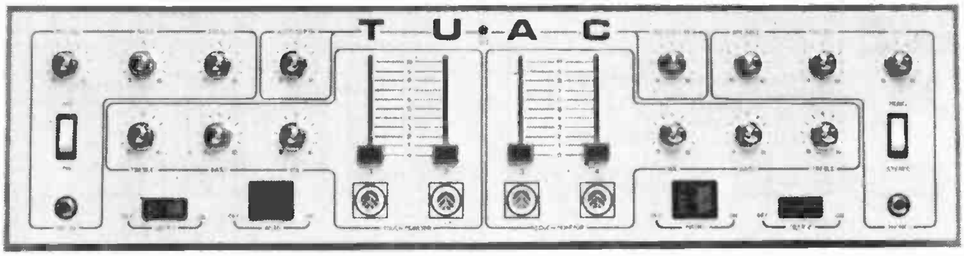
Send large stamped addressed envelope with all enquiries or send £1 (refundable against purchase) for fully illustrated 20 page catalogue.

TUAC

MANUFACTURERS OF ELECTRONIC AND AMPLIFICATION EQUIPMENT

PERSONAL SHOPPERS MON TUES. THURS. FRI and SAT
9 a.m.-6 p.m. WED 9 a.m. 1 p.m.

TUAC STEREO DISCO MIXER



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.

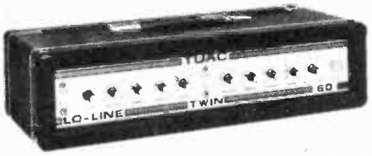
OUTPUT: Up to 3 volts (+12dB) available. Attenuated output for TUAC Power Modules. Rotary master and balance controls. Band width 15Hz-25kHz ±1dB.

P.F.L.: Output 250mW 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 switch. Auto fade illuminated on/off switch. Mains powered with integral screen and back cover. Complete with full instructions.

£75·00

Size: 25in long × 6in high × 5in deep



TWIN 60

£80·00

Output power 60 watts R.M.S. Four inputs, two channels each with volume, treble, middle and bass controls. Variable wave form control.

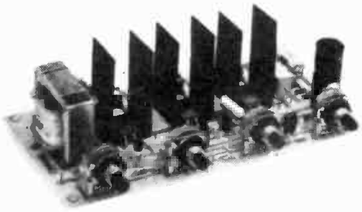
★ **Lo-Line Twin 125** (125 watts version)	£98·00
★ **Lo-Line 60** (single pre-amp version)	£65·00
★ **Lo-line 125** (single pre-amp version)	£81·00
★ **Lo-line 125** slave output power 125 watts R.M.S.	£70·00

▲▼ All Lo-Line Amplifiers are 25½in long × 11½in high × 6½in deep ▲▼

NEW TUAC LO-LINE STEREO 250 125 WATTS PER CHANNEL—£130

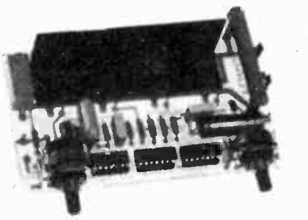
3 CHANNEL LIGHT MODULATOR

- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
- Full wave control
- 12 easy connections



£15·50 Single Channel Version 1500 Watts £7·25

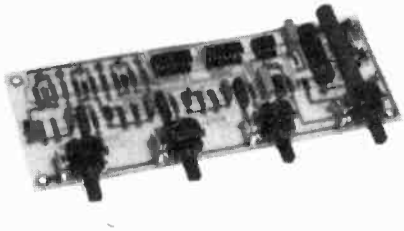
4 CHANNEL SOUND TO LIGHT SEQUENCE CHASER—4LSMI



- RCA 8A Triacs
- 1000W per channel
- Fully suppressed and fused
- Switched master control for sound operation from ¼W 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
- Full wave control
- 13 easy connections

Patents applied for **£22·00**

ADD SEQUENCE CHASING AND DIMMING EFFECTS TO YOUR TUAC 3 CHANNEL LIGHT MODULATOR



- Speed Control 3 per min. to 10 per sec.
- Full logic integrated circuitry
- Dimmer control to each channel
- 9 easy connections

SEQUENCE DIMMER MODULE—3SDMI **£9·50**

HOW TO ORDER BY POST

Make cheques P.O.s payable to
TUAC LTD (PE2)
or quote Access Barclaycard No
and post to TUAC LTD (PE2)
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We accept phone orders against
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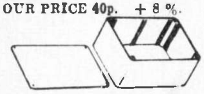
An ideal box to give a small project a professional finish.
SIZE (internal) 81mm × 51mm × 28mm.
OUR PRICE 40p. + 8 %.



10in 8ohm DUAL CONE L/S

Manufactured by "ELAC" to a very high standard these loudspeakers are a real bargain.
SPEC:—Size—10in. Dual Cone Power—10 Watts. Frequency—40-12000Hz. + 25%. Our price £3·75 ea.

I.C. SOCKETS + 8%

D.I.L.

8 pin—13p	24 pin—24p
14 pin—14p	28 pin—28p
16 pin—14p	36 pin—36p

FERRIC CHLORIDE

Anhydrous ferric chloride in double sealed one pound poly packs.
Our Price 65p per lb. + P/P + VAT @ 8%.

MINIATURE RELAYS

Brand new range of British made relays, size: 1¾in × 1in × ⅝in.
All two changeovers with 250V 1·5A contacts and suitable for fitting on 0·1m veroboard.

Type	Volts	Current	Ohms	
27/A	12V	17M/A	700	All
21/A	12V	28M/A	430	£1·30
12/A	6V	33M/A	185	each

+ 8%.

MINI LOUDSPEAKERS

2½"	80 ohm	60p
2½"	40 ohm	60p
2½"	8 ohm	60p

+ 25%.

LOW PRICE TRANSISTORS

BF303B	15p	TIP42A	75p
AC142R	25p	OC75	22p
BC149B	15p	AA129	6p

I.C. EXTRACTION TOOL

Saves damage to valuable I.C.s
ONLY 40p + 8% VAT

3 KILOWATTS PSYCHEDELIC LIGHT CONTROL UNIT

Three Channel: Bass, Middle, Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed.)
£18·50 plus 75p. P.&P.+8%.

CABLE LESS SOLDERING IRON WAHL "ISO-TIP"

- ★ Completely portable.
- ★ Solders up to 150 joints per charge.
- ★ Recharges in its own stand.
- ★ Fine tip for all types of soldering.
- ★ Only 8in long and weighs just 6 ozs.

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2N2925	0·15
2N2926	0·12
2N3054	0·48
2N3055	0·45
2N3702	0·11
2N3705	0·15
2N3706	0·11
2N3707	0·13
2N3709	0·10
2N3710	0·11
2N3711	0·11
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BFX29	0·28
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BFX85	0·28
BFX86	0·25
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OAZ210	0·40
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OAZ222	0·45
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OAZ242	0·15
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OC16	1·00
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OC22	1·00
OC23	1·25
OC24	1·10
OC25	0·40
OC26	0·40
OC28	0·66
OC29	0·65
OC30	0·40
OC35	0·55
OC36	0·60
OC41	0·35
OC42	0·40
OC43	0·70
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OC44M	0·17
OC45	0·20
OC45M	0·18
OC46	0·27
OC57	0·60
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7408	0·28
7409	0·28
7410	0·16
7411	0·25
7412	0·30
7413	0·36
7416	0·36
7417	0·36
7420	0·16
7422	0·25
7423	0·37
7425	0·37
7427	0·37
7428	0·40
7430	0·16
7432	0·37
7433	0·37
7437	0·37
7438	0·37
7440	0·22
7441AN	0·92
7442	0·79
7450	0·16
7451	0·16
7453	0·16
7454	0·16
7460	0·16
7470	0·36
7472	0·38
7473	0·41
7474	0·42
7475	0·59
7476	0·45
7480	0·60
7482	0·87
7483	1·10
7484	1·00
7486	0·47
7490	0·58
7491AN	1·00
7492	0·70
7493	0·70
7494	0·86
7495	0·80
7496	0·95
7497	3·87
74100	1·89
74107	0·45
74110	0·58
74111	0·86
74118	0·90
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74121	0·50
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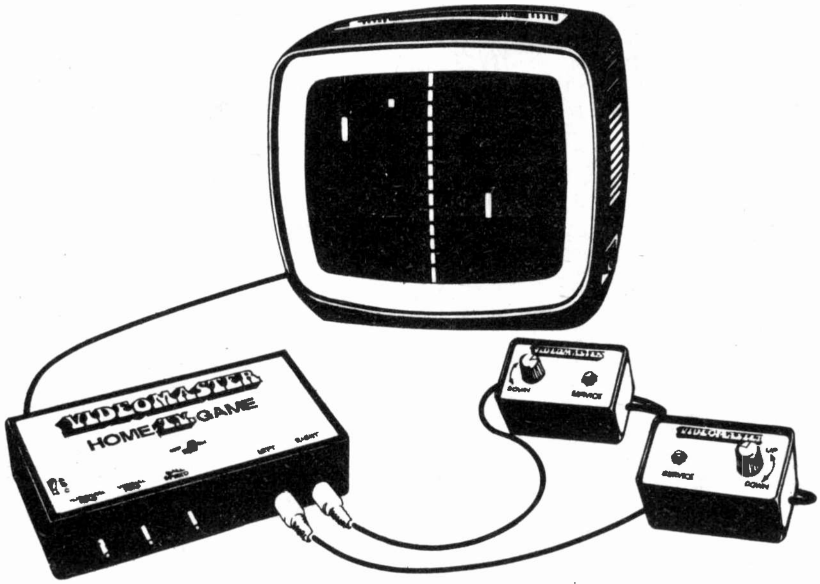
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Std ¼in. Open-type Stereo Chassis Socket	19½p
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Std ¼in. Screened Mono Line socket	28p
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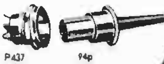
Std ¼in. Screened Stereo Line Socket	43p

DIN	Plug	Chassis Socket	Line Socket
2-pin L/S	10p	9p	12½p
3-pin	11p	10p	14p
4-pin	15p	10p	—
5-pin A (180°)	15p	10p	17½p
5-pin B (240°)	15p	10p	17½p
6-pin	15p	11p	21p
7-pin	15p	10p	17½p

MAINS



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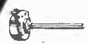

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(knob extra 12½p)
Values available: 1k, 5k, 10k, 25k, 50k, 100k, 250k, 500k
Single-gang Lin: 54½p, Log 61½p
Dual-gang Lin and Log 72p

Presets: 0.1W Vertical or Horizontal 100, 220, 470 ohms, 1k, 2k2, 4k7, 10k, 22k, 47k, 100k, 220k, 470k, 1M .... 9p each

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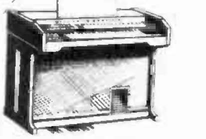

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two pole make (GB)	29p
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1.0	63	3	47	63	6	330	16	00
1.5	63	3	68	6.3	3	330	63	03
2.2	63	3	68	16	4	470	6.3	6
3.3	63	3	68	63	00	470	10	00
4.7	63	3	100	4	3	470	25	01
6.8	40	2	100	10	4	470	40	02
6.8	63	3	100	25	5	680	6.3	00
10	25	2	100	40	6	680	16	01
10	63	4	100	63	01	680	25	02
15	16	2	150	6.3	4	680	40	03
15	40	3	150	16	5	1000	4	00
15	63	4	150	25	6	1000	10	01
22	10	2	150	40	00	1000	16	02
22	25	3	150	63	01	1000	25	03
22	63	5	220	4	4	1500	6.3	01
33	6.3	2	220	10	5	1500	10	02
33	16	3	220	16	6	1500	16	03
33	40	4	220	25	00	2200	6.3	02
47	4	2	220	40	01	2200	10	03
47	10	3	220	63	02	3300	6.3	03
47	25	4	330	4	5	4700	4	03
47	40	5	330	10	6			

Case Sizes (mm)

Case Size	Length	Diameter	Price
2	12.5	4.8	7½p
3	12.5	6.1	7½p
4	20	6.7	7½p
5	20	8.3	7½p
6	20	10.3	10p
00	33	10.4	22½p
01	33	12.9	23p
02	33	15.4	40p
03	33	18.4	44p

OMNIUM GATHERUM

12-way 5 Amp Terminal Block	17p
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Copper clad SRBP board (200 x 100mm)	66p
Copper clad fibreglass board	£1.04
Probe Clips (1 red, 1 black)	42p
Solder 10m of 22swg	28p

RESISTORS

CARBON FILM

⅓W (MIN RES) 1 ohm to 1M: 5%; 1M2 to 10M: 10% E12	2p each
½W (STD RES) 1 ohm to 10 ohm: 5%. 1M2 to 10M: 10% E12 — 11 ohm to 1M: 5% E12 and E24	2p each

METAL OXIDE

½W (OXIDE) 10 ohm to 1M: 2% E12 and E24	5p each

WIREWOUND

3W (W/W MIN) 0.22, 0.27, 0.33, 0.47 ohms, 1 ohm 5%	11p
1.2 ohm to 270 ohm: 5% E12	15p

Also 1% Oxide, 1W Carbon Film, 5W and 10W Wirewound types stocked.

E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades.

E24: 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades.

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AY-1-0212	£5·04	MVR35 (TO3)	£1·73	uA7805 (TO 3)	£1.89
AY-5-1224	£3·40	M252	£8·10	uA7815 (TO 3)	£1.89
CA3046 (14-pin DIL)	86p	NE555V (8-pin DIL)	85p	ZN414 (TO 18)	£1.50
LH0042C (TO 99)	£3·78	SG1495 (14-pin DIL)	£4·00	CO4001AE	23p
LM301A (8-pin DIL)	39p	SG3402 (14-pin DIL)	£2·17	CD4007AE	23p
LM308 (8-pin DIL)	80p	TBA810S	£1·25	CD4011AE	23p
LM380 (14-pin DIL)	£1·13	uA709C (TO 99)	42p	CD4016AE	56p
LM381 (14-pin DIL)	£1·85	uA723C (TO 99)	50p	7400	17p
LM3900 (14-pin DIL)	85p	uA723C (14 pin DIL)	50p	7413	42p
MC1310P (14-pin DIL)	£1·90	uA741C (8 pin DIL)	28p	7447	91p
MC1496 (14-pin DIL)	95p	uA741C (14 pin DIL)	30p	7473	36p
MC3302P (14-pin DIL)	£1·35	uA747C (14-pin DIL)	64p	7474	33p
MFC4000B	74p	uA748C (8-pin DIL)	39p	7490	55p
MFC6040	£1·04	uA78L05 (TO 92)	45p	7493	55p
MM5314 (24-pin DIL)	£4·78	uA78L15 (TO 92)	45p	74121	42p
MVR5 (TO 3)	£1·73	uA78M05 (Plastic)	£1·13½		
MVR12 (TO 3)	£1·73	uA78M15 (Plastic)	£1·13½		

TRANSISTORS & DIODES

AC127	10½p	BC213L	19p	BFY51	17p	2A 400PIV Bridge	55p
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AC176	18½p	BC327	27½p	BY164	61p	2N2646	48½p
AD161/2MP	£1·07	BC328	20p	BZX61 series	22p	2N2905	35½p
AF117	27p	BC337	27½p	BZY88 series	13p	2N2926 Or, Ye	15p
BAX13	6p	BC338	25p	C106D1	58½p	and Gn	16p
BC107	12p	BCY71	24p	MCR102	38p	2N3053	19½p
BC108	11p	BD131	49p	MJ2955	92p	2N3054	60p
BC109	14p	BC132	57p	MJE2955	£1·21	2N3055	53p
BC142	16p	BD131 2MP	£1·18	MJE3055	73p	2N3702	16p
BC143	19p	BD135	51½p	MPF102	45p	2N3703	15p
BC147	12½p	BD139	61p	OC71	25p	2N3704	17½p
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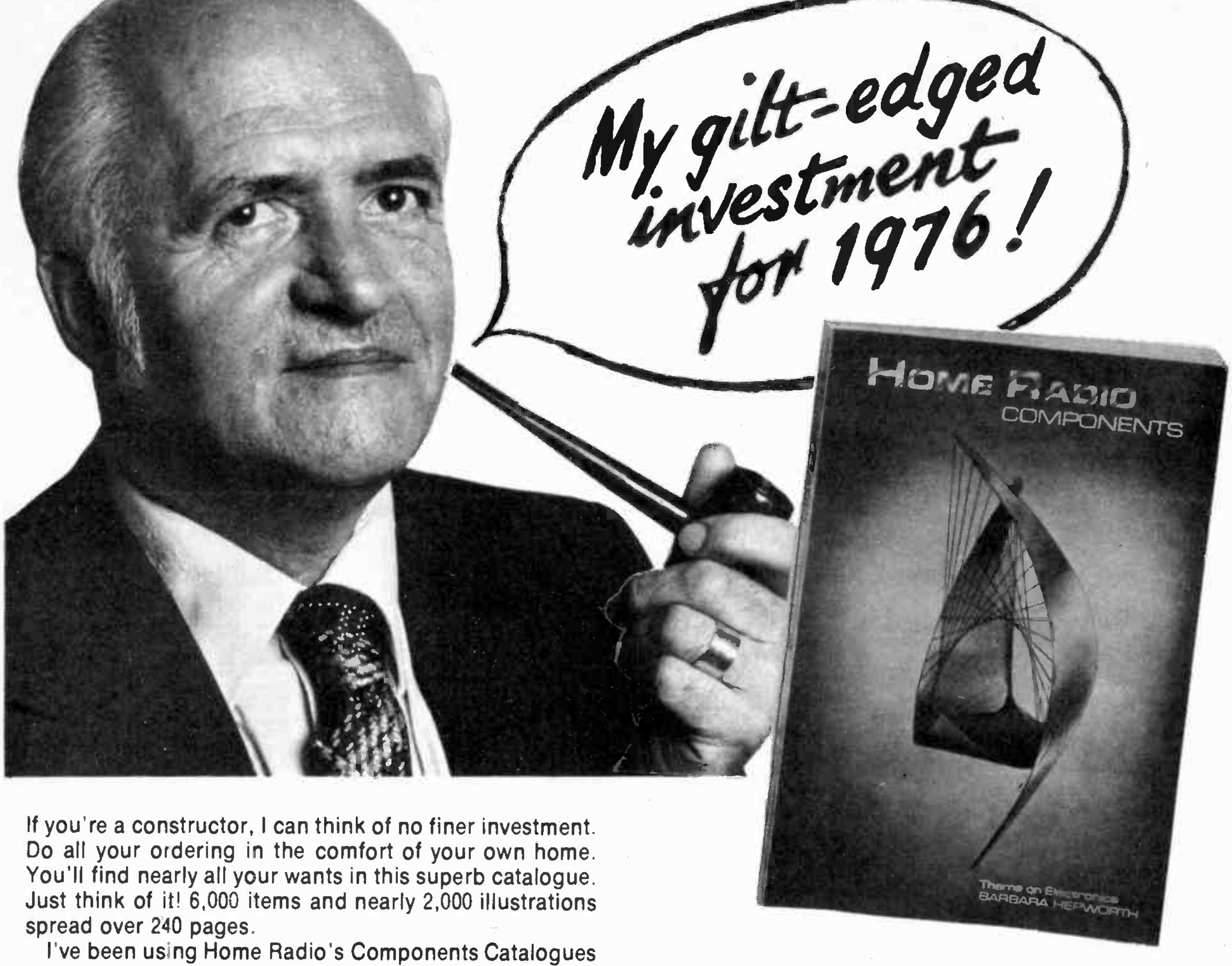
BC169C	15p	BFX29	32½p	WOOS	27p	2N3708	16p
BC178	16p	BFX30	35p	W04	30p	2N3819	27½p
BC179	17p	BFX84	32½p	ZIJ	94p	2N3866	86p
BC182L	12½p	BFX85	35p	ZTX108	11p	2N3903	25p
BC183L	15p	BFX87	32½p	IN914	5p	2N3904	27½p
BC184L	15p	BFX88	34½p	IN4148	5p	2N5245	56p
BC212L	17½p	BFY50	17p	2A 50PIV Bridge	48½p	2N5459	64p



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PE

EXCOMMUNICATION

Ancient and modern are brought together in a news report concerning an archeological "dig" planned at Babylon. We learn that the resources of present day technology, including magnetometers and computers, will aid the team of investigators in their search for the remains of the Tower of Babel, that ancient international talking shop for affairs of culture and commerce.

The world has seen many changes since 2,000 B.C. The modern "Tower of Babel" is represented not by a single centre, but by an immense network of global telecommunications—its threads, material or immaterial, spreading out in all directions, in all media. Today any "confusion" is only apparent—not real—for it is a highly organised scheme thanks to 20th century electronics. Yet demands for communication in all tongues, including new computer-age languages, are never fully satisfied. Technology is constantly being stretched to new frontiers in order to provide additional channels and more sophisticated signalling methods to permit a greater amount of intelligence to be transmitted further distances with, of course, utmost reliability.

Almost coincidental with the recent official opening of the new Post Office Research Centre, dedicated especially to meet the great demands for increased, improved, and additional services in telecommunications, comes a thought-provoking objective view of the anti-social effects some forms of telecommunications have produced in Amercia in the century since Alexander Graham Bell took out his patent for a telephone in 1876.

In the fourth of his Reith Lectures (*BBC Radio 4, December 3, 1975*) Daniel J. Boorstin said:

> . . . In the following century, every new advance of electronic technology—from the telephone to the radio to television—tended increasingly to isolate individual Americans and keep them at home."

In this broadcast the speaker also stated:

> ". . . advancing technology tends to have a proportionately much greater effect on large quantities than on small. The longer the distance to be covered, the greater the power of technology to reduce the required time. This means that, within the short distances that circumscribe man's everyday community, the powers of this technology are negligible."

The above quoted comments are surely as applicable to Britain as America, though we have yet to feel the deeper effects of isolation and segregation of citizens that apparently is commonly experienced in parts of the U.S.

Telecommunications through its manifold services has proved a benefit to most people, in some way or another; it is an indispensable mainstay of modern life. But what is its likely long term effect upon personal relations; and can we hope to escape total enmeshment within this network with its battalions of automated peripherals? Ah, Mr Bell, little did you realise just what would develop from your original magneto-telephone. How strange and absurd it seems that an invention intended to overcome distance and to bring people "together" seems likely in its ultimate achievement actually to isolate persons from one another at the local community level. Is there a remedy, and in whose hands is it likely to be found?

F.E.B.

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PROGRAMMABLE WASH/WIPE CONTROLLER

By D.W. LEE B.Sc.

THE unit to be described provides intermittent operation of the windscreen wipers, with a maximum delay of 25 seconds (variwipe facility) and a programmed wash-wipe facility giving single handed operation of the windscreen washers and wipers.

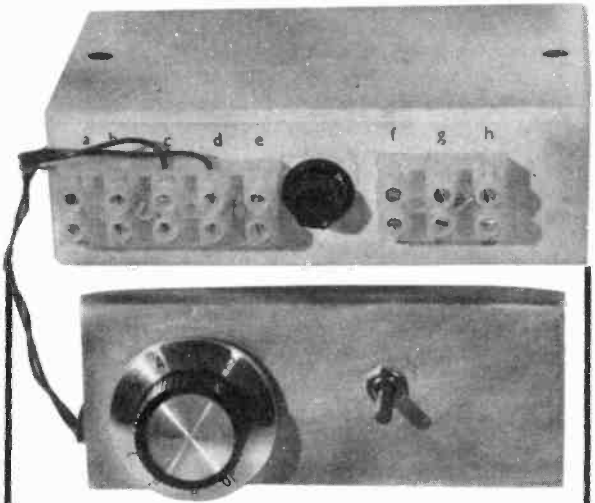
The unit can be fitted to all cars having 6 or 12V electrical systems regardless of earth polarity, providing that the vehicle is equipped with self-parking electrical windscreen wipers (single or two speed) and an electrical windscreen washer.

CIRCUIT DESCRIPTION

The unit uses the by now familiar 555 timer i.c. connected in its astable mode to provide the variwipe facility. The circuit diagram is given in Fig. 1. C2 charges via VR2, VR3 and R3. The output at pin 3 remains high until the voltage at pin 6 reaches 2/3 V_{cc}. When this value is reached the internal comparator causes pin 7 to go low and C2 discharges through R3, and the relay is energised.

When the voltage at pin 6 reaches 1/3 V_{cc} TR1 and TR2 are turned off, hence the relay is switched off and C2 starts to recharge and the cycle repeats. VR2, VR3, R3 and C2 determine the time for which the relay is off, whilst R3 and C2 determine the time for which the relay is on. The relay needs only to be energised for sufficient time to start the wipers until the self-parking switch takes over, and with the components used here, this time is approximately 0·5s. VR2 is the main delay control, VR3 sets the fastest running speed of the unit, C3 and D3 protect the i.c. from the back e.m.f. of the relay.

Capacitor C5 and D4 decouple the supply to the i.c. and prevent spurious triggering of the relay when the brake lights, indicators, etc. are operated. Without D4 and C5 the supply voltage can drop momentarily when the brake lights are operated. With these components included the voltage at pin 6 will hardly change. S1 is the washer motor switch. On closing S1, C1 charges through R1, the surge limiting resistor, and D1. This positive potential is passed to pin 6 via D2 which normally isolates C1 from C2 preventing C1 from charging via VR2, etc. Thus, closing



COMPONENTS . . .

Resistors

R1	10Ω ¼W 10%
R2	3·9kΩ ¼W 10%
R3	22kΩ ¼W 10%

Potentiometers

VR1	10kΩ lin. min. horiz. preset
VR2	1MΩ lin. (with switch—see text)
VR3	100kΩ lin. min. horiz. preset

Capacitors

C1	1,000μF 25V elect.
C2	22μF 16V tantalum
C3	0·1μF 100V mylar or polyester
C4	0·01μF 100V mylar or polyester
C5	470μF 25V elect.

Diodes, integrated circuits

D1, 4	1N4001
D2, 3	1N914
IC1	NE555

Miscellaneous

FS1	20mm fuse-holder and 500mA anti-surge fuse
RLA	12V single pole changeover (contacts 5A rating) coil resistance greater than 120Ω, e.g. min. open p.c. relay Doram 349-125
S1	s.p.s.t. biased toggle switch
S2	s.p.s.t. toggle switch (can be incorporated with VR2—see text)
5A	8-way connecting strip, Veroboard (38 × 24 holes) 0·1in. pitch, plastics box 4½ × 3 × 1¼ in. (115 × 76 × 32mm).

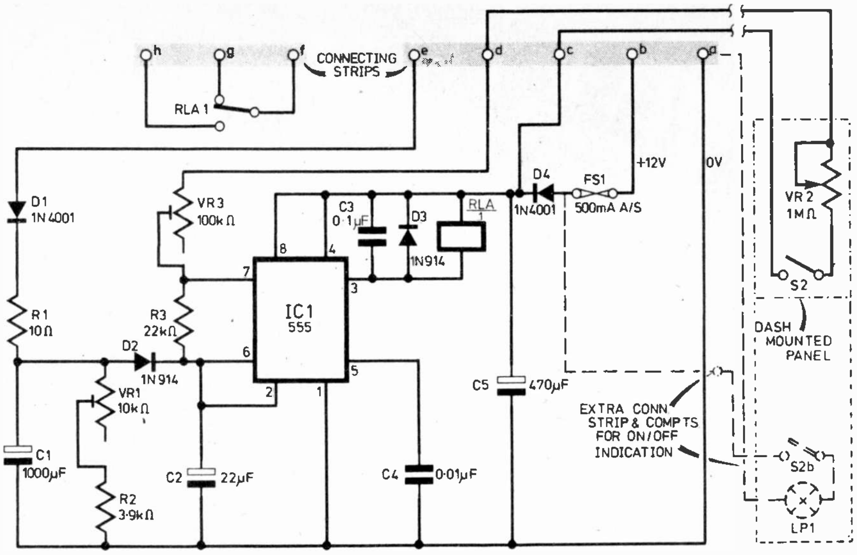


Fig. 1. Circuit diagram of the controller

S1 causes the washer motor to operate and the relay to close which starts the windscreen wiper in motion. C1 is discharged through both the VR1, R2 and D2, R3 combinations. VR1 thus determines the time the wipers continue to operate after releasing S1. D1 prevents C1 from discharging through the washer motor when S1 is released. With the components selected the delay before the wipers self-park can be varied between 4 and 11 seconds.

Switch S2 can either be a separate switch or be ganged to VR2. Both alternatives have been tried but the former was found to be slightly more convenient. If a warning light is required S2 should be a double pole switch and the supply for the light being taken from before D4 in order to preserve the decoupling action of D4 and C5.

CONSTRUCTION

The circuit may be conveniently constructed on a 3·8 × 2·4in (80 ×60mm) piece of 0·1in pitch Veroboard (Fig. 2). If the suggested layout is followed

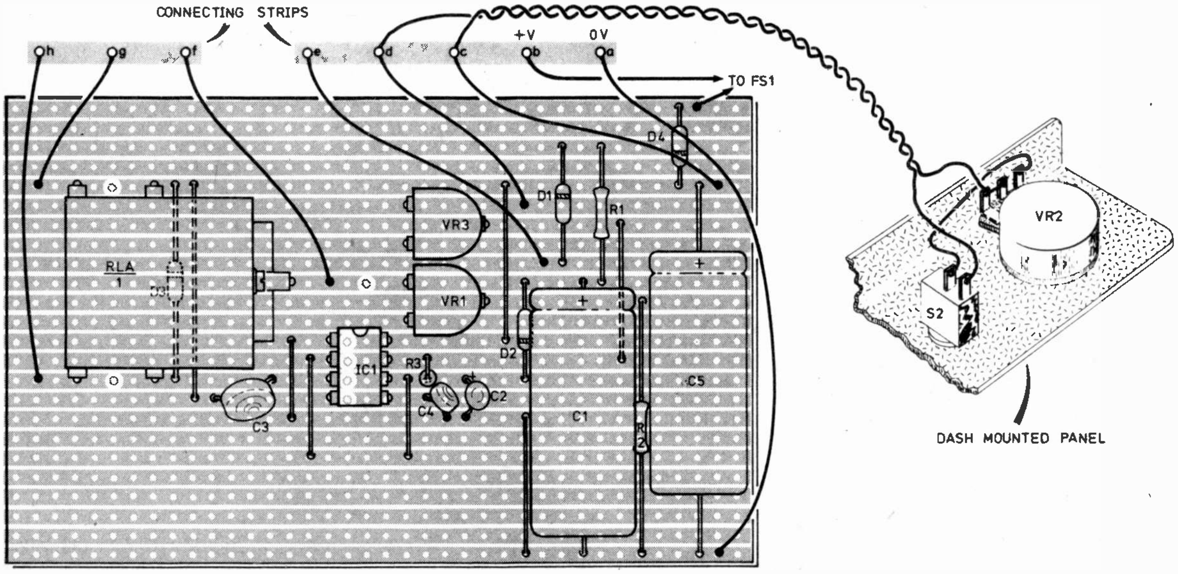
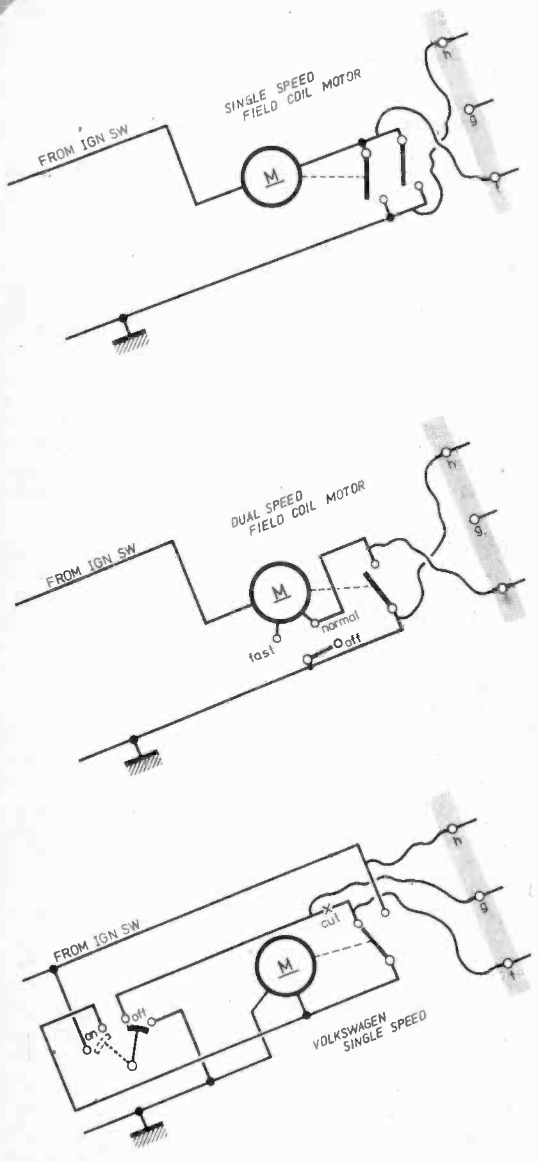


Fig. 2. Veroboard cutting details and component layout

WIPER MODIFICATIONS...



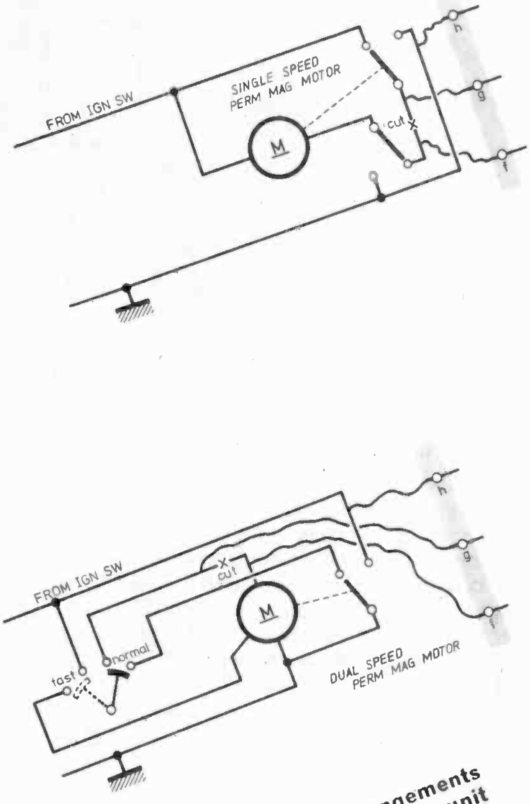
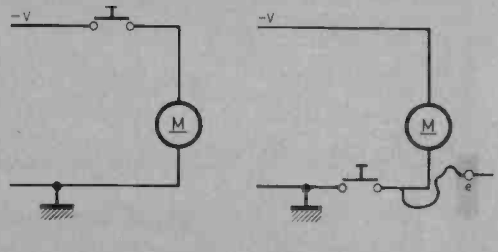
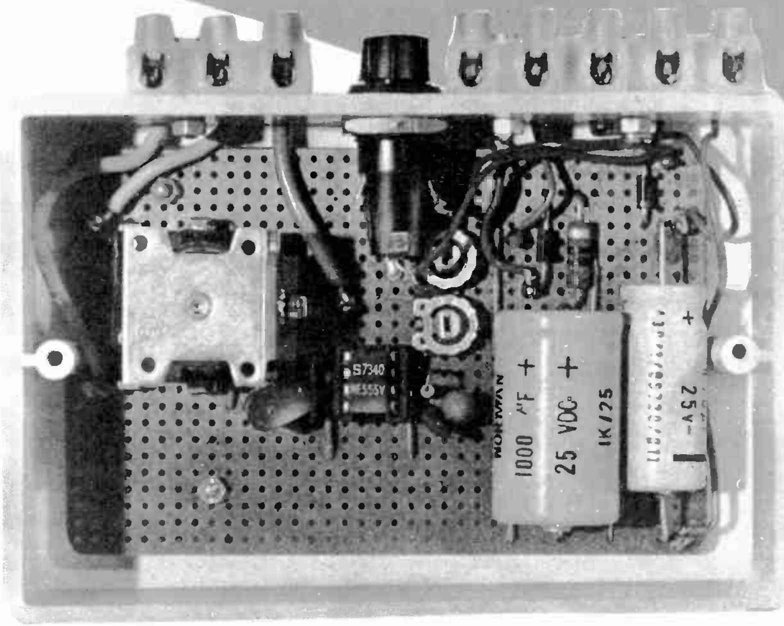


Fig. 3. Various wiper motor arrangements and corresponding connections to the unit

WASHER MODIFICATION

Fig. 4. Washer motor wiring details for positive earth vehicles, before and after connection to the unit





the only breaks necessary are the four beneath the i.c. and the three between the relay pins.

Construction should commence with cutting and trimming the board to fit into the case, then the three holes for the relay should be enlarged with a small round file or drill.

When the board has been assembled connect S2 and VR2 and then connect points a and b to a suitable power supply (a 9V battery will suffice). Set VR3 to maximum resistance, close S2 and after a short delay the relay should be heard clicking on and off. If all is well fit the circuit board into the case using insulating spacers, and connect the flexible leads to the connecting strip as in Fig. 2.

INSTALLATION

It will be necessary to determine the type of windscreen wiper motor used and the method of wiring it, before the unit can be installed. Various configurations and the corresponding connections to the correcting strip are shown in Fig. 3.

The relay specified has contacts rated at 5A, which have proved quite adequate since they are hardly ever required to break the supply to the wiper motor. For the washer motor the connection to point e from S1 should be taken from the motor side of the switch for negative earth vehicles. For positive earth vehicles a slight modification will be needed, see Fig. 4.

SETTING UP

Having installed the unit with VR1 and VR3 set at maximum resistance, VR2 should be set to minimum resistance and S2 closed. After a short delay the wipers should make one sweep and then self-park. The value of VR3 should be reduced until there is about a 1 second delay between the wipers parking and the relay closing to initiate the next sweep. It is advisable to hinge the wipers away from the screen to prevent any damage caused by "wiping" a dry screen.

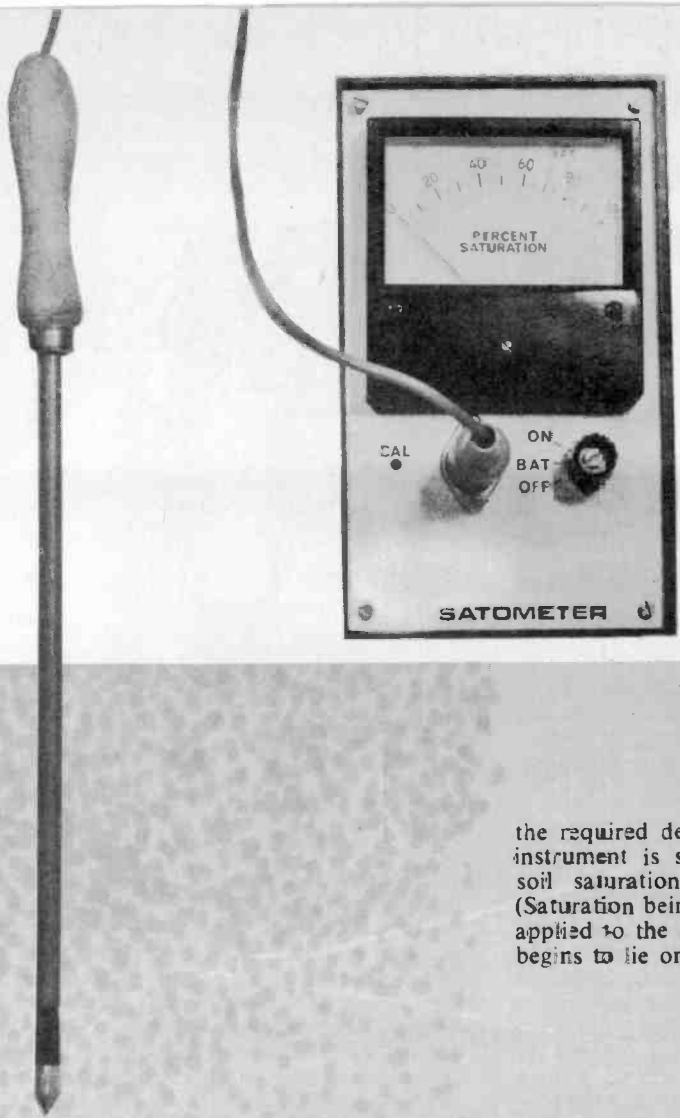
Next VR1 can be adjusted; closing S1 should cause the washers to operate and the wipers to work continuously for about 11 seconds. The value of VR1 should be reduced so that the wipers operate for long enough to clear the screen and so that the relay contacts open half way through a sweep of the wipers, in order to minimise the possibility of the relay contacts having to break the supply to the wiper motor.

USES

The three functions: continuous wipe, variwipe, and wash-wipe can be used independently. With the wipers operating continuously, closing S1 washes the screen as normal. With the variwipe in action, closing S1 results in the programmed wash-wipe after which the wipers revert to the variwipe action. If both the wipers and the variwipe are off, closing S1 results in the programmed wash-wipe.

Finally, with the wipers off or on variwipe a very quick flick of S1 will start the wipers working for the preset interval, without giving the washer motor time to spray more than a few drops of water onto the screen. This last feature is very useful for clearing the screen of spray from passing lorries, etc. whilst on the motorway.

For cars without electric windscreen washers, components S1, D1, R1, D2, C1, VR1 and R2 can be omitted. They can be retained, however, to preserve the screen clearing action as described above. ★



SOIL SATURATION METER

By D. W. LLOYD

GROWING plants today is rapidly becoming a necessity with the ever increasing cost of food. Also being a very popular pastime, it is surprising how many people still leave the success of their labours to either luck or their possessing those coveted "green fingers".

Plants can wither and die in harsh dry summers, but in the other extreme, over watering can also be damaging since it can lead to rotting of the roots. To enable the gardener to control and maintain a careful watch on the moisture content of the soil, the Satometer described in this article was produced.

The instrument is a small hand unit and is very simple to use. It consists of a small hand-held box with a meter display and is powered by a small 9V battery. Firstly, a probe is pushed into the soil to the required depth (i.e. root depth). Then when the instrument is switched on a direct reading of the soil saturation level is displayed on the meter. (Saturation being defined as the point at which, when applied to the soil, water is no longer absorbed and begins to lie on the surface.)

CIRCUIT OPERATION

The circuit diagram is shown in Fig. 1. The unit consists of a multivibrator whose output feeds a diode bridge circuit via a capacitor. The capacitor is incorporated to isolate d.c. thus preventing possible polarisation of the probes and ensuring repeatable readings. If any d.c. flows through the probes a gradual oxide formation takes place which can slowly alter the calibration of the instrument.

The multivibrator design used is conventional, except for the inclusion of Zener diodes D1, D2 and D3. These have been added so that circuit operating conditions do not vary as the battery ages.

Soil saturation is displayed on a 100μA meter connected via a calibrating resistor across the diode

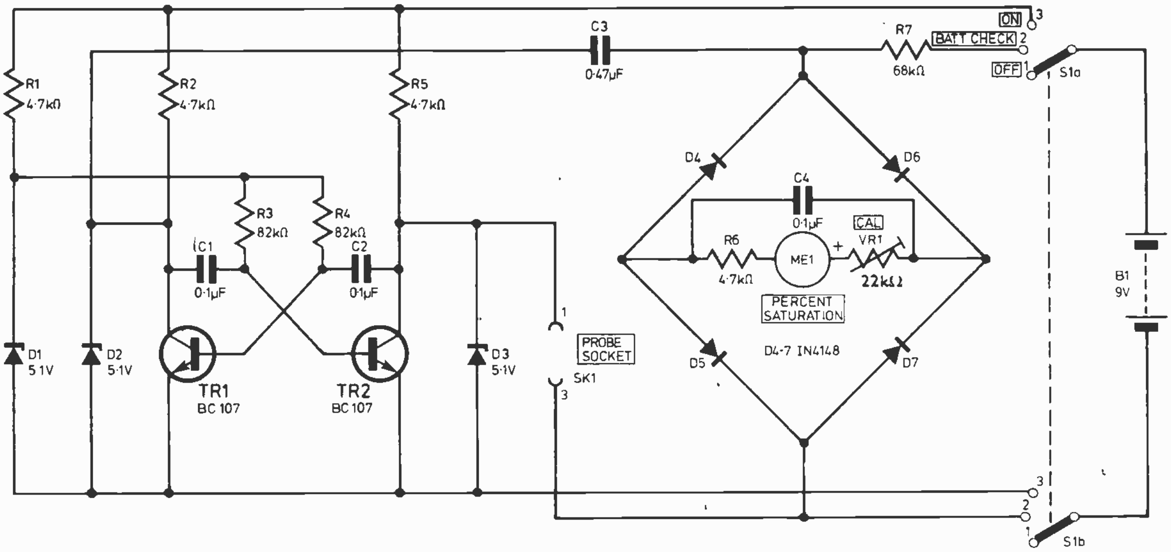


Fig. 1. Circuit diagram of the Satometer

COMPONENTS . . .

Resistors

R1	4·7kΩ
R2	4·7kΩ
R3	82kΩ
R4	82kΩ
R5	4·7kΩ
R6	4·7kΩ
R7	68kΩ

All 10% ¼W carbon

Potentiometers

VR1	22kΩ lin.

Capacitors

C1–2	0·1μF plastic or ceramic
C3	0·47μF plastic or ceramic
C4	0·1μF plastic or ceramic

Semiconductors

D1–3	5·1V Zener diode (BZY88 5V1)
D4–7	1N914 or 1N4148
TR1–2	BC107

Miscellaneous

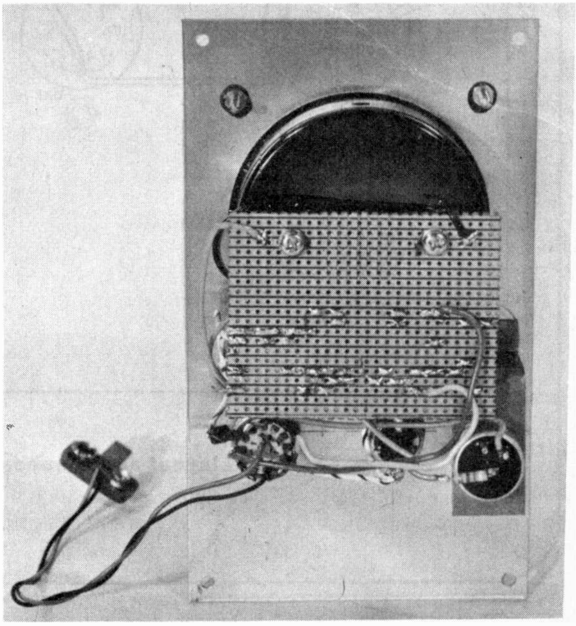
S1	3-way 2-pole switch
ME1	100μA meter movement (SW100)
SK1	Din socket
PC1	Din plug

9in. × ⅜in. dia. (230mm × 10mm) copper tube, 11in. (280mm) 6BA threaded rod, ⅜in. dia. (8mm × 20mm) brass rod, 9in. (230mm) flexible insulation (an old p.v.c. cable sheath of the correct size will suffice)

bridge. Capacitor C4 smooths the supply to the meter.

CONSTRUCTION

Constructing the unit is straightforward, the most difficult part being the large hole in the front panel for the barrel of the meter. In the absence of a proper tool to make this, one can use the standard method of drilling small holes round the circum-



SATOMETER WIRING

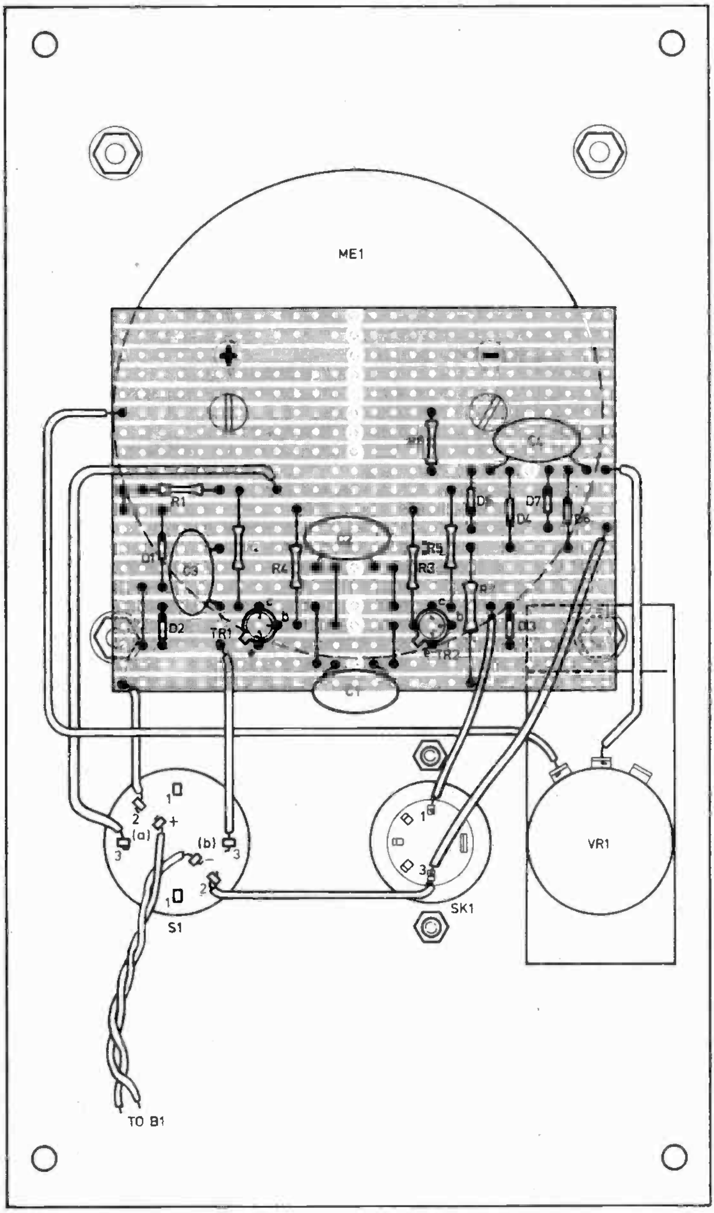


Fig. 2. Internal layout and Veroboard details

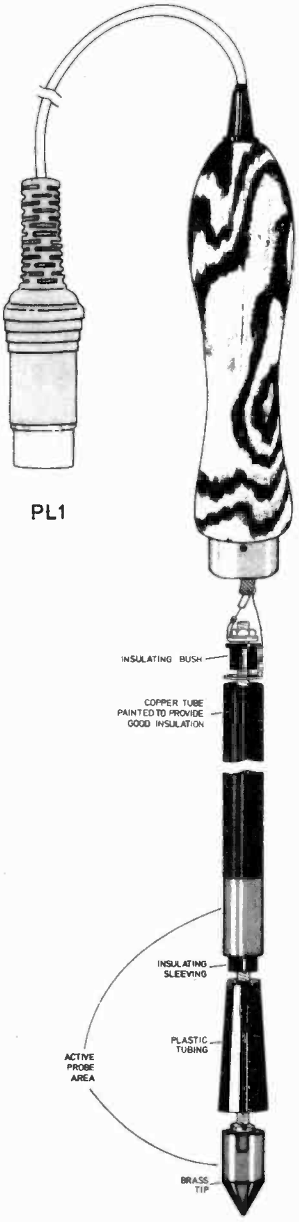


Fig. 3. Details of the probe

ference of the hole to be made, knocking the centre out and then filing down the rough edges with a round file.

CASE

Plastics boxes obtainable from most hobby shops give a very professional appearance to the finished instrument. The one used in this article was supplied with a front panel ready for drilling. The front panel is held by four posts, one at each corner of the box and these were also usefully employed to anchor a piece of bent aluminium which provided a battery space. Foam draught excluder was then used to hold the battery in place.

The only other piece of metal work is the calibration pot bracket which, as can be seen, is very simple. This completes all of the hardware. It can all be assembled in the box or on the front panel as appropriate. The component board should now be dealt with, and when complete this fits on the rear of the meter.

The component board is constructed on Veroboard, and the layout is given in Fig. 2.

PROBE DETAILS

The probe is made from a tube of copper piping and a solid brass or copper tip, with an insulating coat along the whole length, except for the area indicated in Fig. 3. The tip is insulated from the main stem by an old plastics "Biro" stem as shown. Brass is a good material as the non-insulating parts require no treatment against rust, and the wire connections at the blunt end can be soldered direct. To ease insertion into the earth the end is filed into a point.

Insulation of the rod is important and a coating that will not come off when the probe is inserted into the ground is essential. A good hard paint well keyed onto the rod is therefore used. Finally, a din plug and socket and a length of wire are used to connect the probe to the instrument.

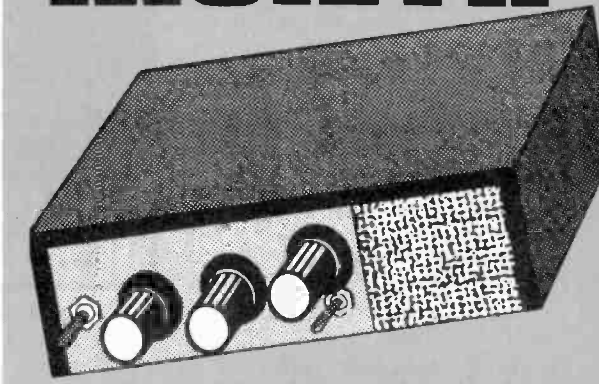
SETTING UP

Testing of this unit is done by obtaining a bucket of soil from your garden and watering it until it can absorb no more. The soil is then saturated and with the probe inserted to about half the bucket's depth, the calibration potentiometer is adjusted until the meter reads 100 per cent saturation. The unit is now ready and calibrated for use.

USE OF THE SATOMETER

The full benefits of the Satometer cannot be realised unless plant requirements are known. A trip to a local library would therefore be worthwhile to give you all the information required, as it is a far reaching subject which is impossible to cover here. However, for the majority of plants a 50 per cent level is usually adequate. Roses, for example, will be happy with anything from about 30 per cent to 70 per cent. Marrows are watery plants though and prefer an average of 80 per cent with only plus or minus 10 per cent variation for good results. So by adjusting your watering techniques you should be able to get results as good as the experts. ★

...NEXT MONTH*



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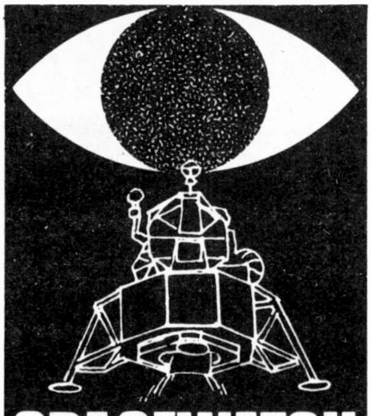


SPACEWATCH

BY FRANK W. HYDE

VENUS PROBE

Another milestone in space and astronomical history was made by the arrival of *Venus 9* and *10*, the two Soviet spacecraft with the facilities of landing two descent craft on the surface of Venus, the mystery planet. The history of this mission follows a more or less normal pattern; the vehicles were launched according to plan and made their swift journey from Bikaner to the vicinity of Venus.

The five-month journey was completed without mishap and then the drama began. Previous attempts had been made to land descent craft but none had succeeded in reaching the surface of the planet. On this occasion, however, two descent craft were landed, one from *Venus 9* and the other from *Venus 10*. The two landings were made at different points on the surface but at almost the same time.

TOUCH DOWN

The descent craft landed at a speed of between 7 and 8 metres a second. Pictures were taken immediately after landing for, as it turned out, there was no dust to be disturbed, as on Mars and the Moon.

The descent craft from *Venus 9* landed on a plateau which was approximately 2,500 metres above what might be termed the Venusian "sea level". The descent craft from *Venus 10* landed on a plain some 2,200 kilometres away from the other craft. It is, therefore, a very unique situation where two levels of the planetary surface could be assessed at the same time. The *Venus 10* craft sent back some very remarkable photographs which could be turned over to the newspapers without further processing.

Once again here was a situation for which the planners were not prepared, yet the results so dramatically obtained were the result of very special design techniques. Since the atmosphere of the planet was so dense it had been assumed that the light reaching the surface from the Sun would be at a very low level. The cameras were, therefore, designed for very low level lighting. The result was perfect pictures of the Venusian surface.

FIRST PICTURES

The first picture sent back was from the craft which landed on the plateau. This showed a scattered collection of rocks, large and typical of young mountainous regions. The next picture from the plain was quite different, showing rocks from an older type of mountainous landscape. It would seem that from the examination of the rocks that they are laminar and sedimentary in nature. These are well known types with which geologists are familiar.

The landscape showed rock outcrops among the more general debris. A Soviet planetologist, Dr Mikhail Marov, said that the plain showed a stony desert. This means that Venus can be classed as a young and still living planet. So though the same pattern appears as for all the solid planets, the surface of Venus is arid and uninviting. It is also very hot and the crust is probably pliant for this reason.

The formations on the plateau show that it is probably tectonic and the fact that some of the rocks show recent fracture may indicate some volcanic activity. Considering the nature of the accumulations, the dark colour and content of radioactive elements, these rocks would appear to be similar to the basalt rocks on Earth. Similarly, the history of the crust formation like the Moon and the Earth confirms that there is a standard geochemical process on all the solid planets. Thus, though having a different appearance from each other they are still a standard type.

ATMOSPHERIC STUDIES

During the lowering of the descent craft which took about 75 minutes physical and chemical parameters were measured. The optical nature of atmosphere was studied and also the structure as the descent craft went lower and lower towards the surface of the planet.

During the time that signals were received, which lasted some 65 minutes for each descent craft, measurement of the light was recorded. The photography of the terrain and an examination of the nature of the rocks near the craft was also made. In both the pictures returned it was possible to see the curved horizon of the planet. The actual temperature was somewhat higher than had been suspected. This was 465°C; the wind velocity at the surface was 3·5 metres/sec, and the pressure of the atmosphere 92 atmospheres.

SPECIAL TECHNIQUE

The photography was by a specially developed system which consisted of a panoramic television system with opto-mechanical scanning. The pictures were relayed via *Venus 10*. The pictures will, of course, be the subject of extensive study for they have in the words of Chief Topographer, Boris Nepoklonov, "we can surely dismiss already the old idea of Venus as a desert created by constant wind erosion, and an extreme range in temperature".

Rocks were not sharp but resemble pancakes with sections of cooled lava or weathered rock debris in between. From the standpoint of geochemistry, Alexander Badilevsky, says that everything points to a planet that is "living". However, this is something to be studied both in the pictures and from the results of other experiments which are part of the Venus mission.

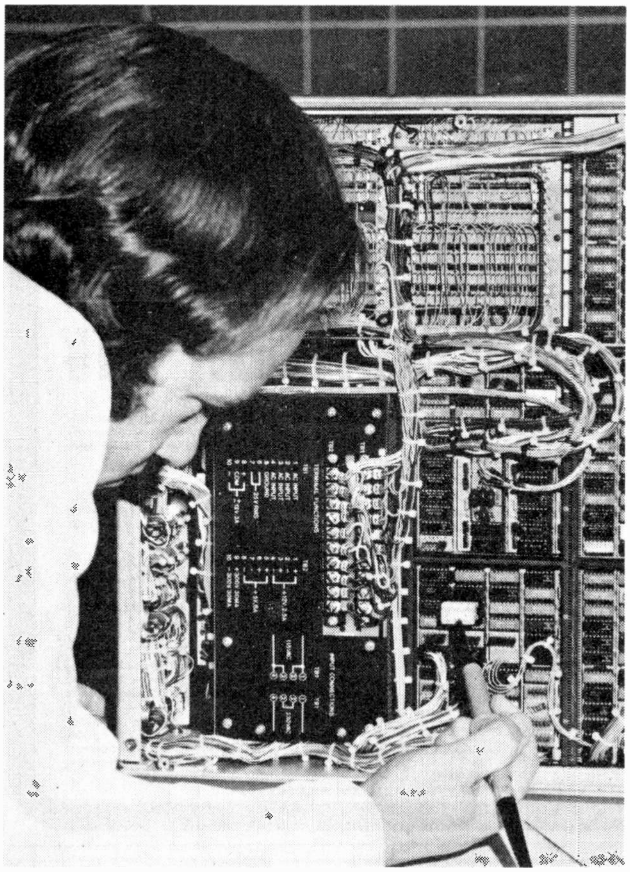
SECOND GENERATION

The two main spacecraft *Venus 9* and *Venus 10* could be said to be the second generation of automatic stations intended for a deeper study of Venus.

The special heat resisting shell is cast off after the first stage of braking; this makes it possible to instal experiments outside the shell of the craft, thus providing greater facilities for study of the planet. Also, it was possible in the new design to instal better shock absorbing equipment which could have a high degree of stable orientation.

Many problems arose in the redesign of the shell which had to be small and capable of withstanding temperatures up to 2,000°C and a frontal force of more than 300 tons when entering the Venusian atmosphere. Further, it had to be easy to jettison the heat shell.

Perhaps it would be right to conclude this story of the new and very exciting chapter in the exploration of the so-called mystery planet by citing Dmitry Grigoryev's words—"We geologists of the Earth find it difficult at first glance to suppose that we are seeing on these photographs outcrops destroyed in situ. It looks more likely that some unknown force has scattered these rocks over the planet's surface. Perhaps they fell or slipped down from the surrounding rocks. It could also be caused by meteorite craters of gigantic size. They do resemble the sedimentary rocks well known to us."



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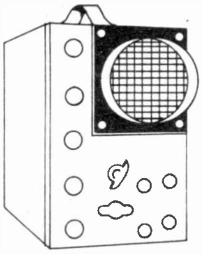

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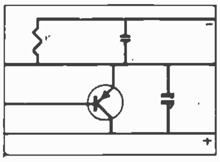

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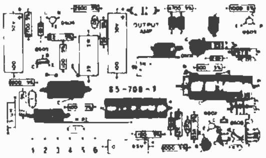

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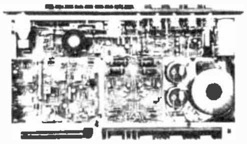

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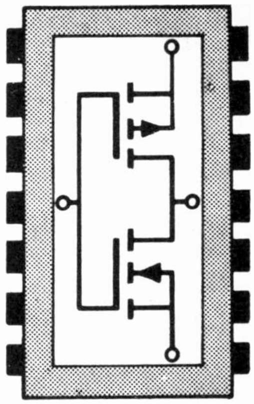


By D.B. JOHNSON-DAVIES & A.M. MARSHALL B.A.

PART 2

THE opening article of this series described the main basic element from which complementary MOS i.c.s are constructed — the complementary inverter pair. This is an arrangement where *n*- and *p*-channel MOSFETs are connected in series to operate in push-pull fashion across the supply rails (Fig. 2.1).

When one device is on, the other is off and the idling or quiescent power consumption is a few nanowatts. The switching characteristic of the CMOS inverter very closely approaches that of the ideal switch. The switching thresholds of the two devices are typically 45 per cent of the supply voltage. Thus CMOS has a high degree of immunity to noise—a powerful attribute in industrial and automotive applications.

Switching power consumption increases linearly with operating speed. At 2MHz a typical CMOS gate will consume 1mW at 5V—the same as a low-power TTL gate. At 20kHz the power consumption of the CMOS gate will reduce to 0.01mW, while the consumption of the TTL gate remains at 1mW.

Finally, it was shown that CMOS operates from a single positive supply which, for standard devices, can be anywhere in the range of 3 to 15V. The positive rail is called V_{DD}, since the drains of the *p*-channel devices are connected to it. The other rail is generally referred to as V_{SS}, since the sources of the *n*-channel devices are connected to it. It is normally 0V but can be negative if the signal has a negative swing.

THE TRANSMISSION GATE

Another way of arranging the *n*- and *p*-channel devices is to connect them in parallel instead of in series as in the inverter. This forms the CMOS transmission gate which has a considerably superior performance over any other form of semiconductor switch. It behaves as a bi-directional single-pole, single-throw switch with a very high off/on resistance ratio of 10^9 ohms. It can handle both analogue and digital signals.

All CMOS i.c.s are constructed from the two basic building blocks; the inverter and the transmission gate. The transmission gate enables CMOS to do things that are virtually impossible with other logic families.

The basic transmission gate circuit is shown in Fig. 2.2. The transmission gate is on when the gate of the *p*-channel device is at 0V and the gate of the *n*-channel device is at V_{DD}. When the levels at the gates are reversed, the transmission gate is off and a resistance of about 10^{11} exists between the input and the output.

In the basic form shown in Fig. 2.2 the resistance between the input and the output when the transmission gate is on (R_{ON}) is several hundred ohms; the actual value varies rather sharply with the voltage applied at the input. The addition of a third *p*-channel device to delay the turn off of the *n*-channel device, gives a much flatter R_{ON} versus V_{IN} curve. This enables the transmission gate to switch analogue signals with very low distortion.

The advantage of having opposite polarity devices in parallel, is that the analogue signal can swing over the whole CMOS supply range. With a single device, the signal swing is limited by the gate threshold. Furthermore, with the complementary pair, the signal can flow both ways.

The circuit of Fig. 2.2 is used extensively in the fabrication of flip-flops, latches, shift registers and counters. It enables these functions to be implemented much more economically than the equivalent bipolar functions, which means that more logic can be integrated on a CMOS chip. As an example, a D-type flip-flop in CMOS requires an eighth of the chip area as the same function in TTL.

THE BILATERAL SWITCH

When the parallel pair is combined with an inverter, as in Fig. 2.3, we have the CMOS bilateral switch. This is operated by the application of a "0" (V_{SS}) or a "1" (V_{DD}) to a single control terminal. When the control pin is high, both the *n*- and *p*-channel devices are on; thus the switch is on. Similarly, both parallel devices are off when the control terminal is low.

LOGIC GATES

NOR and NAND gates are readily formed by combining the complementary inverter pairs in series-parallel arrangements.

If *p*-channel devices are connected in series from the positive rail to the output, and the *n*-channel devices connected in parallel from the 0V rail, NOR gates are created (Fig. 2.4).

On the other hand, if the *p*-channel devices are put in parallel and the *n*-channel devices in series, NAND gates are formed (Fig. 2.5).

For clarity these arrangements are represented in Figs. 2.4 and 2.5 by interlocking pushbuttons. It can be seen, in the case of the NOR gate, that if all inputs are low, then all the series transistors are on and the output is high. If one input is high, then one of the series transistors will be off and the output will be low, whatever the state of the other inputs. Similarly

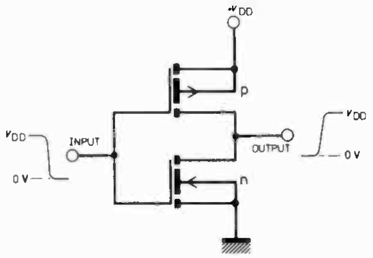


Fig. 2.1 (left). Complementary *p*- and *n*-channel devices connected to form the basic CMOS element, an inverter

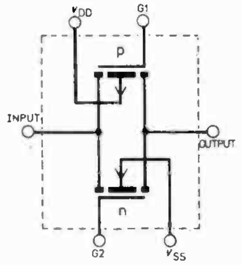


Fig. 2.2. Parallel connection of the complementary pair forming the basic transmission gate. It is not only a basic building element in CMOS i.c.s but also makes an excellent switch for analogue signals

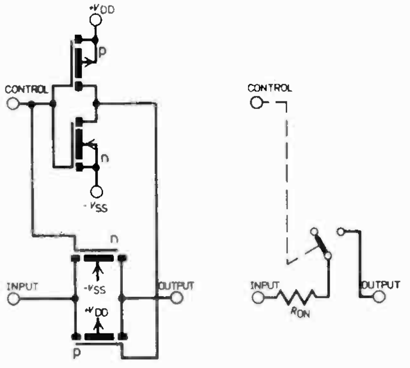


Fig. 2.3. The CMOS bilateral switch, formed by adding an inverter as a control element. It is equivalent to a fully-floating s.p.s.t. switch and both digital and analogue signals can pass in either direction. Transmission bandwidth is at least 50MHz

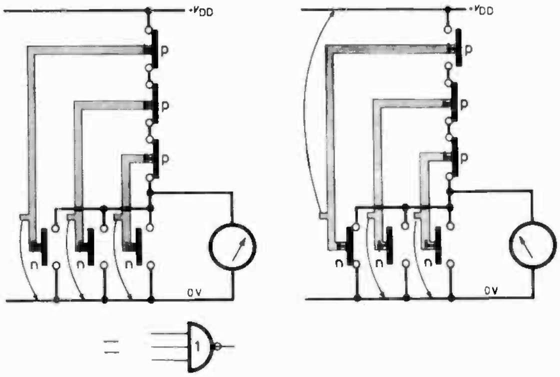


Fig. 2.4. Simplified representation of series-parallel connection of CMOS inverters to form 3-input NOR gate. When all inputs are "low", the output is "high". If any input goes "high", the output goes "low"

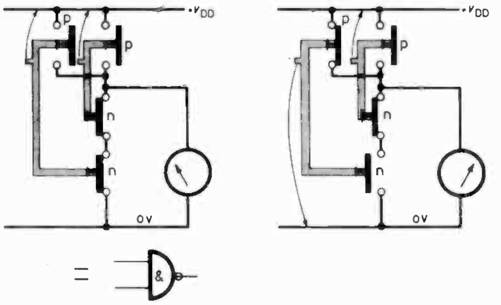


Fig. 2.5. CMOS 2-input NAND gate; the complement of the NOR gate. The *n*-channel devices are now in series instead of parallel. If either input goes "low", the output goes "high"

with the NAND gate; if all inputs are high, the output will be low since the *n*-channel devices in series will all be on and connect the output to the 0V rail. If any input goes low, then the output will be high.

FAN-IN AND FAN-OUT

CMOS has limited fan-in and almost unlimited fan-out. As shown above, each extra input to a gate requires an additional complementary pair. This in practice limits the number of inputs, for standard gates, to four. The reason for this is that what is known as pattern sensitivity at the output, becomes a significant problem as the number of elements in a gate is increased.

Pattern sensitivity can be understood by referring to Fig. 2.4. When all the inputs are low, the output is connected to V_{DD} via the series *p*-channel devices. If the output impedance is to be held within reasonable limits, then as more elements (i.e. inputs) are added, the on resistance of each series device must be increased. This is done by enlarging their geometries or chip areas. Similarly, the *n*-channel devices in the NAND gate (Fig. 2.5) have to be progressively increased in size.

BUFFER SOLUTION

The solution to pattern sensitivity is to buffer the gate output with two inverters. This need not increase the chip area, since smaller geometry transistors can be used to generate the logic function while only two large transistors are required for the final output inverter.

Apart from eliminating patterning, output buffering improves CMOS performance in several other ways. Since the input geometries are small, the input capacitances are reduced thus increasing the performance at high speeds. Output drive can be truly symmetrical, since there is only one sink or source transistor regardless of the number of inputs. The added buffer stages also provide increased voltage gain, which further improves the switching transfer characteristic and increases the noise immunity (Fig. 2.6).

Fan-out is limited only by the effect on operating speed of paralleling output capacitances. The d.c. fan-out amply covers any designer's practicable requirements; being more than 100.

PART NUMBERING SYSTEMS

This series of articles is concerned with the standard CMOS logic family, which was originated by RCA as the CD4000 series under the trade mark COS/MOS. In 1971 Motorola made a firm commitment to the production of CMOS with the announcement of not only second-source versions of some of the CD4000 series, but also some special Motorola designs. The Motorola trade mark is McMOS.

Today Motorola and RCA are, by far, the two largest producers of the standard CMOS logic family. This series of articles will, therefore, be confined to the products, and their various designation systems, of these two companies.

The situation is that both companies offer a range of CMOS devices which are pin-for-pin replacements for one another, although the precise specification and the internal construction may vary between the two companies. Also, both companies manufacture CMOS devices which are special in-house designs but which are not necessarily second-sourced by the other.

PREFIXES AND SUFFIXES

RCA prefix CMOS devices, CD4---; while Motorola uses MC14---. Thus the CD4001 is equivalent to the MC14001. The infix 5 appears in parts originated by Motorola and has no other significance. Thus the MC14518 is equivalent to the CD4518.

Suffixes indicate type of packaging and operating temperature and voltage range. The ordinary commercial plastic packaged device is the type that will be used throughout in these articles.

For this type of device Motorola uses the suffix CP which specifies an operating voltage range of 3 to 16V, and an operating temperature range of −40 to +85°C.

RCA uses the suffix AE or BE. AE specifies 3 to 15V operation over the temperature range −40 to +85°C, while BE specifies 3 to 18V operation over the same temperature range and incorporates output buffering (see above under fan-in).

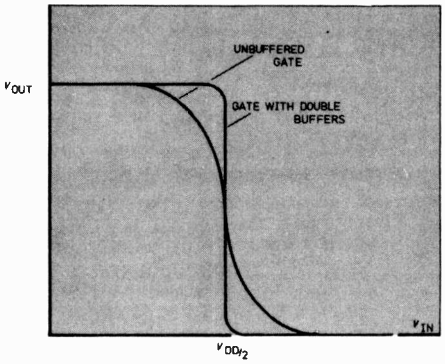
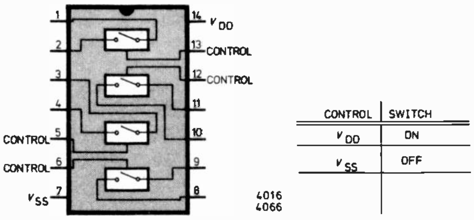


Fig. 2.6. Comparison of the switching characteristic of buffered and unbuffered gates. Feeding the gate output through two inverters gives an ideal transfer characteristic, increases noise immunity and avoids output patterning



CONTROL	SWITCH
V_{DD}	ON
V_{SS}	OFF

Fig. 2.7. Package diagram of the 4016 and 4066 quad analogue switches. Each switch is independent and can transmit signals with a bandwidth of up to 50MHz, while the on/off control pins can be switched at up to 10MHz

Other suffixes indicate military-grade devices or more expensive packaging, and need not concern us here.

Therefore when CMOS devices are described and used in circuits in these articles and no prefixes or suffixes are used, it should be understood that reference is being made to the commercial plastic-packaged range, described above, from either Motorola or RCA.

THE QUAD ANALOGUE SWITCH

CMOS technology has produced an excellent means of switching analogue signals. The CMOS bilateral switch avoids the drawbacks encountered in bipolar, f.e.t. or single-channel MOS analogue transmission configurations. Also it can be used independently of any other logic or component in many systems that require fully-floating switches.

The 4016 contains four independent bidirectional switches in one 14-pin dual-in-line package (Fig. 2.7). The switches are purely ohmic with an on resistance of about 300 ohms and off resistance in the region of 10^{11} ohms. They will transmit frequencies of up to 50MHz, while the on/off control pin can be switched at up to 10MHz. This makes it a simple matter to multiplex video signals with low distortion. A simple, high-performance oscilloscope trace doubler/quadrupler using this technique will be described later in this series.

REMOTE SWITCHING

The matching between four switches on a chip is excellent and crosstalk is low; typically −50 to −80dB. The control is isolated from the switching circuit and has a very high impedance of 10^{12} ohms. Thus the 4016 would be excellent for remote switching over long lines in noisy environments. Another application is in switching electronic organ-stop filters. Pre-arranged mixtures of stops can also be selected by a simple toggle switch.

The only constraint on the switched signal relative to the control signal is that the switched signal must never exceed the levels of the supply lines. Thus if a sine wave of 10V peak-to-peak with an average value of 0V is to be switched, V_{DD} must be at least +5V and V_{SS} at least −5V.

The output of CMOS devices is generally the inverter. This is a "totem pole" structure whereby the output is always at either V_{DD} or V_{SS}. Certain applications, such as digital filters, require outputs similar to the TTL open-collector output. This is easily implemented with the 4016, as is three-state operation for common bussing of outputs. This will be discussed later.

An alternative pin-compatible device to the 4016 is the 4066. This has a lower R_{ON} of around 80 ohms at 15V.

The 4016 is one of the few CMOS devices where the specification varies considerably between manufacturers. For critical applications the data sheets should be consulted.

Next month: CMOS gates and flip-flops. How gates can be biased in the switching region to give low power, high gain linear amplification. An oscilloscope trace doubler will be described.

NEWS BRIEFS

BLIND CALCULATORS

THE development of two new calculators from America should be of great help to the blind.

Developed by the American Foundation for the Blind, one calculator has braille output and the other a voice output.

The braille calculator is a modified standard five function type with a floating decimal point and equipped with a braille cell. Within the cell is a two-by-three array of solenoids positioned beneath a similar array of small pins. Energising the solenoids forces the pins above the cell surface in patterns which represent the decimal point and numerals 0 to 9 in braille.

The audible calculator, developed for the Foundation by Telesensory Systems Inc. of California, has a 24-word vocabulary built into a speech generating read-only memory i.c. It has six basic functions, including square root, percent, automatic constant, floating decimal and an eight-digit visual display.

The speech key can be depressed repeatedly to announce the display information without initiating further calculations.

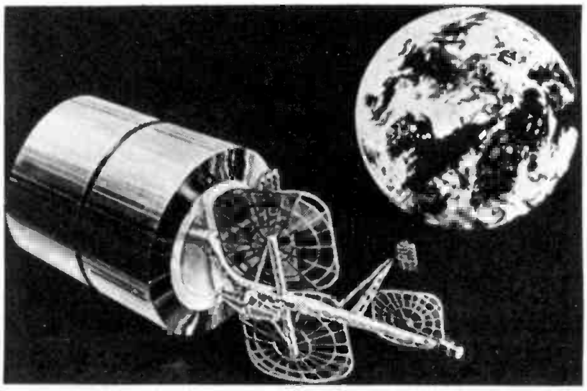
The American Foundation for the Blind hope to be able to offer these calculators on a world-wide distribution basis.

SKY LINK

THE world's biggest communications satellite successfully launched from Cape Canaveral in September, is now undergoing tests and will go into service shortly over the busy Atlantic region carrying phone calls to and from the UK, the rest of Europe, North and South America, Africa and the Middle East.

The satellite is capable of carrying more than 6,000 telephone calls and two television channels at once. It is the first of a new generation of high capacity satellites to be launched over the coming years.

Nearly eight feet taller than a London double-decker bus, the satellite is provided by the International Telecommunications Satellite Organisation (Intelsat) in which the UK is the second largest shareholder. United Kingdom calls will be handled by the Post Office's earth satellite station at Goonhilly, Cornwall.



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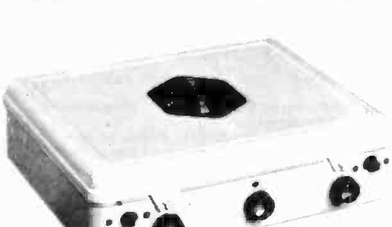

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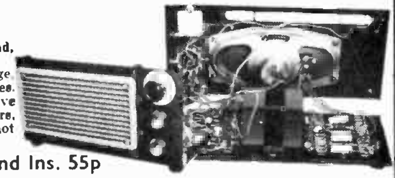

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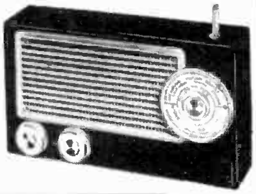

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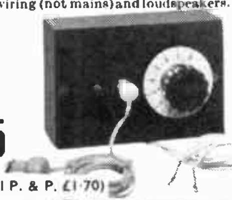

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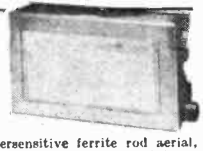

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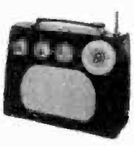

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4 different types—all have 0–9 and DP keys plus the following:

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400 assorted carbon resistors	£1·50
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50V ceramic plate capacitors, 5%: 10 of each value 22pF to 1,000pF, total 210 caps., £3.

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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.

AERIAL FIXING

Claimed to take less than two minutes to erect, a new type of TV or radio aerial bracket has just been introduced by **Rawlplug.**

The adjustable arms of the corner bracket fit into two small holes which have to be chiselled out of the mortar of the brickwork. Once in position, a single locking nut is then tightened to complete installation.

One bracket is reckoned to be sufficient for aerial masts up to 6ft high. Two brackets are recommended for higher masts.

Ideal for most domestic aerial installations, the Rawlplug SSB1 retails at £2·21 plus VAT (8%). For addresses of nearest stockists, readers should write to: **The Rawlplug Co. Ltd., Rawlplug House, 147 London Road, Kingston-upon-Thames, Surrey, KT2 6NH.**

FIRE ALARM

Ideal for garages, lofts and small rooms, the new fire alarm system, type FB-75, from **Photain Controls** is also suitable for the elderly or infirm.

The unit has been designed so that it is easily installed by just fixing to a wall and connecting to the nearest power point. Once connected to the supply the unit will sound the alarm (85dB) automatically for any temperature rise, smoke detection or, if operated manually by pulling a cord, emergency.

For smoke detection it is claimed that the alarm will operate within 30 secs of the unit detecting a level of smoke equivalent to 5 per cent obscuration of a light beam over a distance of 1 metre. The heat detection will operate the alarm when the ambient temperature reaches 60°C and will reset when the temperature falls to 55°C.

Once triggered the alarm bell will only cease ringing when smoke or heat are no longer present. In the case of manual operation, pulling the cord for a second time stops the bell ringing.

The recommended retail price for the FB-75 is £20 plus VAT. Further information is available from **Photain Controls, Unit 18, Hangar 3, The Aerodrome, Ford, Sussex.**

POWER UNITS

A range of Selmar compact and reliable mains charging and power units for electronic calculators or low-voltage equipment, such as battery operated recorders, is now being marketed by **Stellar Components (Sales).**

These power units have been designed to meet the new British Electrical Safety Standards which become law in April. Suitable for most models of calculators, the units are supplied with a four-pronged universal plug to cover various input sockets found on calculators.

From a safety point of view it would seem to be a bad practice to have three of the four prongs, with a voltage at their tips, bare to the elements—a possible safety risk?

One of the units from the range is a multi-voltage unit which switches between 4·5V, 6V and 9V at 300mA. The recommended retail price for this unit is £3·95 plus VAT. Details and prices for the other units can be obtained from **Stellar Components (Sales) Ltd., The Causeway, Maldon, Essex.**

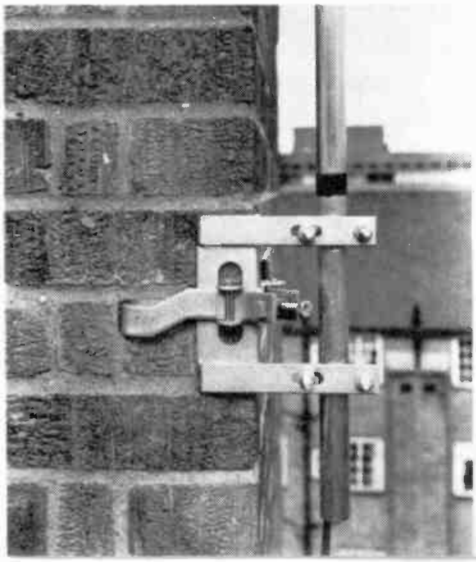
DATELINE

To coincide with the announcement of **AMI Microsystems** setting-up a new section to market certain products under the brand name of OM-EX, they have introduced a range of special "notebooks" cum executive desk-top calculators/calendars. They are also marketing a range of l.e.d. and l.c.d. digital watches under the same name.

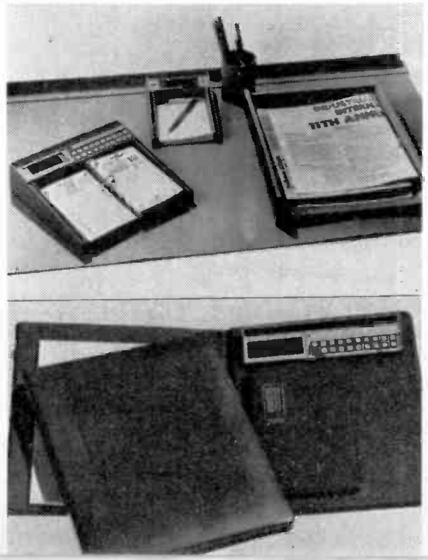
These include a calendar holder, notebook and 3-ring binder incorporating a 4 or 5 function calculator with an 8-digit display, floating decimal and automatic constant.

The highlight of the range is a memo pad holder with a built-in solid-state clock as well as a calculator/calendar.

The recommended retail price for the basic calendar/calculator clock set is £32·50. Complete details of the range of units is available from **AMI Microsystems Ltd., 108a Commercial Road, Swindon, Wilts.**

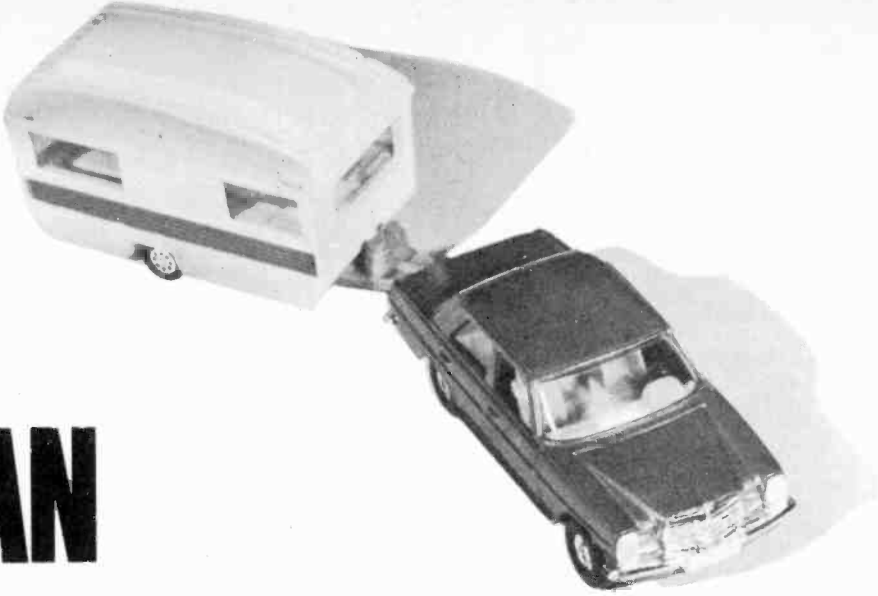


SSB1 aerial mast fixing bracket from Rawlplug



The OM-EX executive desk set and leather notebook

Selmar low voltage charger/power unit from Stellar Components



CAR/ CARAVAN CLOCK With Independent Journey Timer

- ★ *Accuracy within a few seconds per week*
- ★ *Back-up batteries ensure crystal timebase working with ignition off*
- ★ *Alarm and other optional facilities available*

By M. Fischer*

A DIGITAL clock intended expressly for car use must provide the function of any digital clock—to provide an attractive, accurate and reliable display of time. But, additionally, the fact that the clock is in a car demands features not usually found in mains-powered units.

To be legible during the day the display should have the maximum possible brightness, and in order not to distract the driver at night this intensity should be reduced, preferably automatically.

A car clock becomes far more attractive if, in addition to showing the time, it can be used as a stop-watch to time journeys, without interfering with the clock function.

The car clock described here includes all these features.

SUMMARY OF FEATURES

The jumbo-sized l.e.d. displays are driven at the maximum current (and intensity) compatible with a long life-time, giving a readout which is legible under any conditions other than having bright sunlight shining directly onto it. The clock i.c. chosen, the MK50253, has a three-level automatic intensity control, and the display enable input allows an extra MK50253 or MK50250 to be added to serve as a journey timer, sharing the clock display circuitry.

A crystal timebase is used, capable of giving an accuracy of a few seconds a week.

Back-up dry batteries are incorporated to ensure uninterrupted operation if ever the clock is disconnected from the car battery.

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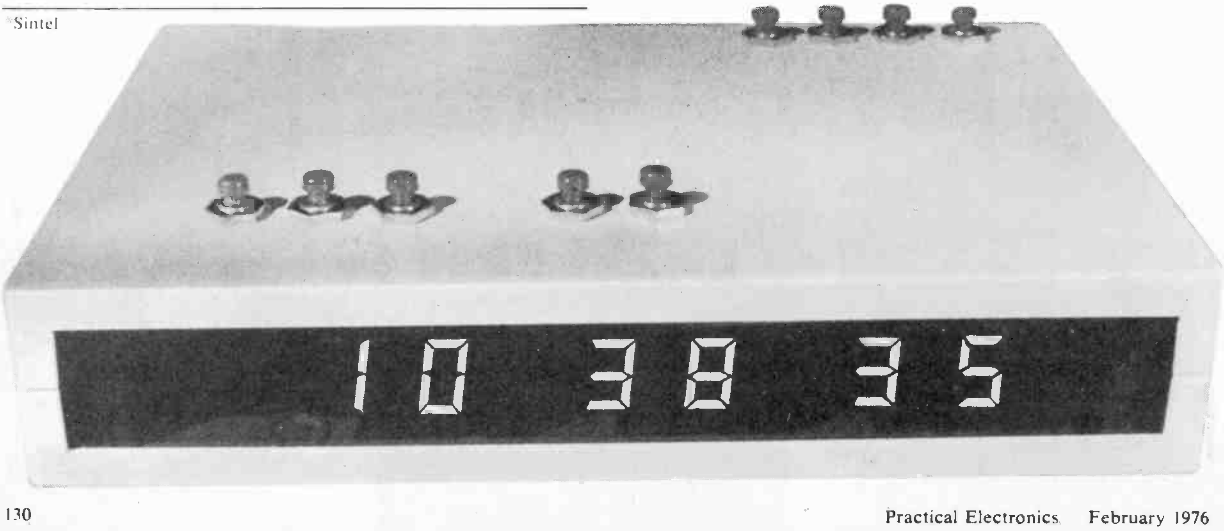
*Sintel



AN EXTREMELY VERSATILE DESIGN

The basic car clock design described in this article is capable of modification or expansion to provide other timing and controlling functions. For such uses, which will generally imply out-of-car installation, the first requirement is conversion for a.c. mains operation.

A mains alarm clock can readily be realised; there is adequate room in the specified case for inclusion of the alternative and additional electronic assemblies.

If the clock is to be used as a controller, a larger size case may be necessary.

Full details of these interesting possibilities will be given in a second article next month.

The MK50253 has an alarm facility and wiring for using this has been included on the clock PCB.

The clock is built on four printed circuit boards: the displays (PCB3); the clock (PCB2); the crystal timebase (PCB4) and the power supply and journey timer (PCB1). The clock p.c.b. will also accommodate all components needed to build a mains-only alarm clock; details of using this and other optional functions will be given next month.

CIRCUIT DESCRIPTION

The main circuit diagram is given in Fig. 1. This shows the clock, display, journey timer and power supply sections, with all interconnections. The practical division into three printed circuit board assemblies is indicated. The crystal timebase circuit is shown in Fig. 2. There are only three connections from this circuit (which occupies PCB4) to the other boards, so little difficulty should arise in correlating Fig. 1 and Fig. 2.

COMPONENTS . . .

Resistors

R1, R2, R6, R9	120kΩ (4 off)
R3–R5	3·3kΩ (3 off)
R7	ORP12 (Mullard)
R8	3·3kΩ
R10	12kΩ
R11	1·2kΩ
R12	820kΩ
R13	1·2kΩ
R14–R28	3·3kΩ (15 off)
R29–R35	120Ω ½W (7 off)
R36–R47	3·3kΩ (12 off)
R48	15Ω
R49	3·3kΩ
R50	12kΩ
R51–R53	3·3kΩ (3 off)
R54, R55	12kΩ (2 off)
R56	1·2kΩ
R57	10MΩ
R58	120kΩ
R59	100Ω
R60	3·3kΩ

All ¼W 10% unless otherwise stated

Potentiometers

VR1	22kΩ	miniature horizontal preset
VR2	4·7kΩ	
VR3	50kΩ	

Capacitors

C1	10nF ceramic 63V
C2	10nF ceramic 63V
C3	10nF ceramic 63V
C4	10nF ceramic 63V
C5	100μF elect. 25V
C6	2·2μF elect. 63V
C7	100μF elect. 25V
C8	10μF elect. 25V
C9	5–22pF trimmer (Mullard 808–00006)
C10	(see text)
C11	82pF ceramic
C12	10nF ceramic 63V
C13	10nF ceramic 63V
C14	10nF ceramic 63V

Integrated Circuits

IC1	CD4011AE	IC4	CD4011AE
IC2	MK50253 or MK50250	IC5	CD4020AE
IC3	MK50253	IC6	CD4025AE

Diodes

D1–D10	1N914 or 1N4148 (10 off)
D11	TIL209 (L.E.D.)
D12	1N914 or 1N4148
D13	TIL209 (L.E.D.)
D14	1N4001
D15	1N4001
D16	1N914 or 1N4148
D17	1N4001
D18	1N914 or 1N4148
D19	4V7 400mW Zener
D20	16V 400mW Zener
D21	12V 400mW Zener
D22	TIL209 (L.E.D.)

Transistors

TR1	2N3703	TR6	2N3704
TR2	2N3704	TR7	2N3703
TR3	2N3704	TR8–TR14	2N3704 (7 off)
TR4	2N3703	TR15	2N3704
TR5	2N3704		

Thyristors

CSR1–6	TIC44 (6 off)

Switches

S1–S10	Miniature s.p. push-to-make (9 off)
S11–S12	on off switch (2 off)

Batteries

B1, B2	9V battery, PP3 (2 off)

Crystal

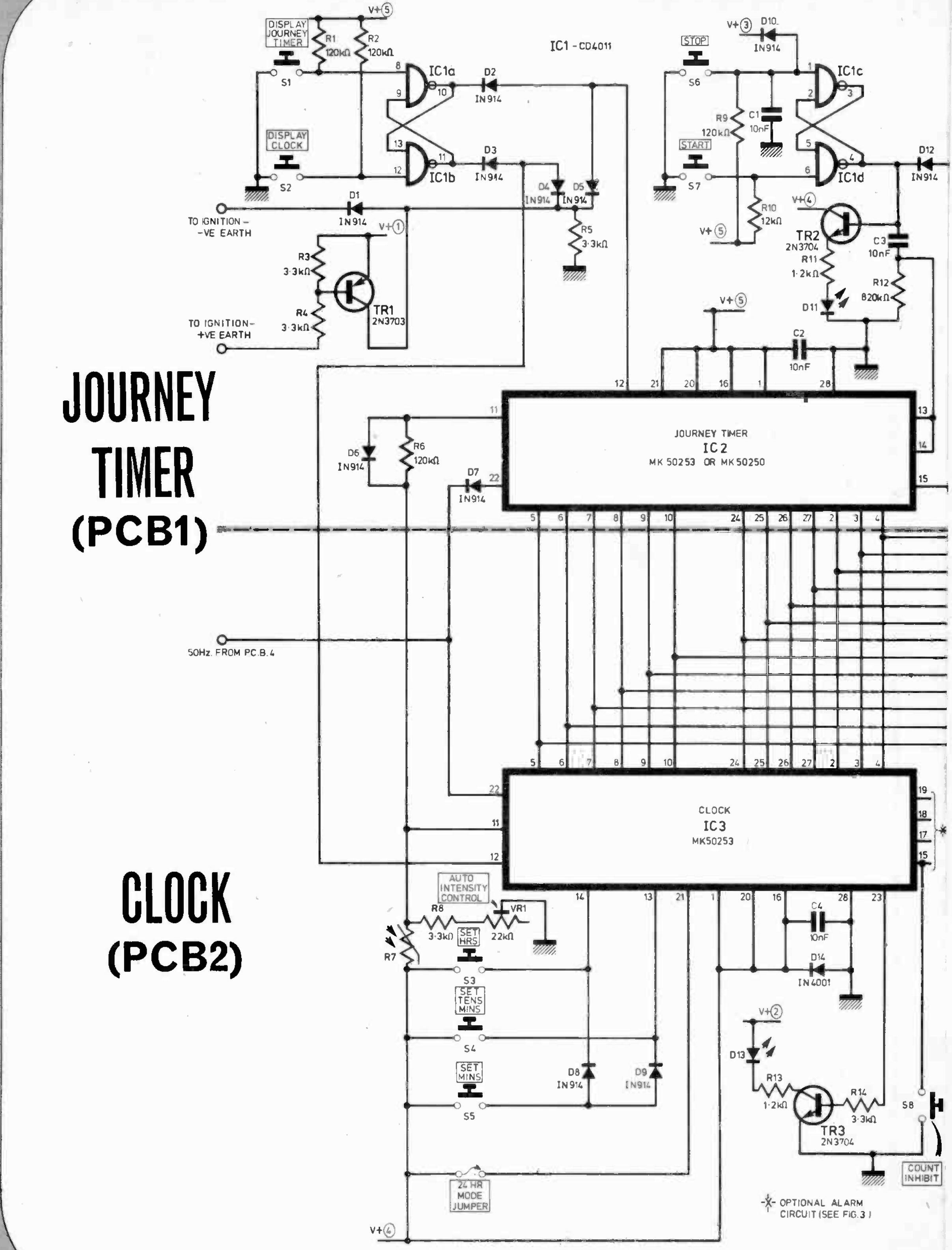
XL1	32·768kHz miniature quartz crystal

Display

X1–X6	L.e.d. displays FND500 (6 off)

Miscellaneous

FS1 Line fuse connector with 2A fuse. 20-way flexible flat cable, tinned copper wire, battery clips (2 off), Soldercon i.c. pin sockets, printed circuit boards PCB1, 2, 3 & 4 (4 off), Verocase 75-1410J, red Perspex front panel. LS1 80Ω miniature loudspeaker.


JOURNEY
TIMER
(PCB1)
CLOCK
(PCB2)
IC1 - CD4011
DISPLAY JOURNEY TIMER
DISPLAY CLOCK
S1
S2
R1 120kΩ
R2 120kΩ
V+⑤
IC1a
IC1b
D2 IN914
D3 IN914
D4 IN914
D5 IN914
D1 IN914
R5 3·3kΩ
TO IGNITION - -VE EARTH
TO IGNITION- +VE EARTH
V+①
R3 3·3kΩ
R4 3·3kΩ
TR1 2N3703
STOP
START
S6
S7
V+③
D10 IN914
IC1c
IC1d
R9 120kΩ
C1 10nF
R10 12kΩ
D12 IN914
V+④
TR2 2N3704
R11 1·2kΩ
C3 10nF
R12 820kΩ
D11
C2 10nF
JOURNEY TIMER
IC2
MK 50253 OR MK 50250
D6 IN914
R6 120kΩ
D7 IN914
50Hz. FROM P.C.B.4
CLOCK
IC3
MK50253
AUTO INTENSITY CONTROL
R8 3·3kΩ
VR1 22kΩ
R7
SET HRS
S3
SET TENS MINS
S4
SET MINS
S5
D8 IN914
D9 IN914
C4 10nF
D14 IN4001
V+②
D13
R13 1·2kΩ
TR3 2N3704
R14 3·3kΩ
S8
COUNT INHIBIT
24 HR MODE JUMPER
V+④
✻ OPTIONAL ALARM CIRCUIT (SEE FIG.3)

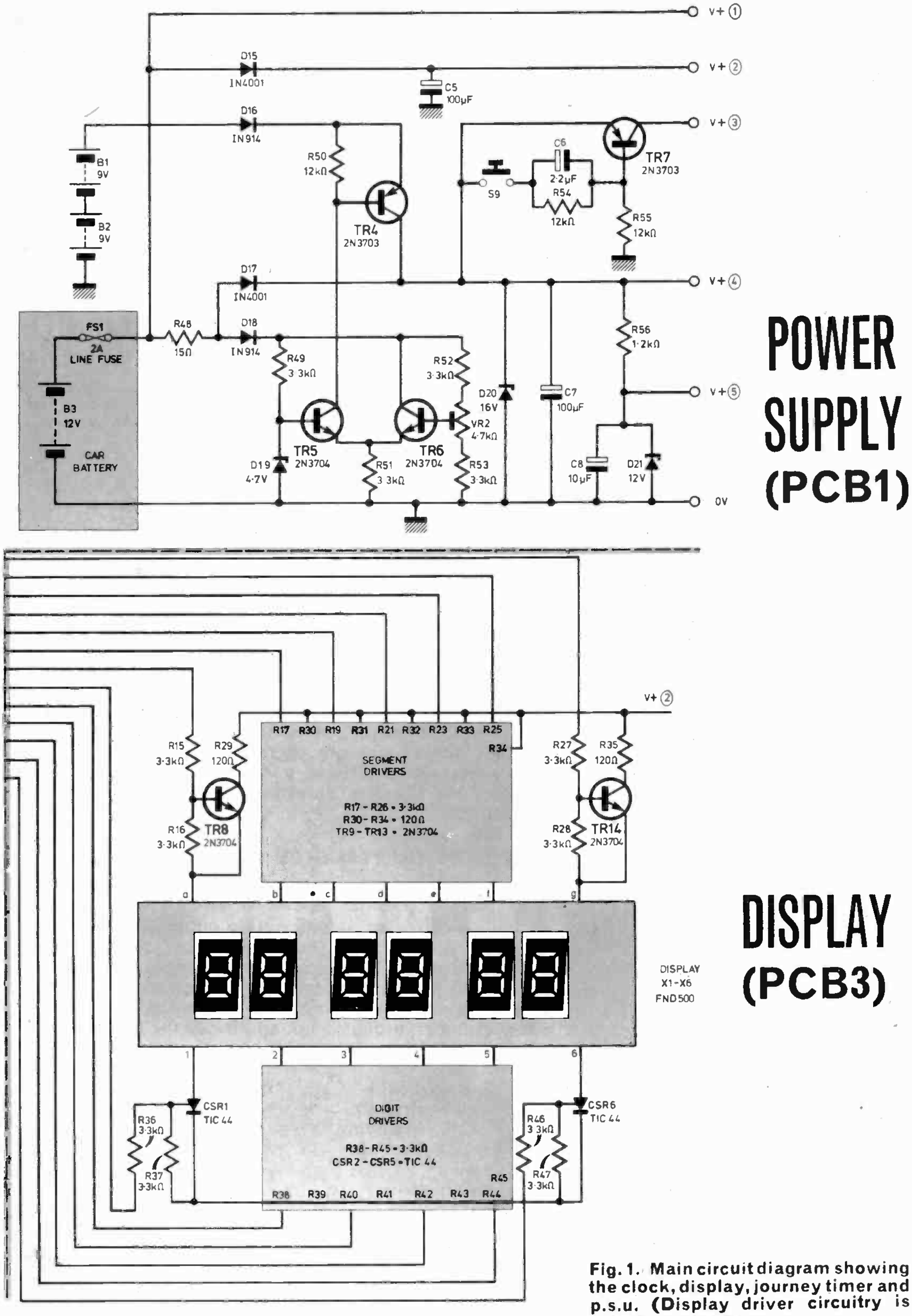


Fig. 1. Main circuit diagram showing the clock, display, journey timer and p.s.u. (Display driver circuitry is located on PCB2)

XTAL TIMER

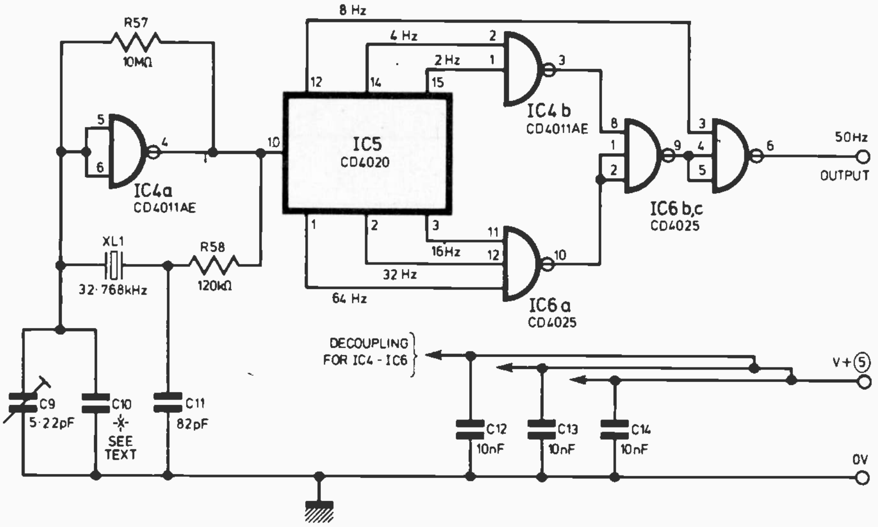


Fig. 2. Circuit of the crystal timebase. Crystal frequency is 32·768kHz

One further portion of circuitry remains: though this is optional—and is likely to be of interest only if a mains version of the clock is contemplated. The circuit in question is the alarm, and is given in Fig. 3.

In the following sections, dealing with the circuitry, the major items of interest in the overall system are described. No attempt has been made however to describe the internal functions of the clock integrated circuits.

ALARM

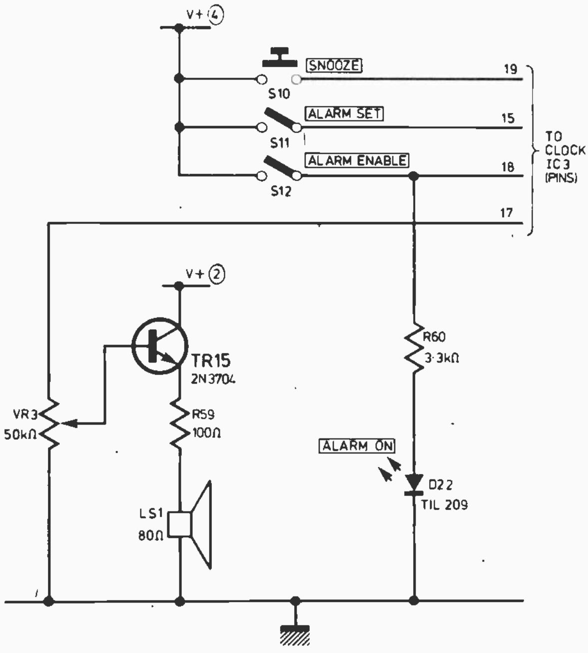


Fig. 3. Circuit of optional alarm

DISPLAY DRIVERS

During the time a particular digit is on, the corresponding digit output pin of the IC3 (MK50253) goes to near V_{SS}, firing one of the thyristors CSR1 to CSR6. Simultaneously the selected segment outputs also go to near V_{SS}, and as the emitters of the segment driving transistors (TR8–TR14) are held at a maximum of +3V by the selected display l.e.d.s and thyristor, these transistors go into saturation producing a segment current determined by the value of their collector resistors R29–R35.

At the end of a digit pulse there is an inter-digit blanking time during which all the IC3 digit and segment output pins are open-circuited. This turns off all the segment driving transistors, which in turn removes the thyristor anode current, switching the thyristor off.

AUTOMATIC INTENSITY CONTROL

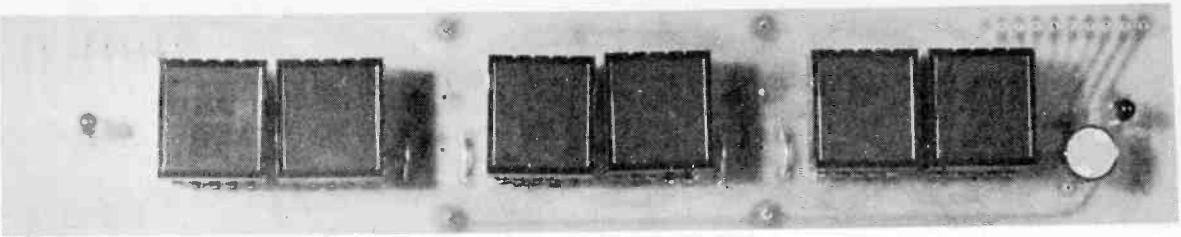
The cadmium sulphide photoresistor R7, R8 and VR1 form a potential divider between $V+(4)$ and $0V$ which drives an output voltage corresponding to the ambient light level, being high when the latter is high. Through its intensity control input, pin 11, the clock i.c. determines whether the voltage is high, medium or low and varies the percentage of time (duty cycle) each digit is on, and hence the apparent intensity. The three duty cycles are:

Intensity	*Duty Cycle*
Bright	14·3%
Medium	7·8%
Dim	2·6%

OTHER FUNCTIONS

The setting switches S1–S8 are simple connections to $V+(4)$. Note that after switching on, the MINUTES SET button *has to be pressed* before the clock will start counting and before the other setting switches will work.

The "P.M." l.e.d. (D13) brightness is automatically varied to match the rest of the readout. The time is displayed in a 12-hour format if pin 21 is left open,



Clock Display board (PCB3)

or in a 24-hour format if the pin is connected (by the jumper provided) to *V*+(*4*).

The alarm is not used in the clock described in this article, but the circuit is shown in Fig. 3 for those who want to add it. The alarm output consists of a "bleep" tone of about 500Hz generated in the clock i.c. Each time the SNOOZE button is pressed the tone is interrupted for 10 minutes.

JOURNEY TIMER

When wired in the 24-hour mode IC2 is reset to zero if the power supply is interrupted. This and the count inhibit feature are used to provide a journey timer "stop-watch" with START, STOP and RESET, which reads in hours, minutes and seconds.

When the display enable pin of IC2 is taken to 0V, all the digit and segment output pins are open-circuited. By connecting each digit and segment driver pin of the journey timer IC2 to the identical pin on the clock chip IC3, the readout can be made to show either the time, or the journey timer count, by suitable manipulation of the two display enable inputs.

This display selection and the journey timer Start-Stop are driven by CMOS flip-flops formed by IC1a, b and IC1c, d. These are controlled by push-button switches S1, S2, S6 and S7.

The display outputs of both IC2 and IC3 are disabled when the ignition is off, so as to turn off the readout and thereby reduce the current consumption of the whole unit to about 20mA. The diodes on the various inputs to the journey timer i.c. (IC2) ensure that these inputs are at 0V when V+(*3*) is at 0V during resetting.

CRYSTAL TIMEBASE

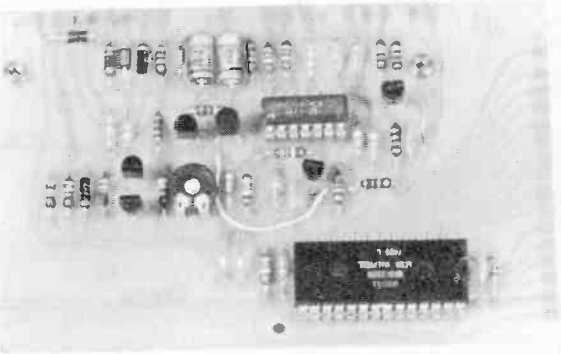
The circuit diagram for the crystal timebase appears in Fig. 2.

A miniature 32·768kHz crystal XL1 (manufactured for electronic watches) is used with a CMOS oscillator IC4 and a divider IC5 to provide outputs at 64Hz, 32Hz, 16Hz, 8Hz, 4Hz and 2Hz. The latter five signals are used to gate the 64Hz square wave so that in every half second only 25 out of 32 pulses are allowed to reach the clock i.c.s, replacing the 50Hz signal which would normally be derived from the mains.

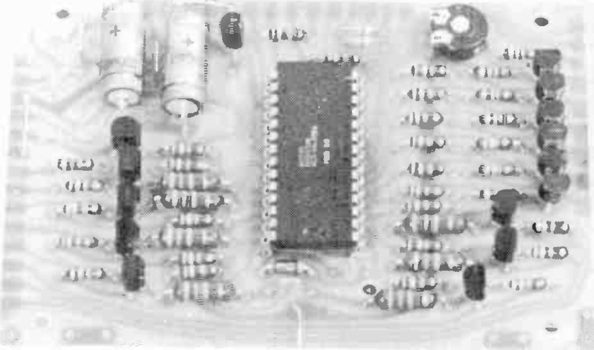
The gating system is formed by part of IC4 and the whole of IC6 suitably interconnected.

POWER SUPPLY

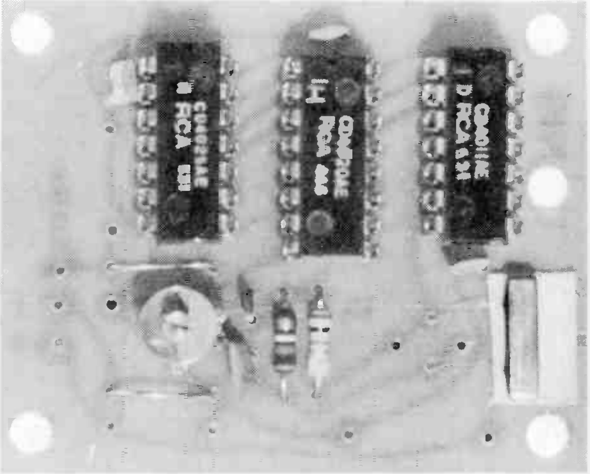
TR5 and TR6 form a comparator which switches TR4 on if the voltage of the car battery (B3) falls below a level preset by VR2. This action allows batteries B1 and B2 to supply power to the clock i.c.s. and CMOS i.c.s.



Journey Timer and PSU board (PCB1)



Clock board (PCB2)



Crystal Timebase board (PCB4)

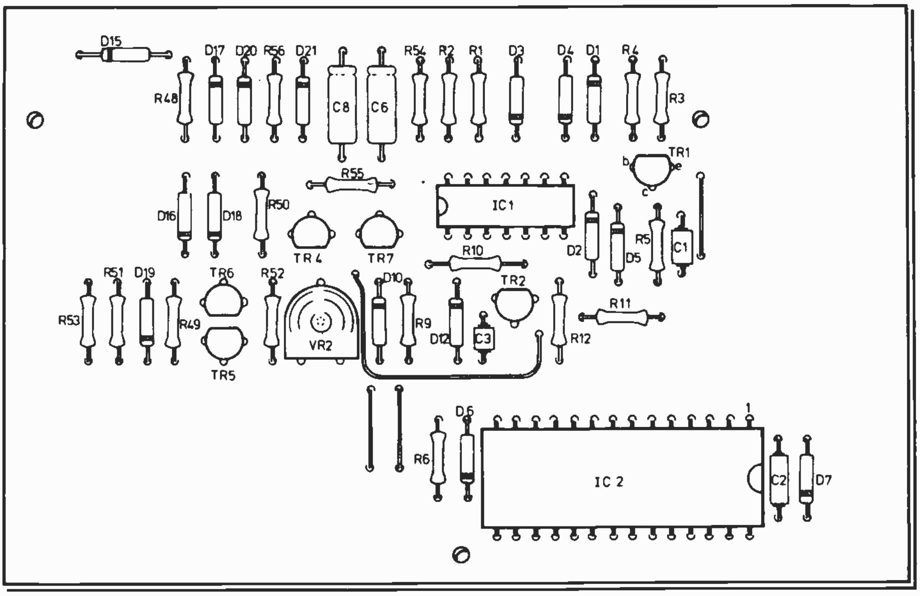


Fig. 4. Main circuit board PCB1 component layout

As these batteries will conduct for a few seconds a day at the most, their life will only be limited by their shelf life, and this should be over one year.

Without this extra back-up the clock could be reset by a low car battery voltage during starting the engine (as this can fall as low as 5V).

Diodes have been included to prevent damage being done by reverse voltage spikes from the car, again occasionally experienced on starting.

A 2A line fuse FS1 is fitted in the lead from PCB2 to the car battery.

CONSTRUCTION

Full size diagrams of the printed circuit boards are given, see Figs. 6, 7, 9 and 11. Component layouts for each board are given, see Figs. 4, 5, 8 and 10. Inter-wiring is indicated in the PCB diagrams. General assembly can be seen in the photograph of the completed clock.

Although the sequence of assembly of the clock is not critical, the following points should be noted.

Soldercon i.c. sockets should be used to mount the displays and i.c.s. The carrier strips on these should not be broken off until *all* other soldering has been done.

The light dependent resistor R7 should be mounted after the FND500 digits, with its face just behind the front plane of the digits, pointing a few degrees away from them.

The use of flat cable for as much of the wiring as possible helps to keep the unit tidy. The wires connecting the segment and digit pins of the journey timer i.c. to those of the clock i.c. are soldered to the bottom of PCB1 at the base of the IC3 socket pins.

The display board PCB3 is held in place by two tinned copper wire struts passing through the clock board PCB2.

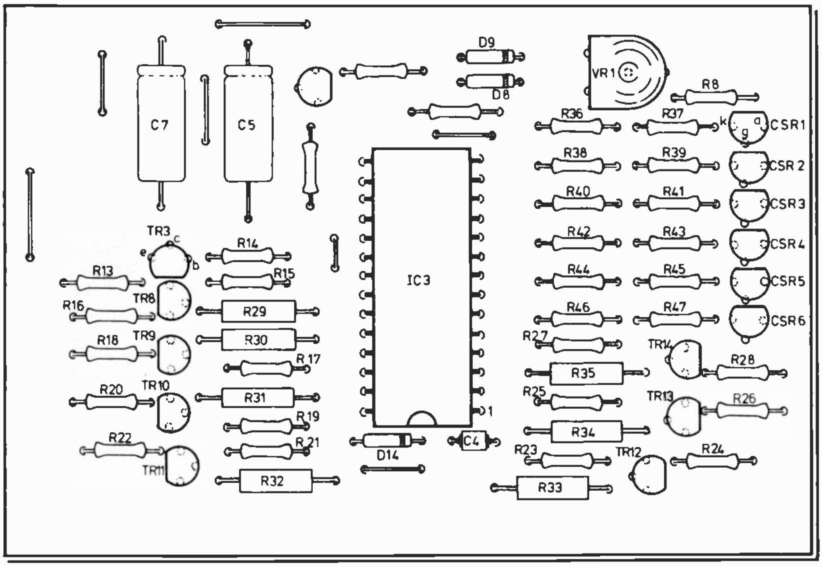


Fig. 5. Clock circuit board PCB2 component layout. (Alarm circuit components are not annotated —details next month.)

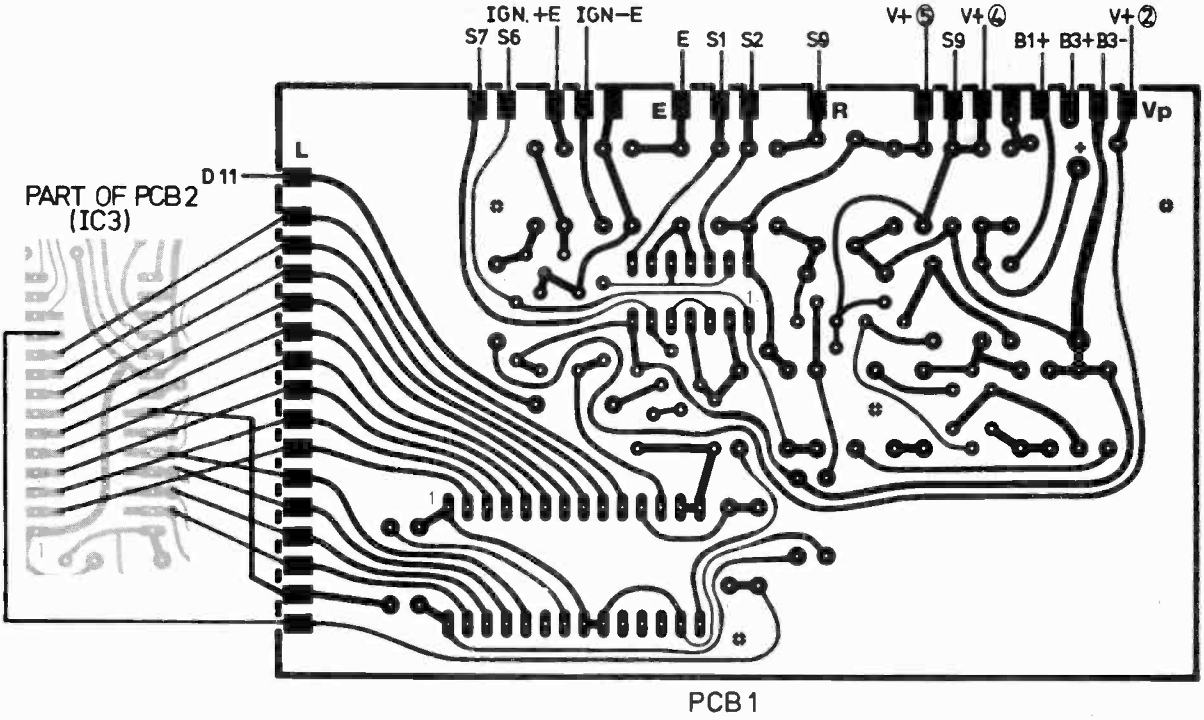


Fig. 6. PCB1 printed circuit master and connecting details. Note the wiring on the left edge is soldered direct to IC3 pins on board PCB2

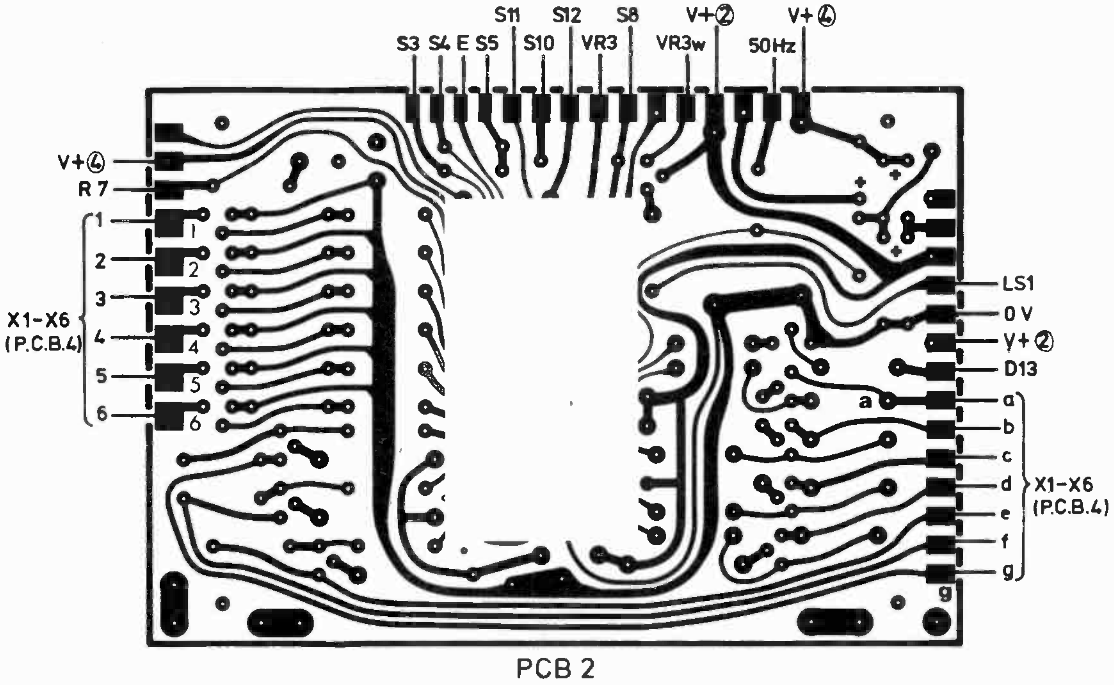


Fig. 7. PCB2 printed circuit master and wiring connecting details

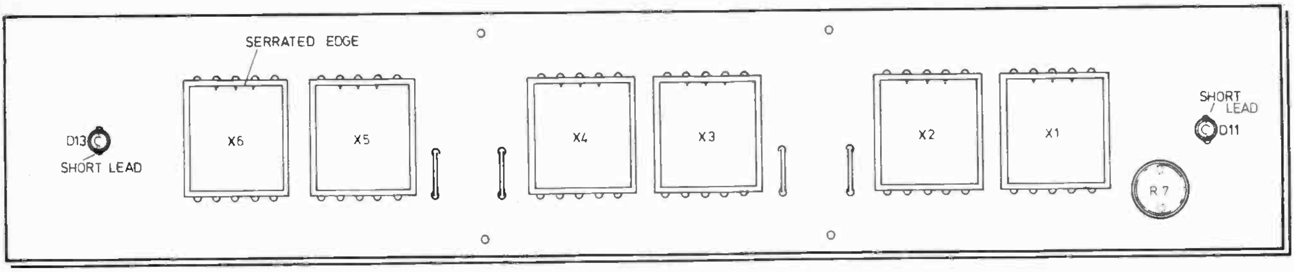


Fig. 8. Display board PCB3 component layout

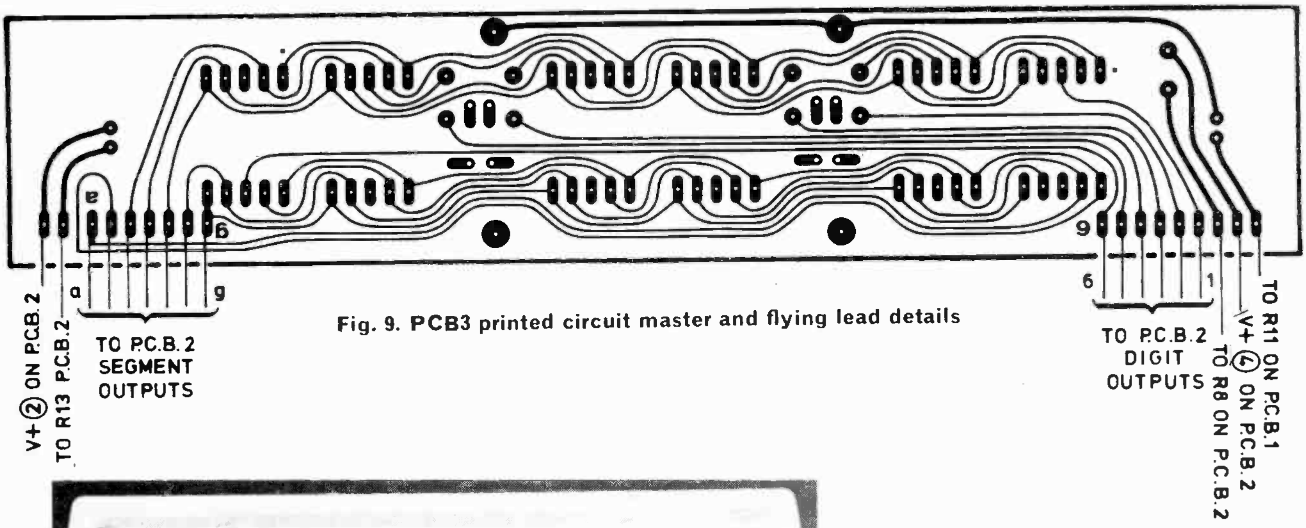
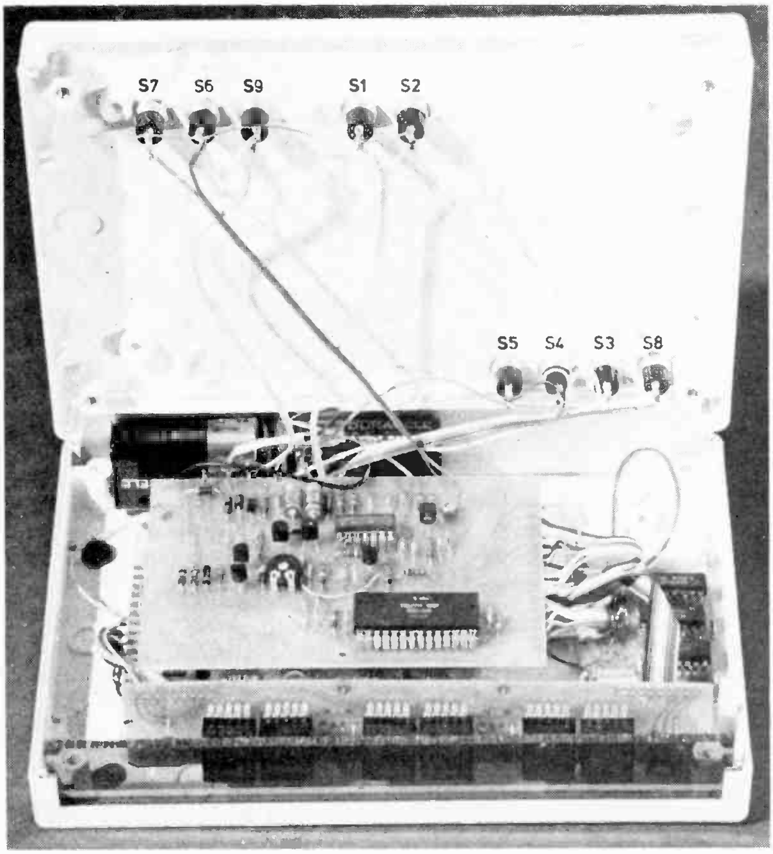


Fig. 9. PCB3 printed circuit master and flying lead details



HANDLING THE I.C.s

Standard m.o.s. handling precautions should be used with the MK50253/0 and the CMOS i.c.s. An easy procedure is to hold the conductive foam in which the i.c. is shipped with the left hand, with the foam and a finger touching several tracks of the p.c.b. until the i.c. is in its socket: with the right hand take out the i.c. and insert in its socket.

To remove an i.c. from its socket, reverse this procedure, putting the i.c. back into the foam which will have been held with the left hand against tracks of the p.c.b.

This way, the body, the foam, the CMOS and the p.c.b. will all be at the same potential, not allowing static to build up.

It is also advisable to be touching some of the pins (of the i.c.) while doing the transferring.

Always switch off power before inserting or removing i.c.s: if soldering on the board after i.c.s have been inserted, always wire tip of soldering iron to p.c.b. 0V, and keep the power off.

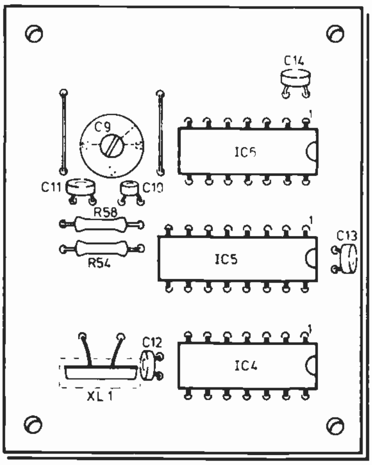


Fig. 10. Crystal Timebase board PCB4 component layout. Note that the crystal is fixed to the board by double sided adhesive tape

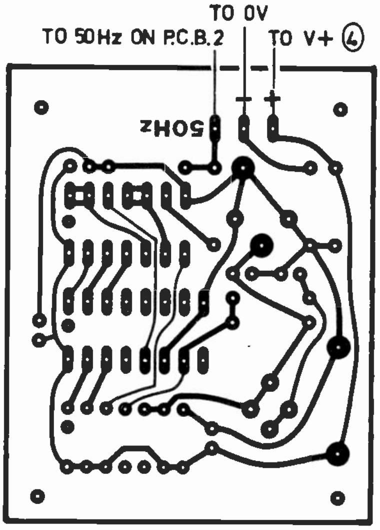


Fig. 11. PCB4 printed circuit master

CRYSTAL AND DISPLAYS

The crystal leads are fragile—so beware! The crystal is fixed to the p.c.b. with some double-sided adhesive tape, about 5mm from the holes for the crystal leads, which should have a gentle bend in them.

The FND500 display has indentations on the top edge (to identify the top of the display). Before switching on double-check that the displays are correctly inserted and that the necessary jumpers are in the p.c.b.

If at any time when the power is on, one segment of a digit is not making proper contact, the full 12V can appear across two segment diodes of the other digits, exceeding their 3V maximum reverse voltage and blowing them. For the same reason they must never be inserted or removed while power is on.

SETTING UP

Power Supply: The car battery voltage at which the back-up batteries B1, B2 cut-in is adjusted by VR2. If the cut-in voltage is too high, say 11V, the clock may go on to "back-up" at times other than during starting. If the cut-in voltage is too low, say 8·5V, the a.m./p.m. diode D13 may start flashing to indicate a low voltage, or the clock may be reset to zero.

VR2 should be adjusted so that cut-in occurs at a car battery voltage of about 10·5V. The car battery voltage may be "varied" for this operation by putting diodes (1N4001) in series with it to drop the voltage in 0·6V steps, measuring the resultant voltage with a multimeter. The cut-in can be detected by using a 50mA ammeter or an l.e.d. to indicate that current is being taken from the back-up batteries.

Automatic Intensity Control: Adjust VR1 to obtain the desired set of thresholds.

Crystal Timebase Frequency: This may be adjusted using the trimmer capacitor C9. To increase the frequency, reduce the capacitance of C9; to reduce the frequency, increase the capacitance of C9. The trimmer is at maximum capacitance when the brass parts cover the nickel parts. If with the trimmer at maximum capacitance, the frequency is still too high, a capacitor must be inserted in parallel with C9 in the position "C10".

The Speaking Clock is a sufficiently accurate reference for frequency adjusting. The Post Office state that the variation from one day to the next is less than 1/20 second.

OPERATION

At switch-on the clock may start displaying either the Clock time or the Journey Timer count. The latter will be 00-00-00; the former will be 12-00-00 if the clock is in the 12-hour mode, 00-00-00 if it is in the 24-hour mode.

SETTING THE CLOCK

Press the DISPLAY CLOCK button (S2) to switch the displays to display clock time. Then press the MINS SET (S5), TENS MINS SET (S4) and HOURS SET (S3) buttons until the correct time is being displayed. The counting is inhibited as long as the COUNT INHIBIT button (S8) is being pressed. Note: The clock will start counting after, *and only after,* the MINS SET button has been depressed (even if only momentarily).

SETTING JOURNEY TIMER

Push the DISPLAY JOURNEY TIMER button (S1), and, if the unit has just been switched on, the RESET button (S9). From now on, the Journey Timer will operate as a stop-watch, controlled by the START (S7), STOP (S6) and RESET buttons. It can be stopped and started again without resetting. The display can be switched back to DISPLAY CLOCK without affecting the Journey Timer, and all the control buttons of both functions are functional irrespective of which display mode has been selected.

Next month: An extension of facilities and some further interesting and useful applications will be described.

Now...the most exciting Sinclair kit ever

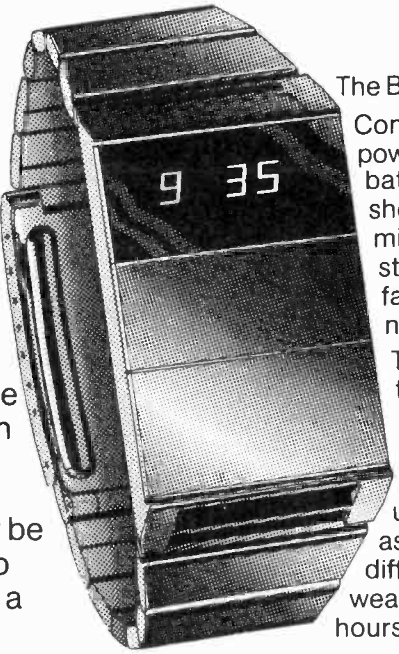
The Black Watch kit

At £17.95, it's

***practical** – easily built by anyone in an evening's straightforward assembly.

***complete** – right down to strap and batteries.

***guaranteed.** A correctly-assembled watch is guaranteed for a year. It works as soon as you put the batteries in. On a built watch we guarantee an accuracy within a second a day – but building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week.



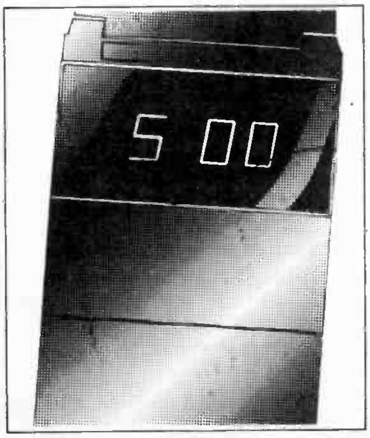
The Black Watch by Sinclair is unique. Controlled by a quartz crystal... powered by two hearing aid batteries... using bright red LEDs to show hours and minutes and minutes and seconds... it's also styled in the cool prestige Sinclair fashion: no knobs, no buttons, no flash.

The Black Watch kit is unique, too. It's rational – Sinclair have reduced the separate components to just four.

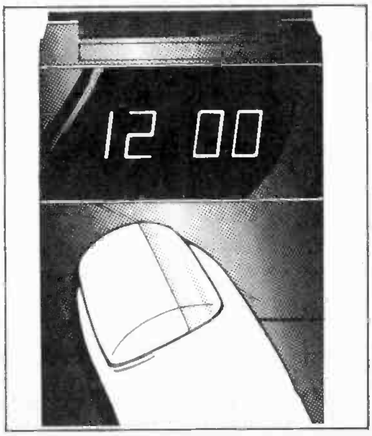
It's simple – anybody who can use a soldering iron can assemble a Black Watch without difficulty. From opening the kit to wearing the watch is a couple of hours' work.

The special features of The Black Watch

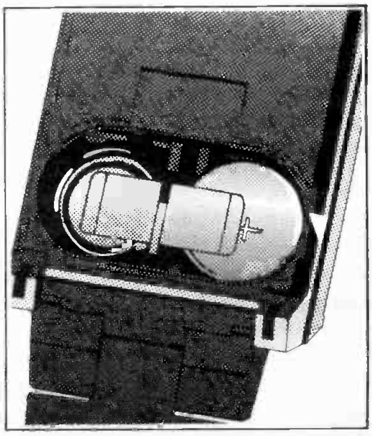
Smooth, chunky, matt-black case, with black strap. (Black stainless-steel bracelet available as extra – see order form.)



Large, bright, red display – easily read at night.
Touch-and-see case – no unprofessional buttons.



Runs on two hearing-aid batteries (supplied). Change your batteries yourself – no expensive jeweller's service.



The Black Watch–using the unique Sinclair-designed state-of-the-art IC.

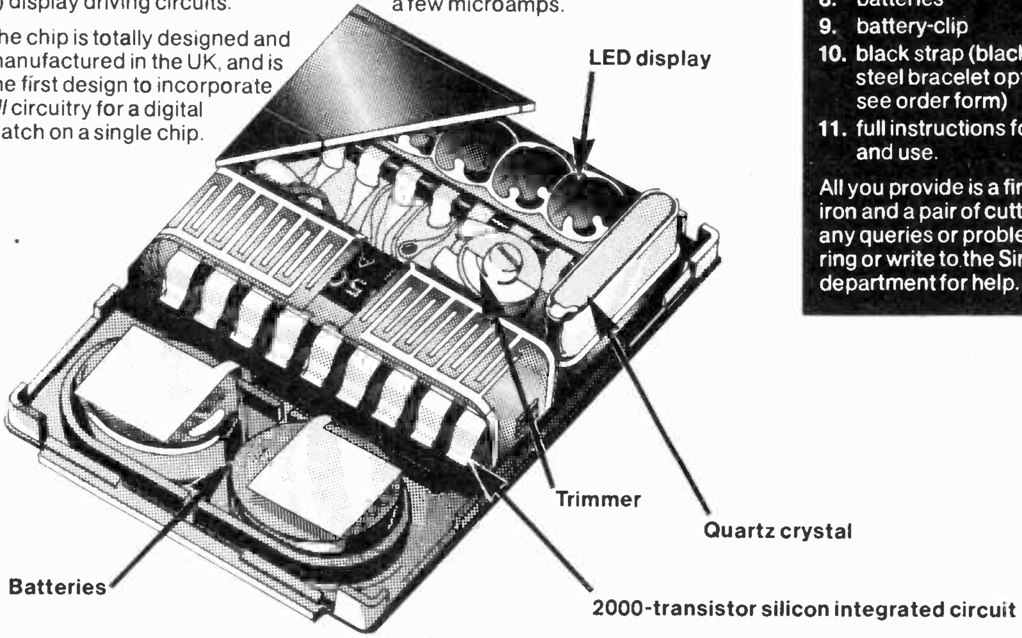
The chip...
The heart of the Black Watch is a unique IC designed by Sinclair and custom-built for them using state-of-the-art technology–integrated injection logic.

This chip of silicon measures only 3 mm x 3 mm and contains over 2000 transistors. The circuit includes

a) reference oscillator
b) divider chain
c) decoder circuits
d) display inhibit circuits
e) display driving circuits.

The chip is totally designed and manufactured in the UK, and is the first design to incorporate *all* circuitry for a digital watch on a single chip.

...and how it works
A crystal-controlled reference is used to drive a chain of 15 binary dividers which reduce the frequency from 32,768 Hz to 1 Hz. This accurate signal is then counted into units of seconds, minutes, and hours, and on request the stored information is processed by the decoders and display drivers to feed the four 7-segment LED displays. When the display is not in operation, special power-saving circuits on the chip reduce current consumption to only a few microamps.



Complete kit £17.95!

The kit contains
1. printed circuit board
2. unique Sinclair-designed IC
3. encapsulated quartz crystal
4. trimmer
5. capacitor
6. LED display
7. 2-part case with window in position
8. batteries
9. battery-clip
10. black strap (black stainless-steel bracelet optional extra–see order form)
11. full instructions for building and use.

All you provide is a fine soldering iron and a pair of cutters. If you've any queries or problems in building, ring or write to the Sinclair service department for help.

Take advantage of this no-risks, money-back offer today!
The Sinclair Black Watch is fully guaranteed. Return your kit within 10 days and we'll refund your money without question. All parts are tested and checked before despatch–and correctly-assembled watches are guaranteed for one year. Simply fill in the FREEPOST order form and post it–today!

Price in kit form: £17.95 (inc. black strap, VAT, p&p).

sinclair

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London Road, St Ives,
Huntingdon, Cambs., PE17 4HJ.
Tel: St Ives (0480) 64646.**
Reg. no: 699483 England. VAT Reg. no: 213 8170 88.

To: Sinclair Radionics Ltd, FREEPOST, St Ives, Huntingdon, Cambs., PE17 4BR.

Please send me Total £

.... (qty) Sinclair Black Watch kit(s) at £17.95 (inc. black strap, VAT, p&p). ....

.... (qty) black stainless-steel bracelet(s) at £2.00 (inc. VAT, p&p). ....

*I enclose cheque for £.................................. made out to Sinclair Radionics Ltd and crossed.

*Please debit my *Barclaycard/Access/American Express account number

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New Post Office Research Centre

Harnessing advanced technology for telecommunications expansion

An explosion in telecommunications is under way. To meet the increasing demands in telephone, telex, computer data, facsimile and other proposed services, a technical revolution will have to take place during the next decade.

Preparations for this revolution are being determinedly and efficiently pursued at the new Post Office Research Centre, Martlesham Heath, Suffolk, recently opened by The Queen. Claimed to be the most advanced centre of its kind in Europe, it will replace Dollis Hill, London, which has been for 54 years the home of Post Office Research.

With a very creditable list of technical achievements in telecommunications behind it, the Post Office is determined to maintain Britain's leading position in world telecommunications in the future. The ultra modern custom designed £11 million centre will assure the right facilities and environment for the staff of 1,800. This will include 850 research engineers and scientists, 550 technicians, 80 draughtsmen and 80 trainees.

Of the many important areas of research currently undertaken at Martlesham, mention has to be restricted to but a few. Those mentioned below are vitally important and indicative of the advanced technology soon to be applied in practice.

TOWARDS THE ALL ELECTRONIC EXCHANGE

Electromagnetic relays are the basic of today's automatic telephone service. In the course of the next ten years these bulky devices will be replaced by semiconductor microprocessors for logical and timing operations. The use of electronic circuits for line signalling will allow existing bulky transformers to be replaced by miniature transformers. Greater reliability, smaller space requirements and lower unit costs will result from this adoption of new technology.

DIGITAL EXCHANGE SWITCHING

The Post Office Research Department has pioneered work on central digital trunk exchanges. These are now past the research stage. Attention is now being turned to the digital local exchange. Higher speed data and facsimile are the kind of new services that digital techniques will permit. Investigations are being made into systems based upon TTL and CMOS.

COMPONENT RELIABILITY

The supreme importance of semiconductor devices in future developments of the telecommunications network is underlined by the detailed work on component reliability standards being undertaken at Martlesham. The task is approached through a blend of basic studies of failure mechanisms and component testing, with the emphasis on accelerated testing to simulate a normal lifespan, often using elevated ambient temperature as the stress factor. Bipolar i.c.s under investigation include linear, TTL and ECL types. Special procedures are being developed for evaluating complex MOS devices, both *p*- and *n*-channel types.

TRANSMISSION METHODS

To cope with the rapidly rising demand upon the telecommunications network, new additional transmission methods will have to be brought into use in the next decade. Research and development has been undertaken in two distinct areas: microwaves via waveguides and optical waves along glass fibres.

The use of circular waveguide to carry millimetric digital signals in the frequency band 30–110GHz has been successfully demonstrated over a 14km route between Martlesham and Wickham Market in Suffolk. The waveguide consists of a 50mm diameter helix of fine copper wire set within a glass fibre tube. It is installed into a welded steel duct; the waveguide and the duct are pressurised with dry nitrogen and dry air respectively.

In an operational system repeaters should only be necessary at intervals of 25 to 30km. The repeaters utilise the latest technical advances in solid state devices and microwave integrated circuits.

The system when exploited up to 90GHz has an inherent transmission capability of 24 Gbits/s each way, i.e. the equivalent of more than 300,000 two-way telephone circuits. Further capacity is available above 90GHz if required. This high-capacity waveguide system should have a significant role to play in the trunk network of the future.

OPTICAL FIBRE COMMUNICATION

For shorter links, as between exchanges in built-up areas, optical fibre cables are expected to offer economic advantages to metal pair and coaxial cables. Lower attenuation at higher message frequencies means fewer repeater amplifiers. The fibre cable will be smaller, lighter and more flexible than existing cables of similar message capacity.

Work in progress at Martlesham covers most aspects of optical cable transmission, including fibre materials and the devices needed to interface between fibres and conventional electronic circuits.

A practical problem for fieldwork has been solved—this being the jointing of the hair-thin fibres. A special jib has been designed which ensures a perfect cut to the end of the fibre; joints can then be made with the minimum of optical attenuation.

An eight megabit-per-second system is being developed which will be capable of transmitting 120 telephony channels over a 4 to 5km length of fibre. This system will use a semiconductor (gallium arsenide) light-emitting diode operating at the infra-red wavelength of about 900 nanometres, together with large-core multimode fibre having an attenuation of about 7dB/km; a silicon avalanche photodiode detector will be used, with conventional solid-state amplifying circuits.

SEMICONDUCTOR UPDATE

□ □ □ By R.W. COLES

ZC2800
ZC5800
MC14440L
MC14440Z
HA2425
MC3491
MC3490
MC3494

SCHOTTKY FUGITIVES

I always thought that Schottky diodes were destined for perpetual imprisonment inside the faster variety of t.t.l. logic (the 74S series), but it seems that some of the little blighters have made good their escape and can be obtained individually from Ferranti.

Schottky Barrier diodes have a lot of interesting properties which makes them well worth a second glance. Their forward voltage drop is much smaller than that of a conventional silicon diode when operated at low currents, being typically less than 450mV at 1mA.

Their switching performance is nothing short of spectacular due to a complete absence of charge storage, and sub-nanosecond performance is quite possible. If you can think of an application for one of these interesting devices as a fast switch or very high frequency detector or mixer, you will be interested in the **ZC2800** and **ZC5800** series.

CLOCK WATCHERS

There are numerous MOS l.s.i. clock clips available to amateurs at the moment, and they all have their particular advantages and disadvantages. Indeed, the most difficult problem seems to be selecting the *best* device for a particular clock design! You may think that there is not much left to say about these circuits, and that any new design is likely to be just a variation on the theme rather than a fundamental change of direction.

The new Motorola clock chip, **MC14440L** is, however, a very definite change of direction when compared with run-of-the-mill devices because it utilises CMOS technology to give an incredibly low power drain of typically 5μA (yes, that's right, *micro* amps!) from a 1·5V battery supply.

Now you may be thinking that 5μA for the chip isn't going to put much strain on the battery but 200mA for the l.e.d.'s certainly will, but the display problem has been taken care of, because the MC14440L teams up with liquid crystal displays to give a clock that will run for a very long time indeed from a single cell!

So, goodbye, mains leads, power packs and the rather doubtful accuracy of mains frequency (the MC14440L runs from a 32·768kHz crystal) and hello small, cool, portable clocks which can go anywhere, anytime.

The usefulness of the MC14440L does not stop there however, because it also has a seconds and date capability and a simple time setting circuit to make the whole thing child's play. Apart from a display and a crystal, the only external components are a few R's, C's and diodes, which makes the MC14440L easy to incorporate into the smallest case design. The chip comes in a 40-pin d.i.l. package, but a tiny 10mm square version (**MC14440Z**) is available for use in digital watches.

SAMPLE HOLD

Sample/hold circuits have been used in analogue instrumentation circuits for many years, but very little has been seen of these useful building blocks in any amateur designs because of their high cost.

The idea is quite simple. At a particular point in time an analogue input voltage is sampled, and stored across a capacitor. The capacitor is used as an input to a very high input impedance d.c. amplifier so that the capacitor is not appreciably discharged and an amplifier output voltage is produced proportional to the input voltage at the time the sample was taken. The output voltage from the "hold" amplifier remains steady until another sample is taken.

The basic principles are simple, but in practice if the sample time is short, and the hold time long, the design of such a circuit using readily available components is by no means simple, and a popular solution in the past has been to purchase a ready-made circuit in modular form. This is an expensive way out, and now at last there is a better way with the introduction of a new monolithic i.c. from Harris, the **HA2425.**

The HA2425 contains a high slew-rate input amplifier, a high performance sampling switch, and an output amplifier with a MOSFET input circuit, connected as a unity gain follower.

A sample/hold circuit can be used to "freeze" a time varying input signal so that an analogue to digital conversion sequence can be performed, and for this type of application the circuit is often used in the track-and-hold mode, where the output is allowed to follow the input signal between "snap-shots". The HA2425 is of course suitable for both sample/hold and track/hold applications, but as we have come to expect from monolithic solutions to old problems, this new i.c. is very versatile, and can be used for a wide variety of other, original applications including analogue multiplexers, de-multiplexers, gated oscillators, phase sensitive detectors and gated op-amps.

GAS DRIVERS

L.e.d. displays are cheap and simple, but if what you really want is an easy-to-read display with style, you would be better off using one of the excellent gas discharge types now available. Now I don't mean the older "Nixie" type of display tubes which were pretty ghastly in some respects, but the new, seven segment devices made by Beckman and Sperry.

These new gas discharge displays look really good, but although the appearance is vastly improved, the old problems associated with driving high voltage cold cathode tubes remain the same, and are likely to send most of us back to the l.e.d.

Thanks to a new family of devices from Motorola, however, the stylish gas displays may be adorning many a clock or counter in the near future. I am referring to the **MC3491** cathode driver and the **MC3490** and **MC3494** anode drivers which take all the high voltage donkey work out of powering a gas discharge display.

The MC3491 contains eight high voltage drivers for connection to the seven cathode segments and decimal point of a display, and each of these drivers acts as a programmed current source to produce optimum display results.

The MC3490 and MC3494 are complementary to the MC3491 and are intended to control the anodes of a time shared display system. The MC3490 accepts a positive going input from the scan circuits while the MC3494 is designed for negative going inputs. All three devices are very versatile in use and can be used in CMOS and MOS systems.

OPTO-COUPLED R.P.M. METER

By D. J. BRADBURY

THIS article describes an optically coupled r.p.m. meter designed to measure the propeller speed of model aircraft engines. The circuit which is intended for use with two bladed propellers has two switched ranges of 0-10,000 r.p.m. and 0-25,000 r.p.m. in order to cover the normal operational range of these engines

The meter may be used by aeromodellers to pick the optimum diameter and pitch of propeller for a particular engine. This is done by checking if the engine will run with a particular propeller at the r.p.m. where it produces its maximum power output.

Also as many modellers prefer to mix their own fuels, this meter would be extremely useful in evaluating an engine's performance on the fuel. For instance, the performance of common fuel mixes is very dependent on the percentage of nitrate additive used. However, this additive is quite expensive and in excess can reduce the operational life of an engine considerably. So by measuring the r.p.m. of an engine for different fuels a compromise between cost and performance may be found.

BASIC PRINCIPLES

To measure the speed of an engine an MS4A photodiode is positioned facing the rotating propeller. The output of the photodiode will be a steady d.c. level (due to ambient lighting conditions) added to which is a pulsing voltage caused by the blades of the propeller. These pulses may be of either polarity, for instance if the background lighting behind the propeller is high then a negative pulse will be given every time a propeller blade interrupts the light falling on the photodiode.

However, if the propeller reflects more light on to the photodiode than it cuts off then the pulses will be positive going. As both these conditions may occur in practice the following stages of the instrument must be able to handle them.

These input pulses are passed through an a.c. amplifier which is followed by a limiting amplifier. The object of these stages is to provide the constant amplitude pulses that are required by the type of pulse counter used in this circuit. The limiting amplifier is followed by a pulse counter which drives a 1mA movement meter. The two r.p.m. ranges of the instrument are obtained by applying different shunt resistors across the meter to vary its sensitivity.

CIRCUIT OPERATION

The input voltage produced by the photodiode D1 (Fig. 1) is coupled via C1 to the base of TR1. TR1 is biased as a normal amplifier and has a voltage gain of approximately 120. The collector of TR1 is coupled to the base of TR2 via C2. TR2 is biased via R3 so that its collector is normally at zero volts.

For negative going input pulses, the pulses on the collector of TR1 will be positive going. Since TR2 is already saturated a pulse cannot turn it on any harder but it will charge up C2 so that when the pulse finishes and the voltage on the collector of

TR1 falls to its quiescent level, TR2's base will be taken low enough for the transistor to turn off. At high speeds C2 must charge sufficiently in a short time and so the value of C2 is kept small.

For positive going pulses the operation of TR1 and TR2 is more straightforward. The pulses appearing at the collector of TR1 will now be negative going and so will switch TR2 off and on without substantial charging of C2.

When TR2 turns off, its collector voltage rises up to about 5·6V where it is restricted from further increase by the Zener diode D2. Thus for normal inputs the pulse height at the collector of TR2 is limited to 5·6V and is essentially unaffected by supply and input level variations. Now when the voltage on the collector of TR2 is low, the junction of the emitters of TR3 and TR4 is held at about 0·6V by TR4 and so C5 has a charge on it given by CV.

Since a two bladed propeller at 10,000 r.p.m. gives one pulse every 3ms;

$$I \simeq \frac{1 \times 10^{-6} \times 4\cdot4}{3 \times 10^{-3}} \simeq 1\cdot47\text{mA}$$

Thus for a 1mA meter to read full scale at 10,000 r.p.m. the resistor VR1 must be adjusted to shunt away 0·47mA.

For measuring propeller speeds up to 25,000 r.p.m., an extra shunt resistor VR2 is switched across the meter via S2.

Although the values of VR1 and VR2 were chosen to facilitate easy calibration of the instrument with the recommended meter, they will allow a wide range of meter movements to be used successfully although they may be a little difficult to set up. A table giving usable movements is given.

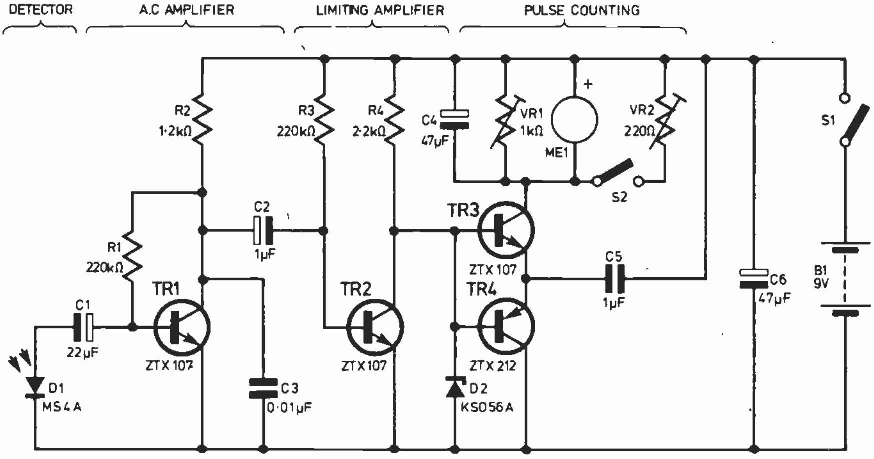


Fig. 1. Circuit of the r.p.m. meter

When TR2 collector voltage rises to 5·6V, TR3 partly discharges C5 by bringing the junction of emitters up to about 5V and so the charge on C5 changes by $C(V_2-V_1)$ Coulombs. This change of charge is independent of normal input pulse widths and rise times and is only determined by the pulse height which is fixed by D2, and by C5 which should be of paper construction for high stability.

The charge lost by C5 is passed on to C4 via TR3 in the form of high current pulses. The accuracy of the instrument would be impaired if TR3 were allowed to saturate during these pulses and so the internal resistance of C4 must be low enough to eliminate the possibility of this occurring. To this end a high value capacitor was used for C4 as these tend to have lower internal resistances than their low value counterparts of similar voltage ratings.

The charge built up on C4 is bled away by the 1mA meter and its shunts at a rate dependent on the charge and since this charge is related to the pulse rate per second the meter reading will indicate the same.

The current fed to the meter circuitry is given by—

$$I = \frac{CV}{T}$$

where CV is the change of charge on C5 per pulse and T is the period between pulses.

Table 1: Usable movements

Meter Sensitivity	Maximum Meter Resistance
1mA	175Ω
250µA	2·2kΩ
100µA	6kΩ
50µA	12kΩ

It is possible to use a 1mA meter movement whose resistance is as high as 820 ohms if the value of VR1 is increased to 4·7 kilohms and VR2 to 470 ohms.

The accuracy and high frequency stability of the circuit when operated with poor batteries or in low light levels are ensured by C3 and C6.

The finished circuit draws a supply current of about 10mA and so will operate for many hours when powered by an Ever Ready PP3 battery. The batteries should be replaced when their output voltage falls below 7V as the calibration of the instrument may become inaccurate.

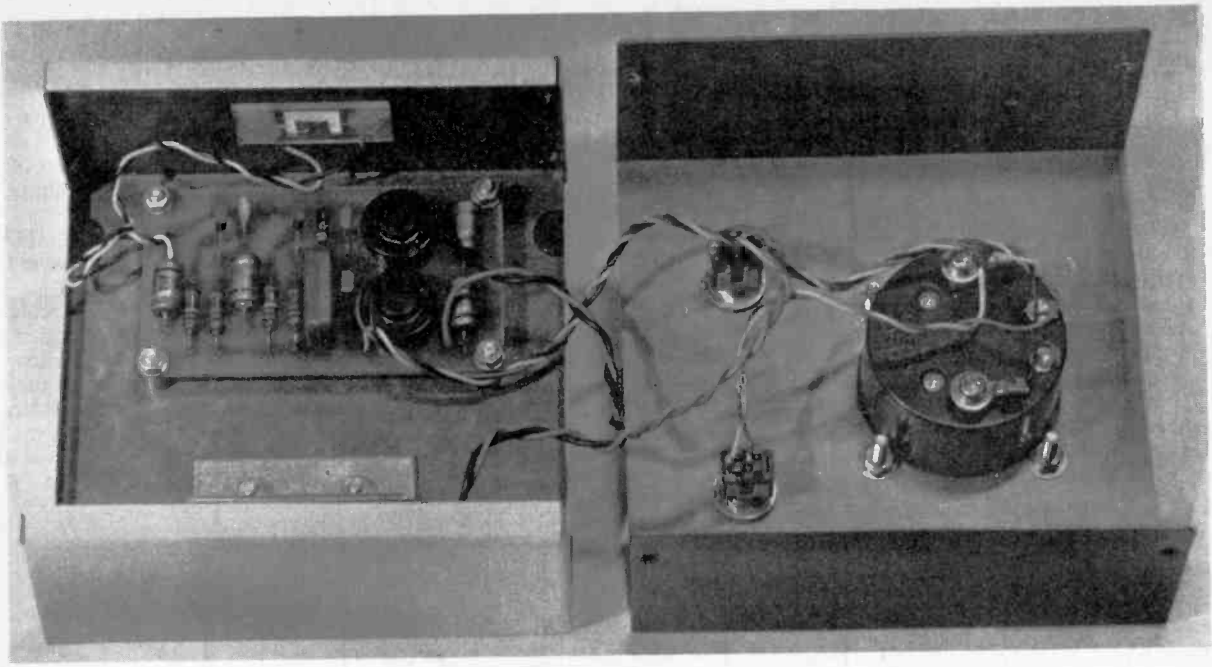


Photo showing assembly. The p.c.b. and component arrangement are shown below

COMPONENTS . . .

Resistors

R1	220kΩ	½W 10%
R2	1·2kΩ	
R3	220kΩ	
R4	2·2kΩ	
VR1	1kΩ	
VR2	220Ω	

Semiconductors

TR1	ZTX107
TR2	ZTX107
TR3	ZTX107
TR4	ZTX212
D1	MS4A.
D2	KSO56A

Potentiometers

VR1	1kΩ
VR2	220Ω

Capacitors

C1	22μF 10V Electrolytic
C2	1μF 10V Electrolytic
C3	0·01μF 18V Disc
C4	47μF 10V Electrolytic
C5	1μF 63V Paper
C6	47μF 10V Electrolytic

Miscellaneous

M1	1mA "Sew" Panel Meter Type SD460.
S1	Single Pole Change Over Switch "Subminature Type".
S2	As Above.
B1	Ever Ready Battery Type PP3.

Instrument Case Size 10 × 10 × 5cms.
P.C. Copper Laminate Size 4 × 7cms.

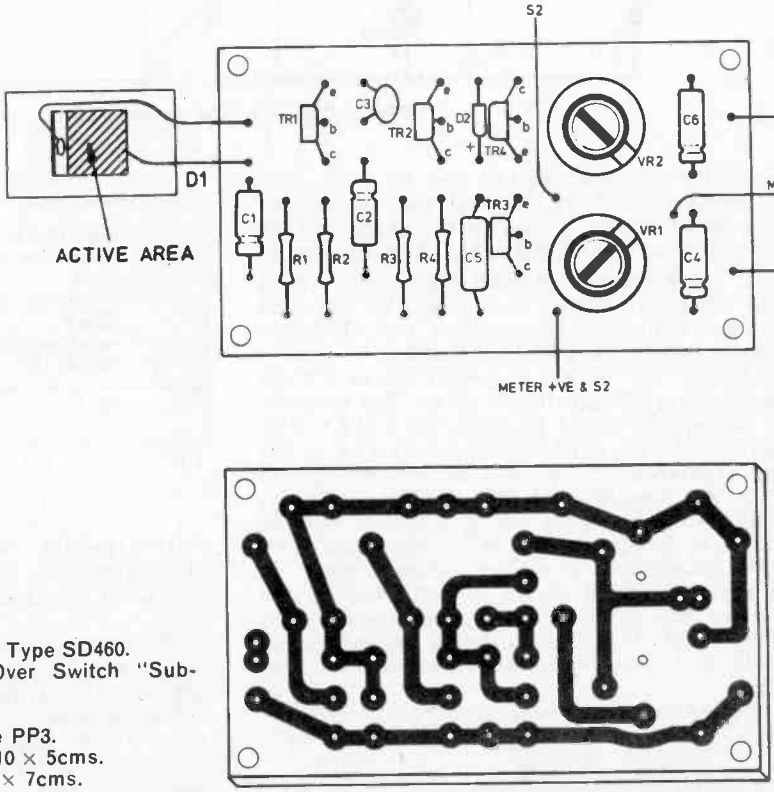


Fig. 2 Component layout and p.c.b. master

CONSTRUCTION

The prototype meter was constructed using the printed circuit shown in Fig. 2. To make the printed circuit first cut out the correct size of copper laminate board and on the copper side, lightly mark out the desired hole points with a scribe or a centre punch. Then with suitable paint and a fine brush put blobs of paint on the punch marks and join these up to the pattern shown with fine straight lines. This method of painting the printed circuit can give very neat results if done carefully. Allow the paint to dry and then drop the board into a solution of ferric chloride to etch away the unwanted copper. When the etching process is complete, clean off the paint from the remaining copper and drill the holes for the components.

The printed circuit, photodiode, meter and battery were all mounted in an instrument case size 10cm × 10cm × 5cm, although if a larger meter is used the case size should be adjusted to suit. With the meter mounted on the top of the case, the photodiode should be positioned on the side of the case above the meter so that when the photodiode is held near a propeller, the meter will be lying face up and easy to read. To mount the photodiode, cut a 1cm square hole in the desired position on the instrument case, then on the inside of the case glue a perspex window over the hole to seal the case against the ingress of oil and dirt. Then place the photodiode against the inside of the window and glue the wires of the device to the perspex with an impact adhesive to hold the device firm. Cut off the excess wire from the photodiode and connect it to the circuit board via some suitably fine, flexible wires, taking care to get the polarity correct.

TEST AND CALIBRATION

Once the circuit is complete and connected to its battery, the following voltages may be measured with respect to the negative rail whilst the photodiode is momentarily covered up. TR1c—4·5V ±2V, TR2c—0·1V.

Also, shorting the base of TR2 to earth should cause its collector voltage to rise to approximately 5·5V. If there is any serious discrepancy in any of the above test voltages, check possible faults such as incorrect component location, short circuits, dry joints, etc.

Once the constructor is satisfied with the above checks the instrument may be calibrated. A simple way of calibrating the meter is to make use of the 100Hz flicker given off by mains fed lamps since this corresponds to an engine speed of 3,000 r.p.m. Hold the instrument within a foot or so of a 100W lamp and adjust VR1 until the meter reads 3,000 r.p.m. on the 10,000 r.p.m. range, then after switching S2 on adjust VR2 until the meter reads correctly on the 25,000 r.p.m. range. The accuracy of this method is limited due to the small meter deflection at the calibration point.

If a signal generator and an l.e.d. are available the instrument may be accurately calibrated. The generator must provide an output greater than 2V r.m.s. between 100 and 1,000Hz.

Connect the circuit shown in Fig. 4 to the output of the generator and place the l.e.d. near the photodiode, being careful to shield out any background lighting as this way contain 100Hz flicker if any mains fed lamps are near.

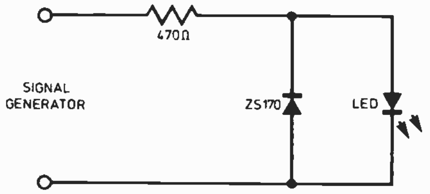


Fig. 3. Additional components needed for calibration

Set the signal generator to 333Hz and adjust VR1 until the instrument reads full scale on the 10,000 r.p.m. range, then raise the frequency to 833Hz and adjust VR2 for full scale deflection on the 25,000 r.p.m. range. The accuracy of calibration achieved by this method will depend on the signal generator itself.

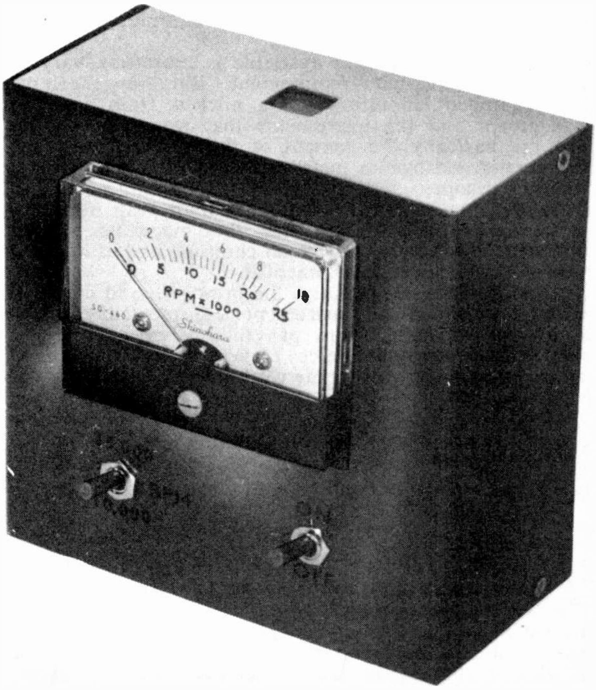
USING THE R.P.M. METER

Once the instrument is calibrated, all that is necessary to determine the r.p.m. of an engine is to hold the meter a few inches away from its propeller and read off the speed. If an erratic reading is obtained, try moving the meter nearer the propeller or more adjacent to the end of the propeller blades.

If the propeller has more than two blades, the true engine speed may be obtained by using the following formula.

$$\text{True r.p.m.} = \frac{2 \times \text{instrument reading}}{\text{number of blades on propeller}}$$

★



BOOK REVIEWS

TRANSISTOR ELECTRONIC ORGANS FOR THE AMATEUR

By Alan Douglas and S. Astley
Published by Pitman Publishing
119 pages, 215mm × 140mm. Price £4.50

THIS is the third and entirely revised edition on the "naming of parts" and circuitry of small home entertainment organs. In previous editions complete constructional details of a transistorised two manual pedal organ was given. With the appearance of integrated circuits—which has meant integrated oscillators and divider systems, distribution gates, amplifiers and rhythm chips—the discrete transistor divider organ is almost an anachronism and for this reason I think the omission is justified.

Unfortunately there is a dearth of books on topical organ circuitry, unless you are fortunate enough to be on the mailing list of companies such as ITT, G.I. or AMI whose ambit of activities embrace organ electronics. This edition fulfils a need in that it covers most aspects of the modern electronic organ combining circuitry, informed opinion and practical advice which one would expect from the co-author Alan Douglas, doyen of the Electronics Organ Constructors Society.

G.G.

ELECTRONIC TEST EQUIPMENT

By Harry Kitchen
Published by Argus Books
199 pages, 225mm × 140mm. Price £4.50

TEST equipment has a vital role in electronics. In design, construction, routine maintenance and trouble shooting, one is wholly dependent on the means to measure, as this is the only way to interpret conditions within a circuit.

The range of test gear available is enormous, varying in sophistication with requirement. But even the most well equipped laboratory has a nucleus from which it has grown and the instruments that usually constitute this are basically the content of this book, namely the multimeter, electronics meter, a.f. and r.f. oscillator and the oscilloscope.

As one would expect from an author who has been a regular contributor to both this magazine and to Practical Wireless, his advice on choosing and using these instruments is essentially practical.

In each of the six chapters the principles and common basic circuitry of an instrument is presented. This is distilled with the wisdom of years of experience and many of the personal choices of instrument would prove an excellent basis for a home workshop or laboratory.

G.G.

ABC OF HI-FI

By John Earl
Published by Fountain Press Argus Books
168 pages, 222mm × 140mm. Price £3.75

A GOOD book for those starting to learn about hi-fi. It contains a wealth of potted information relating to techniques and equipment as well as to the effects they both are employed to produce or to avoid. Most of the vocabulary the budding enthusiast must learn is to be found within these pages. The contents are subdivided into seven chapters, each dealing with a clearly defined subject area: amplifiers, loudspeakers, programme sources and signals, quadraphony, radio tuners and aerials, recording and replay, sound and room acoustics.

The one comparatively new area is quadraphony. This chapter alone might make the book a useful purchase for followers of the art who while, perhaps, well versed in the more orthodox techniques are yet in some ignorance of the considerable enrichment of the hi-fi language this latest development has been responsible for.

Within each chapter subjects are arranged alphabetically; they range from the mundane ("Hum", "Downlead") to the more exotic ("ambiophony", "Dolby Noise Reduction"); treatment varies from the short sentence to a page or more per item. Diagrams, photographs and oscillograms are used to illustrate the text, which has a down-to-earth and practical flavour.

D.D.R.

PHYSICAL ELECTRONICS

By J. Seymour
Published by Pitman Paperbacks
438 pages, 150mm × 210mm. Price £3.25

AIMED at students in electronic engineering and young professional engineers, the book manages to cover this sometimes heavy subject of the physics of electronics without becoming too bogged down—a trap all too many authors often find themselves falling into.

The student will find the book extremely useful as a course book, and the material in it relevant to all three years' work at his university or college. Also, due to its having all the basic information on the functioning of all the popularly used devices, it will provide a good reference for engineers who occasionally need to resort to a textbook, because "they remember doing how an f.e.t. (for instance) works a few years back, but can't quite remember the details".

The book has chapters on microwave devices, junction transistors, field-effect devices, masers and lasers and a comprehensive appendix which expands on some of the theory referred to throughout the rest of the book.

R.W.L.

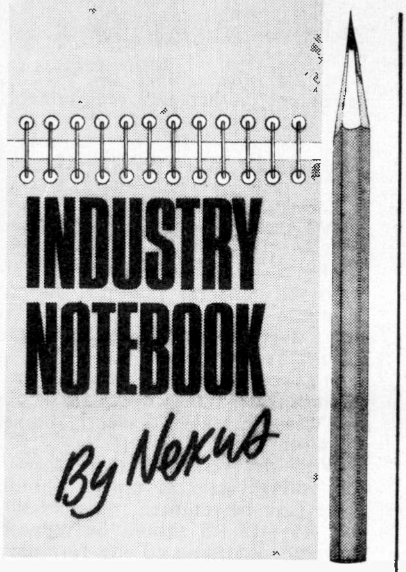
I.E.R.E. JOURNAL, GOLDEN JUBILEE ISSUE

FOLLOWERS of electronics, amateur as well as professional, will find much that is both technically and historically interesting in this Golden Jubilee issue of the I.E.R.E. Journal, *The Radio Electronic Engineer* (Vol. 45, No. 10, October 1975).

It contains 19 papers from Institute members who recall developments in a variety of fields over the last 50 years. A wide panorama of technological progress and achievement is built up by this collection of authoritative papers.

Some of the areas reviewed are: semiconductor devices; electronic components; lasers and optical electronics; fixed and mobile communications; television; radio navigation aids; computer engineering; electronics and nuclear power; ocean technology; medical electronics; electronics in space.

The Radio and Electronic Engineer is normally available only to members of the I.E.R.E. but copies of this issue can be purchased by interested non-members for £2.50 per copy. Send remittance to The Institution of Electronic and Radio Engineers, 8-9 Bedford Square, London W1CB 3RG.



INDUSTRY NOTEBOOK

By Nexus

HAPPY NEW YEAR

While the great buying public is still tightening its belt in face of economic problems at home, with consequent slackness in consumer electronics business, 1976 looks like being a busy and therefore happy year for manufacturers of professional equipment.

The United States is already past the bottom and what's good for the United States is generally good for the rest of the free world. Recent market surveys forecast accelerating business in the first quarter of 1976 with some market sectors showing gains of as much as 25 per cent.

In Britain, leading capital goods exporters are still doing excellent business with substantial backlogs of order due for delivery. A star export performer is the EMI-Scanner X-ray equipment but there are plenty of other big sellers. Redifon, for example, recently clinched another flight simulator order, this time for a £3 million installation in Iraq. Radio communications is still strong with Marconi and Racal leading the field.

Aerospace is doing better than ever with record exports of missiles, principally the Rapier, which in its later version has a strong electronic content, and service companies like International Aeradio are still pulling in extra business like the re-equipment of Sharjah International Airport with navigational aids and other equipment under a £1·2 million contract. In telecommunications GEC won a South African Post Office contract for stored programme control equipment worth £2·5 million.

At home there is optimism that recent pronouncements by the Government on giving encouragement to expansion of private industry really mean what they say and are not mere window-dressing. If the regeneration of British industry means anything at all it means modernisation, including higher levels of automation which, in turn, means more business for electronics.

Consumer electronics may be down in the dumps at the moment but cannot be neglected. An interesting pointer is that Plessey-owned Garrard Engineering Ltd. has been recruiting design engineers for what is described as the "next generation of consumer electronics". To date, Garrard has been exclusively in the record changer business. There is now a big programme of diversification and expansion into both audio and video cassettes and complete equipments such as home music centres and video recorders.

We also have the example of Sinclair Radionics whose long-awaited thrust into the digital watch market is now with us. The "Black Watch" got away to a flying start with a £30,000 national advertising campaign and production is now running at 5,000 units a week in a bid to capture 30 per cent (250,000 units) of the total UK market in 1976.

BATTERY POWER

The electric car has come back. Yes, back! The first electric horseless carriage ran in Britain long before the turn of the century and there were electric taxi-cabs running in London from 1897 to 1899.

Electric road traction is more common in Britain than most people imagine. Present estimates are that there are some 50,000 electrically driven commercial vehicles on the roads, about half the world's total. In addition there are some 75,000 electrically powered trucks and mobile hoists in use in British industry. So there is already a firm home base on which to build a huge export market.

The problem is the same today as it was at the turn of the century—the battery. Front runner for the new generation of electric cars is the sodium-sulphur battery which, weight-for-weight, is claimed to store five times more energy than the conventional lead-acid battery and, of course, it is the power/weight ratio which has always been the stumbling block.

Now the U.K. Atomic Energy Authority, the British Railways Board, Chloride Silent Power Ltd., and the Departments of Industry and Environment have come together in a massive assault on the problem. Research will continue separately at the laboratories of UKAEA, British Rail and Chloride, but results will be pooled and coordinated to eliminate duplication of effort.

Similar work is going on in the United States. The Energy Research Laboratories of Gould Inc. are working on several battery projects. A nickel-zinc battery twice as good as lead-acid is already in use in U.S. Post Office delivery vehicles. A Government-funded project for a battery equivalent in performance to the British sodium-sulphur project is expected to be ready for prototype trials by 1981.

British Rail, however, plan to have a rail car powered by sodium-sulphur batteries running by 1979. It could, on present projection, have a range of 170 miles with a top speed of 75 mph. R&D time scales tend to be elastic but if all goes well with the British effort it suggests a two-year lead.

If the British project proves successful it will not only generate direct product sales but will also bring in "invisible exports" through world licensing agreements.

The prospect of millions of electric cars on the world's roads is heartening for the electronics industry because of all the electronic control gear which is needed.

COMPUTERS

The 1975 Marketing Award from the Institute of Marketing went to International Computers Ltd for its strategy in selling the 2903 computer. In the first two years after the launch, ICL sold over a thousand and the 2903 has now established itself as Europe's best selling computer.

Apart from completely new business (i.e. first-time computer buyers), some 200 existing computer users switched to the 2903 with the bulk of the displaced computers, according to ICL, being of IBM manufacture. Total sales of the 2903 are approaching 1,500 with 50 per cent being exported.

As part of a forward research programme, ICL is setting up a pilot plant for the development of advanced technology l.s.i. circuits. The company says it has no intention of going into volume production and the plant will be used mainly for design speed-up and, thus, earlier exploitation of the new and powerful semiconductor technologies now becoming available.

MPU TAKEOVER IN 1984

By 1984, the year we all love to hate, microcomputer sales in Western Europe will have multiplied 60-fold according to market-researchers Frost & Sullivan. Total sales for 1984 will be £307 million compared with £5 million in 1974. Over the decade sales will have topped £1,200 million with Britain, France and Germany accounting for two-thirds of the European market.

As the MPU will find its main application in "smart" and "inteligent' equipment, it looks as if Orwell's terrifying vision of things to come may well come true if we substitute MPU for Big Brother.

INGENUITY UNLIMITED

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

SURROUND SOUND MATRIX

With the increasing popularity of four channel audio systems, one requires also a mode whereby stereo records can be played as well.

The circuit of Fig. 1 is a very simple matrix providing surround sound from any stereo source. The inputs, front-right (R) and front-left (L), are derived from the pre-amplifier of the stereo amplifier (preferably, after the volume and tone controls, so that these act as common controls for the whole of the system, but before the balance control).

The outputs, rear-right (*Rr*) and rear-left (*Rl*), are taken through the rear level controls VR2 and VR3 to an additional stereo power amplifier, and subsequently fed to the rear speakers.

The operation of the circuit is such that when the Depth Control, VR1a/b, is at minimum, the rear outputs follow the front signals at 180° phase shift (*Rr* = −R; *Rl* = −L), since IC1 and IC2 are working as virtual earth inverting amplifiers. When VR1 is at maximum, IC1 and IC2 are working as differential amplifiers, and so the rear signals are subtractions of each other (*Rr* = L −R; *Rl* = R − L), thereby reproducing only the out of phase signal of the stereo information which is rich in ambient content.

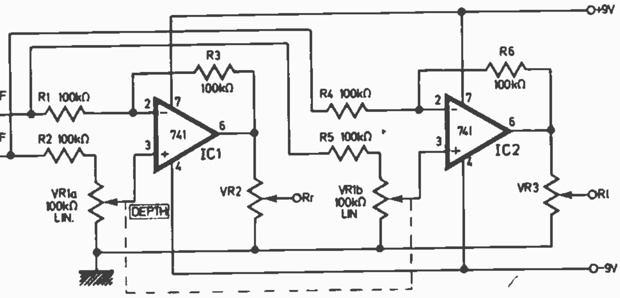


Fig. 1

In use, the setting of VR1 is dependent on personal requirements and the type of material played. The outputs can be expressed generally as: *Rr* = −(R −xL) and *Rl* = −(L −xR), where x is a fraction dependent on the setting of VR1 and can be anything from 0 to 1.

The maximum setting is not always the best; for example, the out of phase signal of worn records is very noisy and distorted. There should be no output on playing a mono record when VR1 is at maximum setting, since L equals R, in this case VR1 should clearly be set to minimum.

With the resistor values shown, the voltage gain is unity. Should some gain be required, resistors R1, R2, R4 and R5 should be reduced in value according to the formula: gain = $\frac{R3}{R1}$ or $\frac{R6}{R4}$. These four input resistors should be all of the same value. The value of the feedback resistors R3 and R6 must be the same as VR1a/b; these should be maintained as specified. VR1 is a dual-gang linear 100kΩ + 100kΩ potentiometer.

M. Greenfeld,
Leeds.

WHITE NOISE GENERATOR

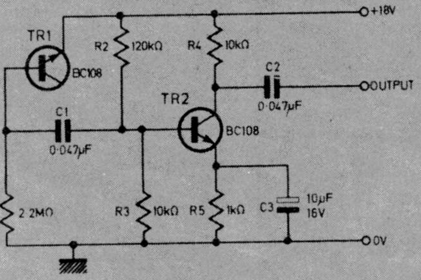


Fig. 1

The noise source for the circuit in Fig. 1 is a reverse-biased BC108 emitter-base junction (TR1) which avalanches and produces a substantial amount of white noise.

Transistor TR2 is an amplifier, producing an output of approximately 500mV across 50kΩ load.

Germanium transistors can be tried in the circuitry but the cheap unmarked untested packs of transistors were found to be the most "noisy" and more suited in the circuit.

J. Hoggarth,
Otley,
W. Yorks.

RETURN OF POST MAIL ORDER SERVICE

BSR HI-FI AUTOCHANGER

STEREO AND MONO

Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. A.C. 200/250V Size 13¾ × 11½in. Above motor board 3¼in. Below motor board 2⅞in. With tubular arm and cuing device with STEREO and MONO CARTRIDGE **£10·95** Post 75p

PORTABLE PLAYER CABINET

Modern design. Rexine covered. Vynair front grille. Chrome fittings. Size 17 × 15 × 8in approx. Motor board cut for BSR or Garrard deck **£5·25** Post 75p

COMPLETE STEREO HI-FI SYSTEM

Two full size loudspeakers 13¾ × 10 × 3¼in. Player unit clips to loudspeakers making it extremely compact, overall size only 13¾ × 10 × 8½in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls 240V a.c. mains.

FEW ONLY

Attractive Teak finish

Bargain Price **£25** £1 carriage

SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0–60 MINUTES £2·50 Post 35p.

Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new and fully guaranteed.

TEAKWOOD LOUDSPEAKER GRILLES will easily fit to baffle board. Size 16½ × 10½in—75p. 10½ × 7¾in—45p

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RA2W Ferrite Aerial	85p	Driver Trans. LFDT4	65p
I.F. P50/2CC 470 kc/s	40p	Printed Circuit, PCA1	85p
3rd I.F. P50/3CC	40p	J.B. Tuning Gang	£1·20
Spares Cores	3p	Weyrad Booklet	10p
P50/1AC	60p	OPT1	65p

Mullard Ferrite Rod 8 × ⅜in., 20p. 6 × $\frac{5}{16}$in., 20p. 3 × ⅜in. 10p

VOLUME CONTROLS

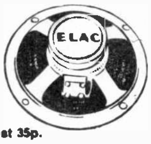
5kΩ to 2MΩ. LOG or LIN. L/S 25p. D.P. 40p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 30p.

80 Ohm Coax 5p yd.

BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd, £2; 60 yd, £3

FRINGE LOW LOSS ideal 625 and colour **10p yd**

8in. or 10×6in. ELAC HI-FI SPEAKER



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With tweeter and crossover. 10 watt. State 3 or 8 ohm. As illustrated. **£5·25** Post 35p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45–60 c/s. Flux 10,000 gauss. 8 ohm, 40 to 11,000 c/s. **£3·45** Post 35p.

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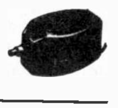
Teak finish 16 × 10 × 9in.

13in × 18in. Bass Woofer, 20 watts, £6·60 **£6·95** Post 75p

THE "INSTANT" BULK TAPE ERASER AND HEAD DEMAGNETISER. Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. **£4·35** Post 30p



BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides 6 × 4in 55p; 8 × 6in 65p; 10 × 7in 80p; 12 × 8in £1; 14 × 9in £1·20; 16 × 6in £1·20; 12 × 3in 60p; 16 × 10in £1·40. ALUMINIUM PANELS 18 s.w.g. 6 × 4in 15p; 8 × 6in 25p; 14 × 3in 25p; 10 × 7in 30p; 12 × 5in 30p; 12 × 8in 40p; 16 × 6in 45p; 14 × 9in 50p; 12 × 12in 55p; 16 × 10in 75p.

ELAC 9 × 5in HI-FI SPEAKER TYPE 59RM

This famous unit now available, 10 watts, 8 ohm.

£3·45 Post 35p

QUALITY LOUDSPEAKER ENCLOSURE

Teak veneered ¾in thick wood cabinet. Size 18½in × 18½in × 8½in. Weight 23lbs. This cabinet features a wide mesh Silver Grill covering a separate compartment for mounting Tweeters or Mid-Range Horn. The fully sealed bass compartment is cut out for 8½ inch Woofer £7·50 Carr. 85p

Rosewood Version £8·50 Carr. 85p

Baffle could be cut to take larger speaker.

RCS POWER PACK KIT

12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£3·35** Post 30p

12 VOLT 300mA KIT, £3·15. 9 VOLT 1 AMP KIT, £3·35.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER—BRITISH MADE

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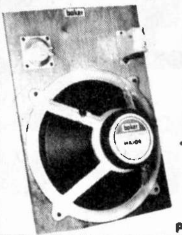

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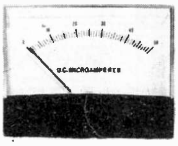

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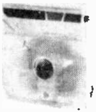

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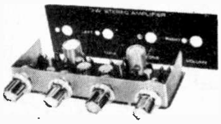

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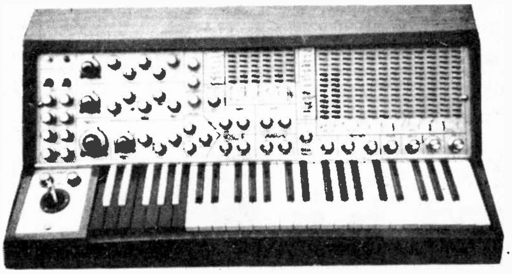

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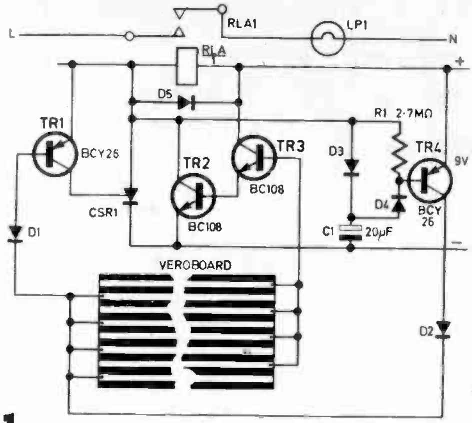

Fig. 1

This circuit was developed for switching a bedside light on/off by touching a plate fixed to bed head.

The plate used is a piece of 0·1 inch Veroboard connected as shown in Fig. 1. When the finger is placed on the Veroboard grid, CSR1 fires and pulls in the relay. If the finger is then removed, CSR1 will remain locked on until touched again.

When in off state all transistors are non-conducting; C1 is charged via D3. On touching the grid, TR1 draws base current via TR2, TR3, D1 thus firing CSR1, switching on load and making a discharge path for C1.

When touched to turn off, C1 discharges via D4 and R1, turning on TR4. TR3 draws base current via TR4 and D2, turning on TR2 and shorting out CSR1. When the finger is removed the load is switched off.

If the finger is not removed immediately after the load has switched on, and C1 has had time to discharge, the load will switch off when the finger is removed.

R. J. Hicks,
Madynlleth, Powys.

BETTER FIGURES

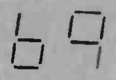

Fig. 1a

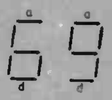

Fig. 1b

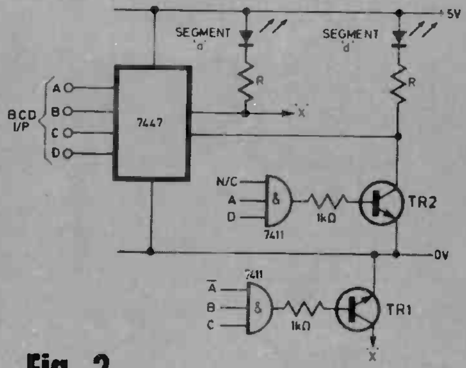

Fig. 2

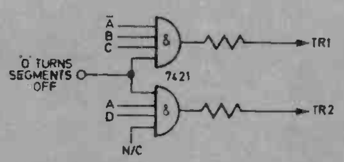

Fig. 3

The display usually obtained from the numerals 6 and 9 with standard TTL decoders such as the SN7447 is shown in Fig. 1a. This can be modified to a more visual numerical readout (Fig. 1b) by using the circuit in Fig. 2. To obtain the improved numerals, segment *A* must come on when 6 is present in BCD at the decoder input, and segment *D* must come on when 9 is present.

Transistors TR1 and TR2 are connected between 0V and the decoder output to form, in effect, "wired—AND" gates with the output. When TR1 or TR2 are on the appropriate segment will light, irrespective of the decoder output. The transistors are fed via TTL AND gates, which detect 6's or 9's at the decoder input.

The AND gates in the prototype were $\frac{2}{3}$ of a 7411. The circuit therefore needs two SN7411's per three displays. TR1 and TR2 can be any silicon *npn* transistors with an I_c max >3mA.

If the digit blanking facilities of the decoder are needed to provide control over the display brightness, the 7411 can be replaced by a 7421, as shown in Fig. 3. This enables the segments turned on by the external transistors to be blanked with the rest of the decoder outputs.

R. Mortimer,
Hemel Hempstead.

NIGHT LIGHT

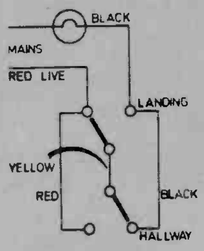

Fig. 1a

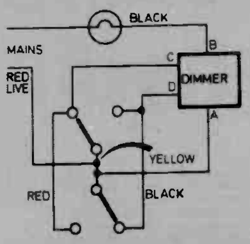

Fig. 1b

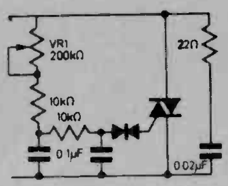

Fig. 2a

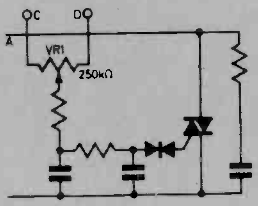

Fig. 2b

As I have a young son who refuses to go to sleep without a light on, I fitted a dimmer to the landing light so that no direct light was thrown into his bedroom.

With the ever increasing cost of electricity, a dimmer seemed to offer a simple compromise. Unfortunately, the landing light is controlled by a two-way switch, one in the hallway and the other on the landing, and I wanted to be able to control the light level and also be able to override the dimmer from the hallway irrespective of whether the light was on or off.

To overcome these problems I modified the wiring as shown in Fig. 1a, b and modified the dimmer as shown in Figs. 2a, b.

The dimmer is modified to bring both arms of the potentiometer out to separate connections and the value raised so that the light was fully off at the centre of its travel. This was to avoid the light from extinguishing at other levels than full on, when using the hall switch.

T. L. Bunney,
Hadleigh,
Essex.

CAR THEFT ALARM

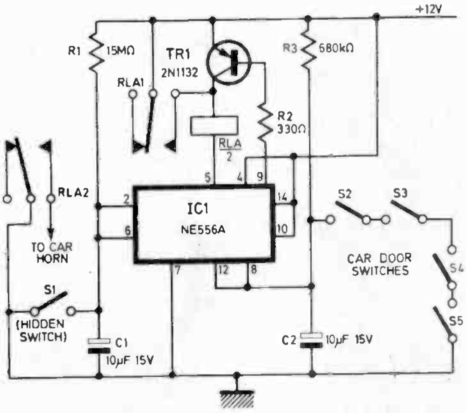

Fig. 1

The NE556 dual timer (which contains two 555 circuits in a single 14-pin dual-in-line package) can be used in the simple circuit shown as a car theft alarm.

If any of the car door switches S2 to S5 is opened, the capacitor C2 commences to charge through R3. After a time which is approximately 1.1*C2R3* (7·5 seconds with the values shown), the output voltage at pin 9 falls to a value which is only a little above that of the negative line. A current of the order of 30mA therefore flows through R2 and saturates TR1. If the voltage at pin 5 is low, the relay RL1 closes.

The contacts of this relay RLA1 short the collector of TR1 to its emitter so that the relay "latches-on"; that is, it remains energised whilst the potential at pin 5 is low no matter whether the voltage at pin 9 rises again (due to the closing of the car door) or not. The closing of the contacts RLB1 causes the car horn to sound.

The hidden switch S1 is used to set the alarm and to dis-arm it when one wishes to leave the car doors open. If S1 is closed, C1 is discharged and the voltage at the output of pin 5 is kept almost at the +12V level. The relay will therefore not close when S1 is in this closed position. If the alarm is sounding, it may be stopped by closing S1 so that the voltage at pin 5 rises.

As the owner leaves the vehicle, he can set the alarm by opening S1 so that C1 commences to charge. If he shuts all of the car doors within a time of 1·1*C1R1* (or about 16 seconds with the component values shown), the relay will not close and the horn will not sound.

Similarly, when the owner returns to the vehicle, he opens a door and C2 commences to charge. However, if he closes S1 within about 7·4 seconds of opening the door, the alarm will not sound.

J. Dance,
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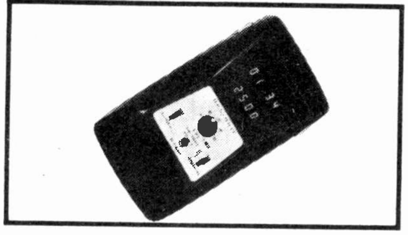

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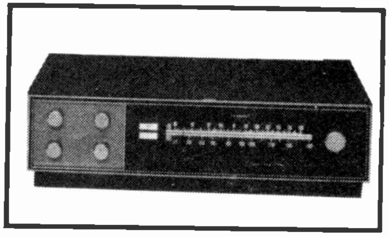
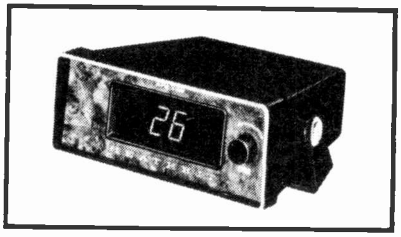


Digital rev counter



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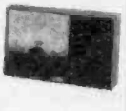

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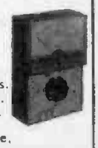

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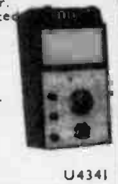

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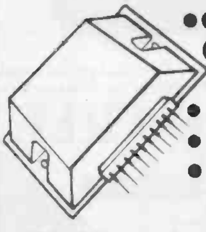

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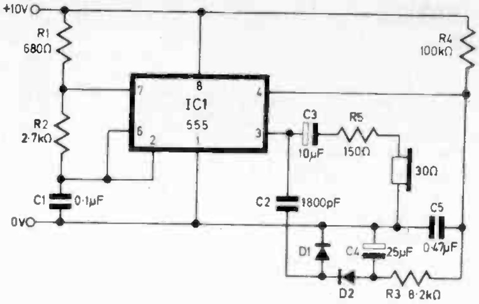


Fig. 1

The need often arises for the audible signalling of a system condition such as excessive load current or excess heatsink temperature. A 555 oscillator/timer directly driving a 30 ohm balanced armature earphone makes a simple and convenient tone-generator; the only snag is that the 555 produces a steady tone that does not stand out well from background noise. An intermittent tone of the same loudness is much better in this respect.

An easy way to do this is to use a second 555 to gate the reset input of the first 555, but the circuit in Fig. 1 shows how this can be done even more simply with a few extra passive components.

With the aid of R1, R2 and C1, IC1 oscillates at about 2·2kHz in a conventional manner driving the earphone. Capacitors C2, C4 and germanium diodes D1, D2 form a pump circuit and the lower end of C4 becomes progressively negative with respect to the 0V rail. When this voltage reaches a certain value, the 555 is reset via pin 4 of IC1. This state of affairs lasts until the charge on C4 and C5 decays through R4, whereupon the 555 gives another burst of oscillation.

With the component values shown in the circuit, the 2·2kHz tone is interrupted about 15 times per second. With a 12V supply, as in a car environment, this becomes 8 times per second. A wide variation of timing is possible by varying the value of C5.

D. R. G. Self,
Ipswich,
Suffolk.

CYCLE LIGHTING CONTROL

With the further restrictions recently announced on the consumption of energy and the ever increasing expense of private motoring, many people are reverting to that more efficient, yet slightly less comfortable mode of transport, the bicycle.

On dark nights and stop-start conditions in heavy traffic, efficient lights on a bicycle at all times is vital. Continuous lighting can be obtained using all-battery lamps with the frequent expense of battery renewal. Dynamo lighting obviates this expense but suffers from the disadvantage that the intensity of light varies from full brilliance down to a dim glow at walking pace and none when stopped (Fig. 1).

It was with this in mind that I devised the circuit in Fig. 2 to combine the advantages of both systems.

In the modified lighting circuit, the alternator output is rectified by the bridge circuit D1, D2, D3 and D4 and feeds the cycle lighting via switch S1.

With an alternator output of less than the battery voltage of 4·5V (a 6V supply could be used but would result in shorter bulb life), the battery provides the lighting power via D5, D1–D4 preventing it from shorting through the alternator windings.

When the output rises above 4·5V this takes over the supply to the lamps, D5 preventing the rectified alternator output from flowing into the battery.

The diodes D1–D5 can be any silicon rectifiers rated at ½A or more at 12V minimum (the off-load alternator output often rises to this value at speed). D1–D4 can be mounted in a plastics tube clipped to the cycle frame, the ends sealed with wax, no significant heat being generated; the total lighting load is only about 5–6W. D5 can be mounted in the lead from the battery which can be mounted in a weatherproof box behind the seat or attached to the frame.

Only cycles with the integral Dynohub type alternator are suitable for this modification; the rim type friction dynamo is usually earthed to the frame by its fixing bracket and would need to be insulated on its mounting before connecting to the rectifier.

A. R. G. Culder,
Leigh,
Lancs.

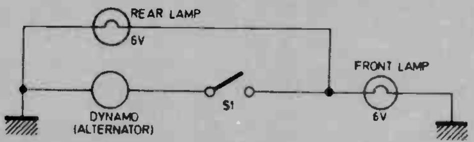


Fig. 1

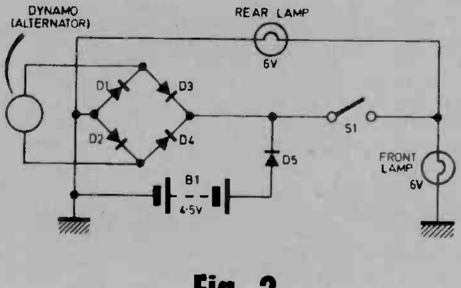


Fig. 2

CHARGER FOR NICKEL-CADMIUM CELLS

Readers might be interested in this automatic battery charger circuit, for use in tape recorders and other equipment operating from nickel-cadmium accumulators.

Operation of the circuit (Fig. 1) is as follows. The cells charge at a rate set by R1 until, as determined by the setting of VR1, the Zener D1 conducts, switching CSR1. This reverse-biases D2, stopping the charge. The l.e.d. also goes out, indicating end of charge.

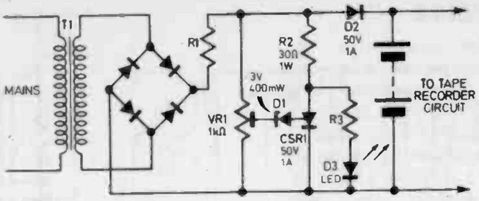


Fig. 1

The circuit will not attempt to charge dry cells put in the unit due to the higher voltage of these. This unit can be used in addition to any mains supply supplying the tape recorder direct.

The value of R1 depends on rate of charge required.

D. Torry.
Chelmsford, Essex.

"INSTANT" DIGITAL STOP WATCH CONVERSION

The following simple modification enables a digital clock to be utilised as a "stop watch" as and when required, and was originally conceived for the purpose of timing international STD telephone calls. No doubt other uses will suggest themselves to readers and there is scope for variations of the basic idea employed.

Fig. 1 shows a simplified block diagram of a typical 4-digit clock using integrated circuits of the 74 or similar series. A 5-pin DIN socket is fitted at the rear of the clock and a miniature 6V relay with two sets of changeover contacts is incorporated within the clock housing; these being wired up in accordance with Fig. 2. A remote switch is connected by means of a suitable length of 2-core screened cable to a 5-pin DIN plug as shown in Fig. 3.

When the "stop watch" facility is required, PL1 is inserted with S1 open, and the clock is set to zero by switching the mains supply off and on. The shorting link across pins 1 and 4 of PL1 causes the relay coil to be energised and the two sets of contacts to change over. One set of contacts prevents the 50Hz input from reaching IC1 until S1 is closed, while the other set changes the clock format from hours and minutes to minutes and seconds.

The clock is therefore held at zero until timing is required to commence. S1 is then closed and the clock begins counting minutes and seconds, to a maximum of 12 or 24 minutes, depending upon the original design. When the event being timed is completed, S1 is opened and the elapsed time will be held on the display until reset to zero by switching the mains supply off and on. Alternatively, a reset might be incorporated in the clock by connecting a normally closed push-button in series with the mains supply.

The relay used in the prototype was found to "pull in" satisfactorily with the coil connected to the +5V rail, but should any difficulty be encountered in this respect, it could be connected to the unstabilised side of the low voltage supply, through a dropper resistor if necessary.

With regard to S1, a push-on/push-off mains type pendant switch was used as this can be held in the same hand as a telephone handset. Very little trouble with contact bounce has been encountered, but "noiseless" type switching circuitry could of course be employed if a higher degree of accuracy is required.

In conclusion it must be emphasised that the remote switch lead be screened as otherwise hum pickup can cause an erratic count to continue despite S1 being open.

A. F. Hayden
Brighton.

Fig. 1

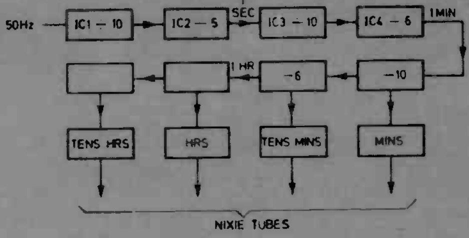


Fig. 2

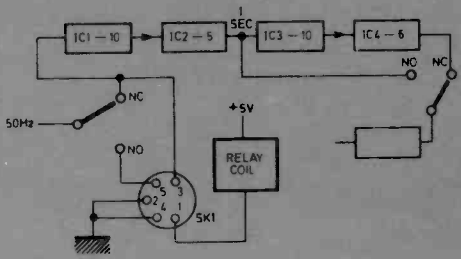
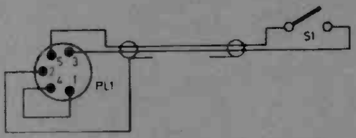


Fig. 3



PATENTS REVIEW...

VEHICLE MONITORING

A system for the remote display of vehicle dashboard information on panels arranged around the rear view mirror is claimed by Regie National Des Usines Renault and Automobiles Peugeot in BP 1 401 356. The intention, of course, is to enable a driver to observe readings on speed, fuel level, water temperature and so on, without taking his eyes off the road.

The rear view mirror surround is provided with a l.e.d. or liquid crystal digital display, Fig. 1. A series of probes convert into variable voltages the measures of all the engine and vehicle functions.

Normally the display shows vehicle speed as sensed by the speed sensor. However, when the driver actuates a pushbutton on the dashboard a master clock starts switching the measure sequences at adjustable time intervals, Fig. 2.

The voltage signals of the successive sequences are fed to a digital voltmeter, the output pulses of which are fed, via the switching system, to a pulse counter which displays them in succession at predetermined time intervals. Simultaneously, the display switching system successively illuminates a series of pilot lights around the display to denote the engine function being measured.

After the full sequence of engine functions have been displayed, the sequence switching system again transmits, for display, a measure of the engine's speed as relayed from the speed sensor.

An alarm system continually compares measured voltages with reference voltages and energises an audible or visual signal if a predetermined threshold is exceeded for any measurement.

BP 1 401 356

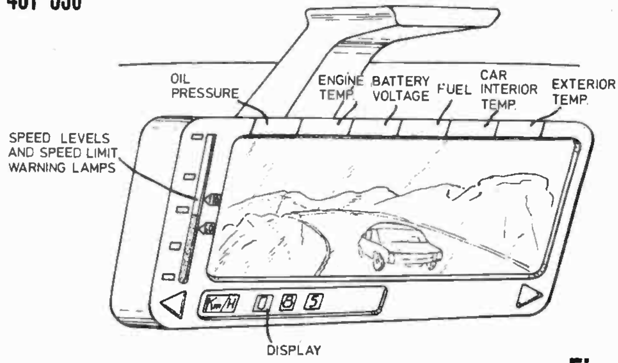


Fig. 1

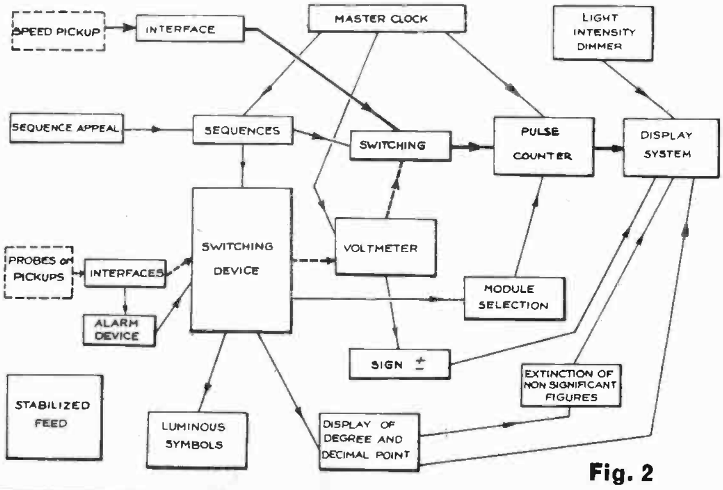


Fig. 2

IN BRIEF

BP 1 404 007—R. F. Koch, *Treating an a.c. signal to produce a modified a.c. signal.* A technique for compressing data signals, such as speech signals, and segmenting them to produce an output which is compressed in time but not distorted in pitch. Possibly useful for talking books for the blind.

BP 1 404 634—Messerschmitt-Bolkow-Blohm GmbH. *Measuring and indicating distance between a motor vehicle and an obstacle.* A pulse radar transmitter and receiver system for use on motor vehicles.

BP 1 407 761—Burroughs Corporation. *Problem oriented language translator and source code generator.* Interesting on two counts. Firstly, in that it shows the extent to which ideas in computer programming can now be patented, and secondly, because the patent covers an interesting system for simplifying the production of problem orientated language (POL).

BP 1 409 343—A. Pirc. *Rotary magnetic engine.* An engine which relies on the reversible magnetic change which occurs in some materials at the Curie point.

BP 1 409 504—A. K. Thatcher. *Computer controlled sonic fuel system.* Variable fuel pulses are supplied to an air system of an internal combustion engine.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent Price 33p each

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.

A Protest

Sir—As a professional in the electronics trade for some 18 years, I feel that I must finally protest about unnecessary projects appearing in your magazine.

The best example to date appears in the December edition. To replace a simple, efficient, usually reliable and inexpensive bi-metal strip bulb by a sophisticated piece of electronic gadgetry using four transistors, a CMOS integrated circuit, four diodes plus other electronic components seems to be the height of lunacy.

As you know, there are people who scoff that many pieces of electronic equipment are unnecessary and their functions could be just as easily performed by their mechanical counterpart more cheaply. It is just this type of project which adds weight to their argument.

B. Timson,
Beds.

Highly Tuned

Sir—I think I can assist you regarding motor cycle electrics and ignition systems in particular (see *Readout*, December 1975 issue).

The small bikes, i.e. those below about 100cc use flywheel magnets. Most of these are single cylinder engines (2-stroke or 4-stroke) and in many cases the timing is adjusted by altering the contact breaker gap. In this case the dwell angle cannot be quoted but a stroboscope is absolutely essential to use with an *F* mark on the flywheel. Usually no auto advance units are fitted.

Above 100cc there are the single cylinder and twin cylinder engines. These use a conventional 6V or 12V Kettering ignition system. The big difference is that on some engines a double ended coil is used which, with a four stroke engine, produces an idle spark. On these engines it is essential to check that ignition timing is identical on each cylinder.

With other twin cylinder engines a separate ignition system is used for each cylinder and this also applies to the three cylinder type mentioned in Mr Simpson's letter. Four cylinder engines normally used two double ended coils with, of course, two contact breakers, but there have been a few exceptions which used a distributor.

This by no means exhausts the list as some competition machines use what is called an energy transformer ignition system which relies on an alternator feeding a.c. to a special type of coil. In this system the peak of the a.c. waveform must coincide with the opening of the contacts which in turn must be correct for the engine. Added to this is a system which uses the rectified output from the alternator to charge up a large electrolytic. This capacitor is discharged through the coil by the contact breaker.

In using a large variety of commercial test equipment on these engines I have found the following limitations:

1. Restricted ranges.
2. Some cannot be used when powered from vehicle battery.
3. Cannot be used on 6 volt and 12 volt systems.
4. Lack of application data, etc.

In regard to your "Engine Analyser", specially for motor cycle use, the tacho range is rather restricted. Please bear in mind that the auto-advance does not finish operation until 4,000 r.p.m. is reached, and this applies to some car engines. Obviously this can be overcome using a 2-stroke/4-stroke switch or relabelling the number of cylinders switch.

In my experience the resistance range would be better if it were 0–100Ω or even 0–10Ω. In practice, resistance measurements of alternator stator windings, motor windings, ignition coil primaries, contact resistance are all of low values.

Finally, one minor point is that I have found it preferable to enclose the strobe light in a rubber torch body and fit a simple lens to concentrate the light.

I must congratulate you on producing the analyser which I am certain will fulfil a real need. This is even more required in regard to servicing motor cycles than is generally realised as these are expensive (£1,500) and highly tuned, which until very recently were serviced in the backyard or on the side of the road.

H. D. Briggs,
Telford.

Short Cut

Sir—Readily replaceable connection of transistors is a frequent requirement when building untested designs and when repairing faulty equipment. This is a time consuming job, and can be done away with by using transistor sockets.

However, as these are relatively expensive and quite scarce, a cheaper and readily available alternative is to use integrated circuits sockets. These can be sawn to the required number of connections with a fine hacksaw; one pair of sockets is lost per cut. For example, by cutting down the centre of the socket, four 3-terminal transistor holders can be obtained from a 14-pin dual-in-line socket.

P. Knight,
New Malden, Surrey.

Board Guides

Sir,—Recently I had the problem of providing guides for Vero printed circuit boards. This was solved by using strips of plastic channelling, see Fig. 1, normally used for sliding glass cabinet doors.

The guides were held in position with one of the many contact adhesives available on the market.

R. Powell,
Suadi Arabia.

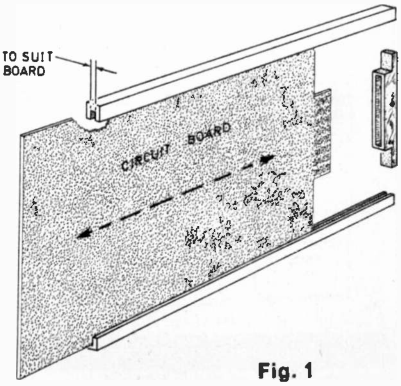


Fig. 1

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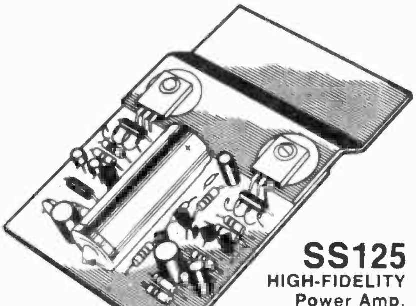

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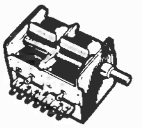
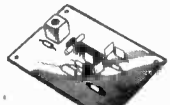
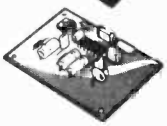
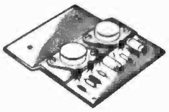




SS201	Tuner front end. Ganged, geared variable tuning, 88–108MHz. A.F.C. facility.	**£5·00**
SS202	I.F. amp. A meter and/or A.F.C. can be connected (size 3in × 2in)	**£2·65**
SS203	Stereo decoder for use with SS201 and SS202 or any good F.M. tuner. A L.E.D. beacon may be attached (3in × 2in)	**£3·85**

AUDIO MODULES





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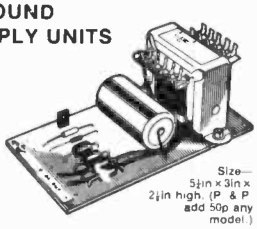

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2N3906	0·27
2N4036	0·67
2N4037	0·42
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2N4059	0·15
2N4060	0·15
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2N4062	0·15
2N4126	0·21
2N4289	0·34
2N4919	0·95
2N4920	1·10
2N4921	0·83
2N4922	1·00
2N4923	1·00
2N5190	0·92
2N5191	0·96
2N5192	1·24
2N5195	1·46
2N5245	0·47
2N5294	0·48
2N5295	0·48
2N5296	0·48
2N5298	0·50
2N5457	0·49
2N5458	0·46
2N5459	0·49
2N5492	0·58
2N5494	0·58
2N5496	0·61
2N5777	0·45
2N6027	0·45
3N128	0·73
3N139	1·42
3N140	1·00
3N141	0·81
3N200	2·49
40361	0·40
40362	0·45
40363	0·88
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·35
40408	0·35
40409	0·52
40410	0·52
40411	2·00
40594	0·74
40595	0·84
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40602	0·61
40603	0·58
40604	0·56
40636	1·10
40669	1·00
40673	0·73
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AC152V	0·49
AC153	0·35
AC153K	0·40
AC154	0·25
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AC176K	0·40
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AD150	1·15
AD161	0·50
AD162	0·50
AD161 }	PR
AD162 }	1·20
AF106	0·40
AF109R	0·40
AF114	0·35
AF115	0·35
AF116	0·35
AF117	0·35
AF118	0·35
AF124	0·30
AF125	0·30
AF126	0·28
AF127	0·28
AF139	0·65
AF186	0·48
AF200	0·65
AF239	0·65
AF240	0·90
AF279	0·70
AF280	0·79
AL102	1·00
AL103	1·00
BC107	0·14
BC108	0·14
BC109	0·14
BC113	0·15
BC115	0·17
BC116	0·17
BC116A	0·18
BC117	0·21
BC118	0·14
BC119	0·29
BC121	0·35
BC125	0·16
BC126	0·23
BC132	0·30
BC134	0·13
BC135	0·13
BC136	0·17
BC137	0·17
BC140	0·68
BC141	0·68
BC142	0·23
BC143	0·25
BC147	0·14
BC148	0·14
BC149	0·15
BC153	0·18
BC154	0·18
BC157	0·16
BC158	0·16
BC160	0·60
BC167B	0·15
BC168B	0·15
BC168C	0·15
BC169B	0·15
BC169C	0·15
BC170A	0·15
BC171	0·16
BC172	0·17
BC177	0·28
BC178	0·27
BC179	0·30
BC182	0·12
BY182L	0·12
BC183	0·12
BC183L	0·12
BC184	0·13
BC184L	0·13
BC186	0·25
BC187	0·27
BC207	0·12
BC208	0·11
BC212K	0·16
BC212L	0·16
BC214L	0·18
BC237	0·16
BC238	0·15
BC239	0·15
BC251	0·25
BC253	0·25
BC257	0·16
BC258	0·16
BC259	0·17
BC261	0·25
BC262	0·25
BC263	0·25
BC300	0·38
BC301	0·34
BC302	0·29
BC303	0·54
BC307	0·17
BC308A	0·15
BC309C	0·20
BC317	0·12
BC318	0·12
BC337	0·20
BC338	0·20
BCY30	0·80
BCY31	0·85
BCY32	1·15
BCY33	0·85
BCY34	0·79
BCY38	1·00
BCY39	1·50
BCY40	0·97
BCY42	0·28
BCY58	0·30
BCY59	0·32
BCY70	0·17
BCY71	0·22
BCY72	0·15
BD115	0·75
BD116	0·75
BD121	1·00
BD123	0·82
BD124	0·67
BD131	0·40
BD132	0·50
BD135	0·43
BD136	0·47
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·87
BD529	0·80
BD530	0·80
BDY20	1·05
BF115	0·36
BF117	0·55
BF121	0·35
BF123	0·35
BF125	0·35
BF152	0·20
BF153	0·25
BF154	0·20
BF159	0·27
BF160	0·23
BF163	0·32
BF166	0·40
BF167	0·25
BF173	0·27
BF177	0·29
BF178	0·35
BF179	0·43
BF180	0·35
BF181	0·36
BF182	0·35
BF183	0·55
BF184	0·30
BF185	0·30
BF194	0·12
BF195	0·12
BF196	0·13
BF197	0·15
BF198	0·18
BF200	0·40
BF225J	0·23
BF244	0·21
BF245	0·45
BF246	0·58
BF247	0·65
BF254	0·19
BF255	0·19
BF257	0·47
BF258	0·53
BF259	0·55
BFR39	0·24
BFR79	0·24
BFS21A	2·30
BFS28	1·36
BFS61	0·27
BFS98	0·25
BFX29	0·30
BFX30	0·27
BFX84	0·24
BFX85	0·30
BFX87	0·28
BFX88	0·25
BFX89	0·90
BFY50	0·23
BFY51	0·23
BFY52	0·21
BFY53	0·18
BFY90	0·75
BRY39	0·38
BSX20	0·21
BSX21	0·29
BU104	2·00
BU105	2·25
C106D	0·65
CA3018A	0·85
CA3020A	1·80
CA3028A	0·79
CA3035	1·37
CA3046	0·70
CA3048	2·11
CA3052	1·62
CA3089E	1·96
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LM301A	0·48
LM308	2·50
LM309K	1·88
LOO5T1	1·50
LM380	1·10
LM381	2·20
LM702C	0·75
LM709	
TO99	0·48
8DIL	0·38
14DIL	0·40
LM710	0·47
LM723C	0·90
LM741	
TO99	0·40
8DIL	0·40
14DIL	0·38
LM747	1·00
LM748	
8DIL	0·60
14DIL	0·73
LM3900	0·70
LM7805	2·00
LM7812	2·50
LM7815	2·50
LM7824	2·50
MC1303	1·50
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MC1330P	0·90
MC1351P	0·80
MC1352P	0·80
MC1466	3·50
MC1469	2·75
ME0402	0·20
ME0404	0·13
ME0412	0·18
ME4102	0·11
ME4104	0·11
MJ480	0·95
MJ481	1·20
MJ490	1·05
MJ491	1·45
MJ2955	1·00
MJE340	0·48
MJE2955	1·20
MJE3055	0·75
MJE370	0·65
MJE371	0·75
MJE520	0·60
MJE521	0·70
MP8111	0·32
MP8112	0·40
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MPF102	0·39
MPSA05	0·25
MPSA06	0·31
MPSA12	0·35
MPSA55	0·25
MPSA56	0·31
MPSU05	0·65
MPSU06	0·58
MPSU55	0·63
MPSU56	0·80
NE555V	0·70
NE556	1·30
NE560	4·48
NE561	4·48
NE565A	4·48
OC23	1·35
OC28	0·76
OC35	0·60
OC42	0·50
OC45	0·32
OC71	0·17
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4022	1·66
4023	0·36
4024	1·24
4025	0·32
4027	0·43
4028	1·50
4029	3·50
4030	0·87
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SN7474	0·36
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SN7484	0·95
SN7485	1·25
SN7486	0·32
SN7490	0·45
SN7491	0·85
SN7492	0·45
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SN74107	0·36
SN74118	1·00
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SN74122	0·50
SN74123	0·60
SN74141	0·85
SN74145	0·90
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SN74151	0·85
SN74153	0·85
SN74154	1·50
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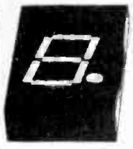

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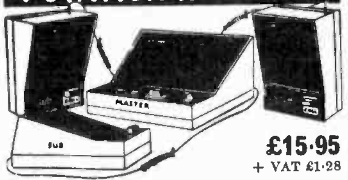

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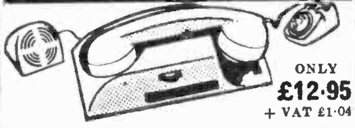

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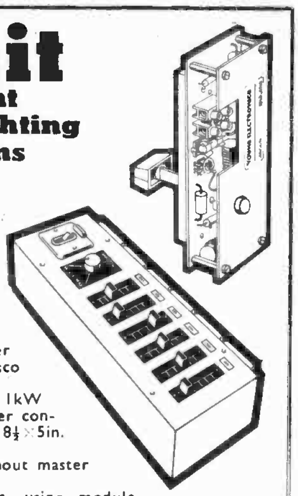

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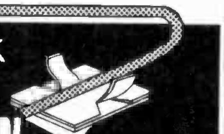

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70	6	3	4·43	72
108	8	4	5·09	85
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Ref. No.	Amps.	£	P & P p
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103	1·0	3·55	72
104	2·0	4·85	85
105	3·0	6·10	97
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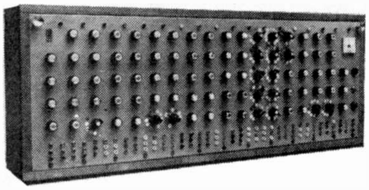

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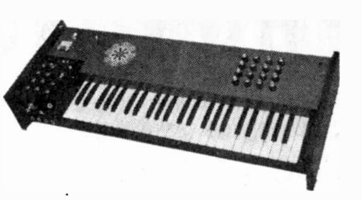

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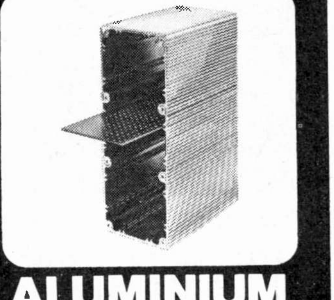

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Power supply component set	£4·96
PCB for 4 frequency channels	£3·32
PCB for power supply and 8 lamp drivers	£1·56
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Panel meter (1μA) (optional)	£3·75

VOICE OPERATED FADER (P.E. Dec· 73)

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P.E. MINIMIX 6

DETAILS IN LIST

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Will modify 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.

Component set with special foot operated switches	£6·25
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Printed Circuit Board	£1·30

HI-FI TAPE-LINK (P.E. Mar./Apr. 73)

Designed for use with reasonable quality tape-decks, this high performance pre-amp includes record, playback and metering circuits. While stocks last.

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Power supply component set	£5·93
Stereo main PCB	£2·80
Stereo sub-assembly PCB	98p

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

An independently designed VCF that can be used with the P.E. Synthesiser.

Component set	£3·41
Printed circuit board	£1·25

ENVELOPE SHAPER

The new ADSR Envelope Shaper published in P.E. October 1975 and having manual control of its Attack, Release and Sustain functions.

Component set incl. PCB	£4·16

Component sets include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Fuller details are in our lists.

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(P.E. Mar./Apr. 74)

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Power Supply, including PCB	£6·42

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Component set (incl. PCB)	£2·55

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)	£2·50

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)	£3·75

P.E. JOANNA

SEE OUR ADVERTISEMENT ON OPPOSITE PAGE

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

Component set incl. PCB	£2·83

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Sophisticated low-noise highly-stabilised power supply kits complete with PCB's and detailed information are now available. Details in list.

Other PCBs (all "as published") While stocks last

Bench Power Supply (P.E. Sept. 1974)	70p
CCTV:	
Master Logic, Video Amp., Sync Mixer and Cathode Switch PCB (P.E. Oct. 1974)	£2·20
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Pre-amp PCB (P.E. Oct. 1972)	85p
Power Supply PCB (P.E. Oct. 1972)	60p
Power Slaves: Power Supply PCB (P.E. Aug. 1974)	55p
Rondo:	
Pre-Amp PCB (P.E. Oct. 1973)	60p
Tone, Balance and Volume Control PCB (P.E. Oct.)	£1·40

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-Amplifier Module Component set and PCB	£3·71
Basic Output Circuits Combined component set with PCBs, for alphaphone cardiophone, frequency meter and visual feed-back lamp driver circuits	£5·39
Audio Amplifier Module Type PC7	£5·50

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Suitable for audio, digital, or general purpose. Controllable through 4 decade ranges 10Hz to 100kHz. Switched attenuation through 10 ranges from 10V to 1mV peak-to-peak.

Component set	£8·88
PCB for above components	£1·60
Power Supply	£5·70
PCB for Power Supply	96p

P.E. TUNING FORK

(P.E. NOVEMBER, 1975)

Main component set incl. PCB	£13·50
Power supply set incl. PCB	£5·57

REVERBERATION UNIT (P.W. Nov./Dec. 72)

A high quality unit having microphone and line input pre-amps, and providing full control over reverberation level.

Component set (exl. spring unit)	£7·55
Printed circuit board	£1·76
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Panel meter (50μA) (optional)	£3·75

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For colour and B & W, an indispensible dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage.

Component set (excl. meter)	£10·72
Printed Circuit Board	£1·74
Panel meter (1mA)	£3·75

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Dual-purpose dark-room unit with good accuracy.

Component set with PCB but excl. meter	£4·88
Panel meter (100μA)	£3·75

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AC128	20p
AC176	20p
BC107	13p
BC108	13p
BC109	13p
BC147	12p
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
BFY50	22p
BFY51	22p
BFY52	24p
BSY95A	22p
MJE2955	110p
OC28	60p
OC71	14p
OC72	14p
OC84	25p
ORP12	66p
ZTX107	12p
ZTX108	7½p
ZTX501	13p
ZTX503	15p
ZTX531	23p
2N706	13p
2N914	22p
2N1304	22p
2N2905	27p
2N2907	22p
2N3053	18p
2N3054	66p
2N3055	48p
2N3702	12p
2N3703	12p
2N3704	12p
2N3819	35p
2N3823E	39p
2N4060	12p
2N4871	36p
2N5245	51p
2N5777	45p

Diodes

1N914	4p
1N4001	6p
1N4002	7p
1N4004	8p
1N4006	9p
1N4007	10p
OA91	7p
OA200	8p
OA202	8p
Z5J	75p
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709 TO5	40p
709 8-pin DIL	40p
723 TO5 ,	95p
741 8-pin DIL	32p
747 14-pin DIL	115p
748 TO5	63p
748 8-pin DIL	63p
μA7805 TO220	165p
μA7815 TO220	165p
AY-1-0212	550p
AY-1-6721/6	188p
CA3046	71p
MFC4000B	73p
MFC6040	83p
SG3402N	202p
EP27/3015F	135p
STK025	595p

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3·3V 400mW	15p
3·9V 400mW	15p
4·7 1W	25p
5·1V 400mW	15p
5·1V 1W	25p
5·6V 400mW	15p
5·6V 1 3W	20p
6·2V 400mW	15p
6·8V 400mW	15p
9·1V 400mW	15p
10V 400mW	15p
11V 1W	25p
12V 400mW	15p
12V 1W	25p
15V 400mW	15p
15V 1W	25p
18V 400mW	15p
18V 1W	25p
20V 400mW	15p
20V 1W	25p
27V 400mW	15p

Electrolytic Capacitors (μF/V)

0·47/63	8p
1·0/63	6p
1·5/63	6p
2·2/63	6p
4·7/63	6p
6·8/40	6p
10/25	6p
10/63	6p
15/40	6p
22/10	6p
22/25	6p
33/6·3	6p
33/16	6p
33/40	6p
33/50	6p
47/10	6p
47/25	6p
47/40	6p
47/63	7p
100/4	6p
100/10	6p
100/25	6p
100/40	7p
100/63	13p
150/16	6p
150/63	13p
220/10	6p
220/16	7p
220/25	11p
220/40	14p
220/63	21p
330/10	6p
470/6·3	6p
470/10	12p
470/25	16p
470/40	20p
500/64	48p
680/6·3	10p
680/25	20p
1000/10	14p
1000/16	25p
1000/25	30p
1000/40	54p
220/25	45p
220/40	71p
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4700/25	75p
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0·01	3½p
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0·022	3½p
0·033	4p
0·047	4p
0·068	4p
0·1	4½p
0·15	5½p
0·22	6p
0·33	8p
0·47	10p
0·68	12p
1·0	15p
2·2	26p

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0·1/35	13p
0·22/35	13p
0·47/35	13p
1·0/35	13p
1·5/35	13p
2·2/35	13p
4·7/35	16p
10/16	16p
10/25	18p
15/6·3	16p
22/16	18p
47/6·3	18p
47/16V	30p
100/3	18p

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Send S.A.E. with all U.K. requests for free list giving fuller details of PCBs, kits, and other components.
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4·3 × 2·3 × 1·2	**65p**
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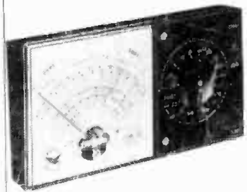

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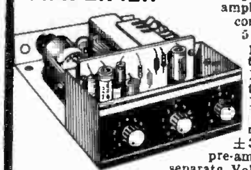
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £15·00. P. & P. 85p.

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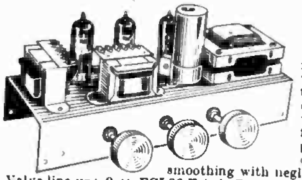

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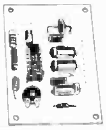

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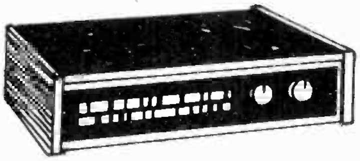

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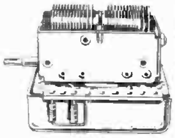
Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2¾" × 1¼" × ¾" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·50 + P. & P. 12p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7-8V + earth. Supplied pre-aligned, with (gang) full circuit diagram and connection details supplied. Beautifully made with precision-geared FM and 323 Pf + 323 Pf AM Tuning only £3·50 + P. & P. 35p.

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Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10¼" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm, 8 ohm or 16 ohm impedance (state which).

OUR PRICE £12·50 each. Carr. £1·60

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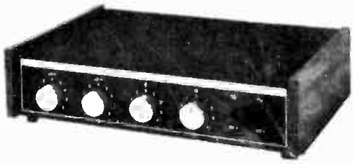
Now also available 8", 10 watts r.m.s. 20 watt peak 40 Hz-20,000 Hz. Overall depth 1". Ideal for Hi-Fi or for use in cars. £5·18 + 40p P. & P.

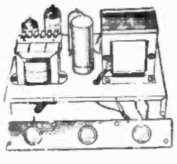
HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12–15,000 Hz. Bass, boost approx. to ±12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

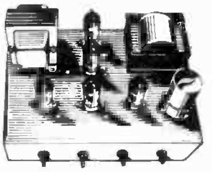
AMPLIFIER KIT	£15·00	P. & P. 55p
(Magnetic input components 33p extra)		
POWER PACK KIT	£5·35	P. & P. 85p
CABINET	£5·35	P. & P. 75p

P. & P. only £1 if all units purchased at same time.
Full after sales service
Also available ready built and tested £32·50. P. & P. £1·00.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II. Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £7·75. P. & P. 85p.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £6·50. P. & P. 85p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15 Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £12·00. P. & P. £1·25. Also available ready built and tested £16·50. P. & P. £1·20.

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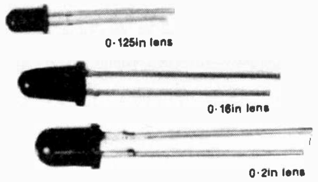

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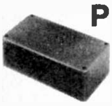

ABS—Ribbed inside on 5mm centres for 1·5mm PCB. Brass corner inserts for securing top with 3mm screws.

62mm × 112mm × 31mm, 1–9 **52p** each; 10 + **48p** each.
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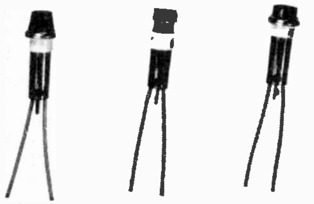
240V (built-in resistance)—150mm lead out wires



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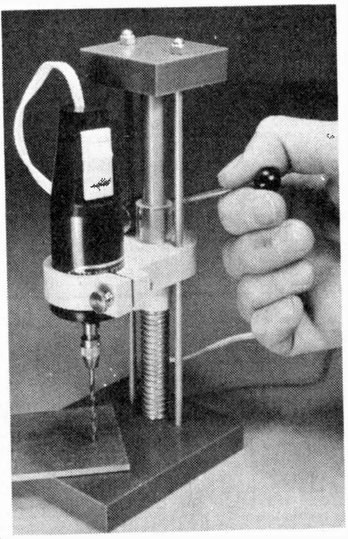
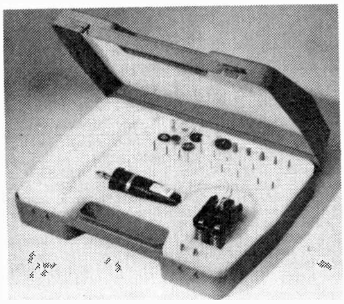


Drill only	**£7·00** p.p. 35p
Stand	**£3·76** p.p. 58p



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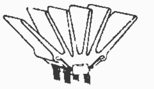
TRANSFORMER	**£5·50** p.p. 75p

S.A.E. FOR DETAILS

JC12 AMPLIFIER



6W IC audio amp with free data and printed circuit **£2·80.** Special offer: only **£2·45** if bought with deluxe kit.

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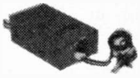

6-WAY SPECIAL
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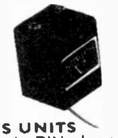

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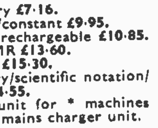

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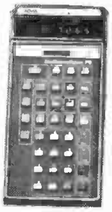

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- Register exchange
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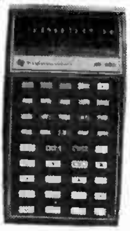

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- = Equals Key
- x^2 Square Key
- $\sqrt{x}$ Square Root Key
- $1/x$ Reciprocal Key
- $x!$ Factorial Key
- sin Sine Key
- cos Cosine Key
- tan Tangent Key
- arc Inverse Trigonometric Key
- EE Enter Exponent Key
- +/− Change Sign Key
- CE Clear Entry Key
- C Clear Key
- + Add Key
- hyp Hyperbolic Function Key
- D/R Angle Change Key
- log Common Logarithm Key
- $\ln x$ Natural Logarithm Key
- e^x e to the xth Power Key
- y^x y to the xth Power Key
- $\sqrt[x]{y}$ The xth Root of y Key
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- RCL Recall Key
- Σ Sum and Store Key

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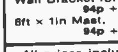

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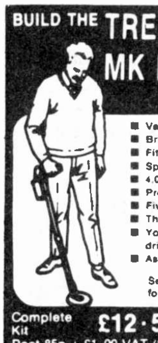

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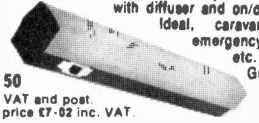

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BC157	11p
BC158/9	13p
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BC178	17p
BC179	20p
BC182/3	12p
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BC214	17p
BCY70	20p
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BD135	54p
BD139	79p
BD140	87p
BF115	24p
BF167	25p
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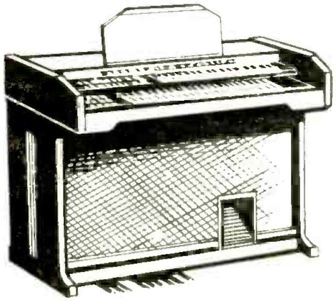

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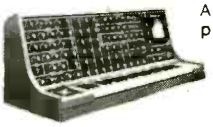

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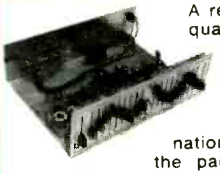

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