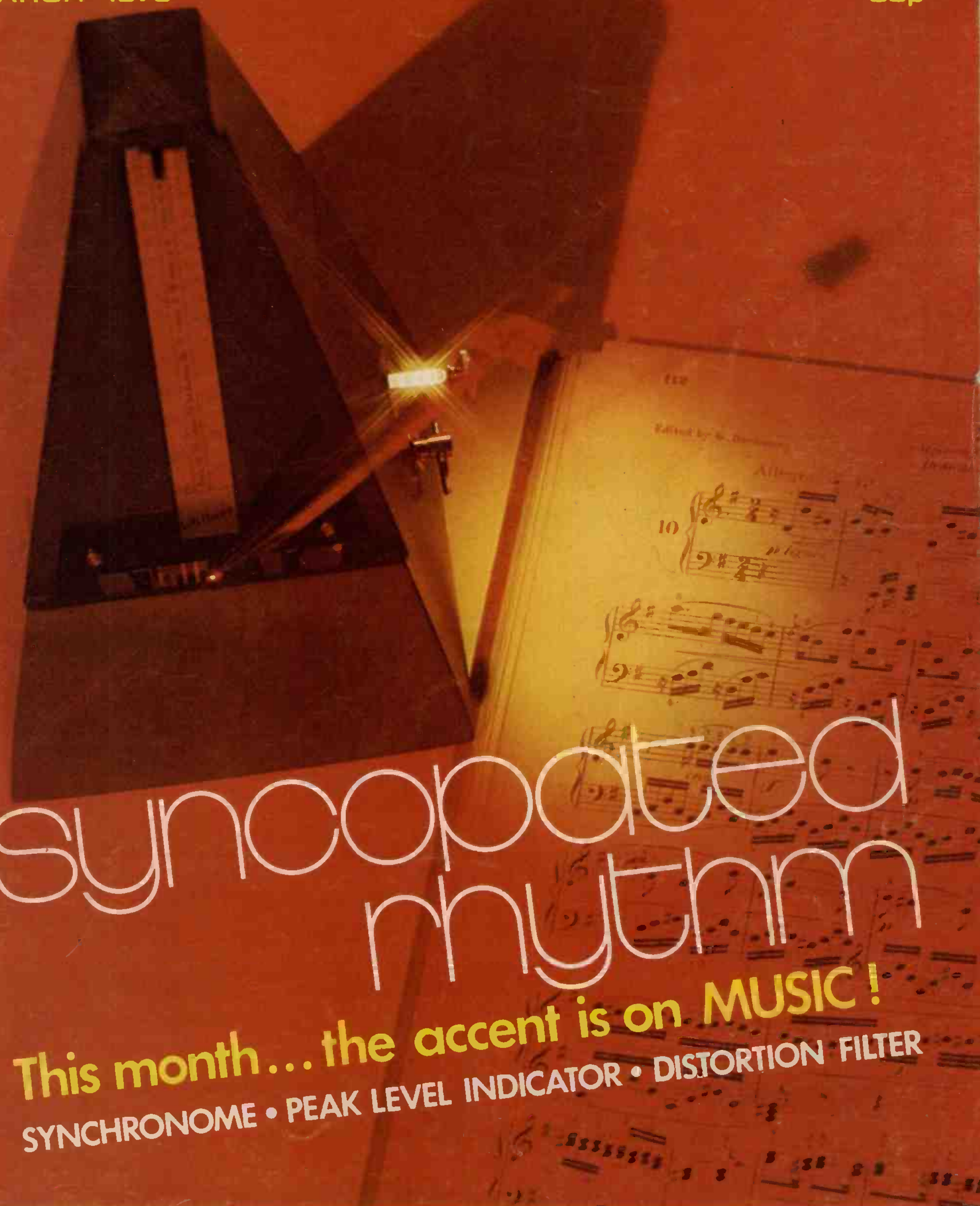
Kmh

PRACTICAL

ELECTRONICS

MARCH 1976

35p



syncopated rhythm

This month... the accent is on MUSIC !

SYNCHRONOME • PEAK LEVEL INDICATOR • DISTORTION FILTER

CHROMASONIC electronics

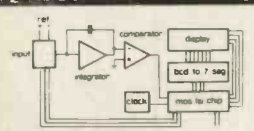
Dept.2, 56, Fortis Green Road,
Muswell Hill, London, N10 3HN.
telephone: 01-883 3705

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 *	£1.27 *
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.*

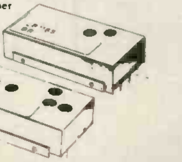
(Data and Circuit Booklets alone 20p.)

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

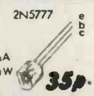
FREE CIRCUITS

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
Il 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	£1.67 *	£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	
78L05WC (TO-92)	60p *
78L12WC (TO-92)	60p *
78L15WC (TO-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 (TO-3)	£2.09 *
7812KC (TO-3)	£2.09 *
7815KC (TO-3)	£2.09 *
7818KC (TO-3)	£2.09 *
7824KC (TO-3)	£2.09 *
Regulators 1A	
7805UC (TO-220)	£1.72 *
7812UC (TO-220)	£1.72 *
7815UC (TO-220)	£1.72 *
7818UC (TO-220)	£1.72 *
7824UC (TO-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 (TO.3)	£1.46 *
L036T1 (TO.3)	£1.46 *
L037T1 (TO-3)	£1.46 *
L129 (SOT-32)	85p *
L130 (SOT-32)	85p *
L131 (SOT-32)	85p *
LM301T (TO-99)	65p
LM301S (8 pin dip)	59p
LM301A T(TO-99)	67p
LM301A S(8 pin dip)	59p
LM307 T (TO-99)	59p
LM307 S (8 pin dip)	57p
LM308 T (TO-99)	£1.96
LM308 S (8 pin dip)	98p
LM308A T (TO-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 *

SN76001N (TAA611)	£1.82 *
SN76003N	£3.30
SN76013N	£1.98
SN76023N	£1.98
SN76227N(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
TAA550	75
TAA570	£2.75
TAA700	£5.03
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
TBA810AS	£1.24
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 *
TDA2010	£3·00
TDA2020	£3·75
ULN2111A	£1.52
ZN414	£1.26

ZN414 Leaflet free with devices (10p alone)

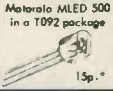
MC1310; 2, 4 & 5 Leaflet free with devices (10p alone)

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 TO92 package



15p.*

		C.Anode R/H Dec. pt.	C.Anode, L/H Dec. pt.	C.Anode ±1	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.

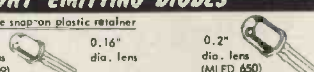
DIGITAL SWITCH

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) 1+	10+	100+	0.16" dia. lens 1+	10+	100+	0.2" dia. lens (MLED 650) 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

Our Bulk Buying Power enables a repeat of our Special Offer:
0.33" (LIT 707) 90p.*(inc. VAT)
0.63" (LIT 747) £1.99 .*(inc. VAT)

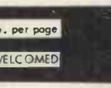
OPTO-ISOLATORS

IL1 4N25 or TIL116
6 pin industry standard package
2.5KV isolation £1.00.*

MAINS TRANSFORMERS

Secondaries		
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
0-9-17 V	-	£1.95 *	£2.27	£2.64 *
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

Items followed by a * inc. VAT at 8% all others include 25%

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. 3 MARCH 1976

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL P.E. PUBLICATION

SOUND DESIGN—Coming soon, details on page 215

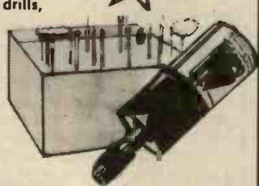
Our April issue will be published on Friday, March 12, 1976
(for details of contents see page 223)

DORAM — A PROFESSIONAL DEAL FOR AMATEURS

- ORDERS BY RETURN OF POST
- NO QUIBBLE REPLACEMENT PART SERVICE
- QUALITY BRANDED PRODUCTS
- FREE UP-DATE INFORMATION SERVICE

TOOLS

The handy EXPO 12V d.c. drill is supplied complete with drill kit containing 4 small drills, two spare collets, two cutters, wire brush, soft buffer, grindstone and 9 various milling and reaming tools.



Drill & kit £9.50 + s
Kit only £4.75 + s

ORYX 50W SOLDERING IRON

Temperature can be altered between 200-400°C.

Iron 240V £6.00 + s
Stand £2.20 + s

ISO-TIP CORDLESS IRON

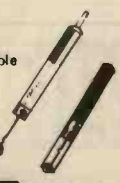
Mains and 12V d.c. versions available
£11.50 + s

DE-SOLDER TOOLS

Three high-suction models available

SR2	£6.20 + s
SR3	£5.20 + s
SR3AS	£4.80 + s

Spare nozzle 60p ea. + s
Please state type

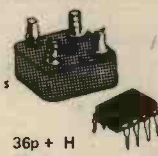


NICKEL-CADMIUM RECHARGEABLE CELLS

Sim. to dry cell	nom. capacity	charge cur. (mA)	
HP7	0·5Ah	50	£1.10 s
—	1·2Ah	100	£1.24 s
HP11	2·0Ah	200	£1.80 s
HP2	4·0Ah	400	£2.70 s

SEMI-CONDUCTOR DEVICES

RECTIFIERS

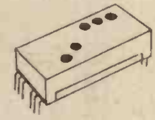


IN 4001	- 8p ea.)	
IN 4002	- 9p ea.)	+ s
IN 4003	- 9p ea.)	

1·0A bridge	(400V)	- 36p + H
1·6A "	(200V)	- 48p + H
1·6A "	(800V)	- 70p + H
2·0A "	(200V)	- 72p + H
2·0A "	(600V)	- 90p + H

MULLARD MODULES

LP 1173	- £6.75 + H
LP 1184/2	- £7.20 + H
LP 1185	- £5.60 + H
LP 1186	- £6.90 + H
LP 1400	- £7.25 + H



TRANSISTORS

BC 107	- 18p s
BC 108	- 17p s
BC 109	18p s
BFY 50	- 24p s
BFY 51	- 24p s
BFY 52	- 24p s
2N 3055	- 80p s
2N 2646	- 94p s
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BC 239C	- 14p H
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ZTX 500	- 16p H
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TIP 32A	- 40p H
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3N 141	- 65p s
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I.C.'s

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MVR 15	- £1.55 s
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7815	- £1.50 s
7824	- £1.50 s
±15V D.I.L.	- £2.82 s
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TBA 800	- £1.60 H
TBA 810S	- £1.80 H
TBA 820	- £1.20 H
ZN 414	- £1.30 H
ZN 424	- £1.25 H
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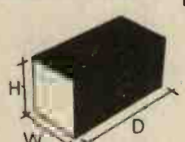

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72710	0·32	0·31	0·28
72741	0·28	0·27	0·26
72741C	0·26	0·25	0·24
72741P	0·26	0·27	0·26
72747	0·79	0·74	0·61
72748P	0·35	0·33	0·31
SL201C	0·46	0·42	0·37
SL701C	0·46	0·42	0·37
SL702C	0·46	0·42	0·37
TAA263	0·74	0·65	0·56
TAA293	0·93	0·88	0·63
TAA350	£1·71	£1·67	£1·57
uA703C	0·26	0·24	0·22
uA709C	0·19	0·18	0·17
uA711C	0·32	0·31	0·28
uA712C	0·32	0·31	0·28
uA723C	0·45	0·43	0·40
76003	£1·39	£1·34	£1·30
76023	£1·39	£1·34	£1·30
76660	0·88	0·86	0·63
LM380	0·93	0·90	0·88
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TBA800	£1·39	£1·34	£1·30
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7402	0·12	0·12	0·11
7403	0·13	0·12	0·11
7404	0·12	0·12	0·11
7405	0·12	0·12	0·11
7406	0·31	0·29	0·27
7407	0·31	0·29	0·27
7408	0·17	0·15	0·13
7409	0·17	0·15	0·13
7410	0·10	0·09	0·08
7411	0·23	0·22	0·21
7412	0·25	0·24	0·23
7413	0·30	0·29	0·28
7416	0·26	0·27	0·26
7417	0·28	0·27	0·26
7420	0·12	0·12	0·11
7422	0·28	0·27	0·26
7423	0·32	0·31	0·30
7425	0·32	0·31	0·30
7426	0·32	0·31	0·30
7427	0·32	0·31	0·30
7428	0·42	0·39	0·37
7430	0·13	0·12	0·11
7432	0·31	0·30	0·29
7433	0·39	0·37	0·35
7437	0·31	0·30	0·29
7438	0·31	0·30	0·29
7440	0·13	0·12	0·11
7441	0·69	0·66	0·59
7442	0·69	0·66	0·59
7443	£1·11	£1·06	£1·02
7444	£1·11	£1·06	£1·02
7445	0·94	0·89	0·69
7446	£1·06	£1·03	£1·00
7447	0·85	0·84	0·82
7448	0·87	0·86	0·85
7450	0·13	0·12	0·11
7451	0·13	0·12	0·11
7453	0·13	0·12	0·11
7454	0·13	0·12	0·11
7460	0·13	0·12	0·11
7470	0·30	0·27	0·25
7472	0·30	0·27	0·25
7473	0·32	0·30	0·28
7474	0·34	0·31	0·29
7475	0·52	0·50	0·48
7476	0·35	0·33	0·31
7480	0·50	0·47	0·44
7481	£1·02	0·97	0·93
7482	0·83	0·79	0·74
7483	£1·00	0·92	0·65
7484	0·93	0·90	0·88
7485	£1·25	£1·19	£1·12
7486	0·32	0·31	0·30
7489	£3·12	£2·81	£2·50
7490	0·48	0·44	0·40
7491	0·75	0·69	0·62
7492	0·54	0·49	0·44
7493	0·48	0·44	0·40
7494	0·56	0·53	0·50
7495	0·72	0·67	0·62
7496	0·85	0·81	0·78
74100	£1·25	£1·19	£1·13
74104	0·38	0·34	0·31
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74100	0·56	0·51	0·46
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74118	0·93	0·88	0·83
74119	£1·38	£1·30	£1·20
74121	0·34	0·33	0·31
74122	0·52	0·51	0·50
74141	0·78	0·77	0·75
74145	0·86	0·84	0·81
74150	£1·37	£1·30	£1·20
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74153	0·82	0·78	0·75
74154	£1·57	£1·43	£1·48
74155	0·82	0·78	0·75
74156	0·82	0·78	0·75
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74162	£1·19	£1·12	£1·06
74163	£1·19	£1·12	£1·06
74164	£1·37	£1·25	£1·19
74165	£1·37	£1·25	£1·19
74166	£1·48	£1·37	£1·25
74174	£1·25	£1·49	£1·12
74175	£1·02	0·97	0·93
74176	£1·16	£1·11	£1·06
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Type	1	25	100+
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BP932	0·15	0·14	0·13
BP933	0·15	0·14	0·13
BP935	0·15	0·14	0·13
BP936	0·15	0·14	0·13
BP944	0·15	0·14	0·13
BP945	0·28	0·26	0·23
BP946	0·14	0·13	0·12
BP948	0·28	0·26	0·23
BP951	0·65	0·60	0·56
BP962	0·14	0·13	0·12
BP9093	0·42	0·40	0·38
BP9094	0·42	0·40	0·38
BP9097	0·42	0·40	0·38
BP9099	0·42	0·40	0·38

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TSO16 16 pin type	0·35	0·32	0·30
TSO24 24 pin type	0·69	0·64	0·62
BPS 8 8 pin type (low cost)	0·14	0·12	0·10
BPS14 14 pin type (low cost)	0·15	0·13	0·11
BPS16 16 pin type (low cost)	0·16	0·14	0·12

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UIC53 =	12 × 7453	0·60
UIC54 =	12 × 7454	0·60
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UIC80 =	5 × 7480	0·60
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UIC83 =	5 × 7483	0·60
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UIC94 =	5 × 7494	0·60
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AC115	*0·20	AF115	*0·25	BC153	0·29	BC440	*0·31
AC117K	*0·30	AF116	*0·25	BC154	0·21	BC460	*0·37
AC122	*0·12	AF117	*0·25	BC157	0·19	BD115	*0·63
AC125	*0·18	AF118	*0·36	BC158	0·12	BD116	*0·81
AC126	*0·18	AF124	*0·31	BC159	0·12	BD121	*0·61
AC127	*0·19	AF125	*0·31	BC160	*0·46	BD123	*0·67
AC128	*0·19	AF126	*0·29	BC161	*0·51	BD124	*0·70
AC132	*0·15	AF127	*0·29	BC167	0·12	BD131	*0·51
AC134	*0·15	AF139	*0·31	BC168	0·12	BD132	*0·61
AC137	*0·15	AF178	*0·51	BC169	0·12	BD133	*0·67
AC141	*0·19	AF179	*0·51	BC170	0·10	BD135	0·41
AC141K	*0·30	AF180	*0·51	BC171	0·10	BD136	0·41
AC142	*0·19	AF181	*0·51	BC172	0·10	BD137	0·46
AC142K	*0·26	AF186	*0·51	BC173	0·15	BD138	0·51
AC176	*0·20	AF239	*0·38	BC174	0·15	BD139	0·56
AC180	*0·20	AL102	*0·68	BC175	*0·35	BD140	0·61
AC180K	*0·30	AL103	*0·68	BC177	*0·19	BD155	*0·81
AC181	*0·20	BC107	*0·08	BC178	*0·19	BD175	*0·61
AC181K	*0·30	BC108	*0·08	BC179	*0·19	BD176	*0·61
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AC188	*0·22	BC114	0·16	BC182	0·15	BD179	*0·71
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ACY17	*0·26	BC116	0·16	BC183	0·15	BD185	*0·67
ACY18	*0·24	BC117	0·19	BC183L	0·15	BD186	*0·67
ACY19	*0·24	BC118	0·10	BC184	0·20	BD187	*0·71
ACY20	*0·24	BC119	*0·31	BC184L	0·20	BD188	*0·71
ACY21	*0·24	BC120	*0·81	BC186	*0·29	BD189	*0·77
ACY22	*0·24	BC137	0·16	BC187	*0·29	BD190	*0·77
AD140	*0·49	BC139	*0·41	BC207	0·11	BD195	*0·87
AD140	*0·49	BC140	*0·31	BC208	0·11	BD196	*0·87
AD142	*0·49	BC141	*0·31	BC209	0·12	BD197	*0·92
AD143	*0·39	BC142	*0·31	BC212L	0·13	BD198	*0·92
AD149	*0·51	BC143	*0·31	BC213L	0·13	BD199	*0·98
AD161	*0·36	BC145	0·46	BC214L	0·17	BD200	*0·98
AD162	*0·36	BC147	0·10	BC225	0·26	BD205	*0·81
AD161 &		BC148	0·10	BC226	0·36	BD206	*0·81
AD162 (MP)		BC149	0·12	BC301	*0·28	BD207	*0·98
	*0·69	BC150	0·19	BC302	*0·25	BD208	*0·98

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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BF115	*0·25	BSY40	*0·29	OC82D	*0·16	2N1132	*0·22	2N2906A	*0·19	2N3706	0·12
BF117	*0·46	BSY41	*0·29	OC83	*0·20	2N1302	*0·15	2N2907	*0·20	2N3707	0·13
BF118	*0·71	BSY95	*0·13	OC139	*0·20	2N1303	*0·15	2N2907A	*0·22	2N3708	0·08
BF119	*0·71	BSY95A	*0·13	OC140	*0·20	2N1304	*0·18	2N2923	0·15	2N3709	0·09
BF121	0·46	BU105	*2·04	OC169	*0·26	2N1305	*0·18	2N2924	0·15	2N3710	0·09
BF123	0·51	MJE521	*0·56	OC170	*0·26	2N1306	*0·21	2N2925	0·15	2N3711	0·09
BF125	0·46	MJE2955	*0·88	OC171	*0·26	2N1307	*0·21	2N2926G	0·13	2N3819	*0·29
BF127	0·51	MJE3055	*0·57	OC200	*0·26	2N1308	*0·24	2N2926Y	0·11	2N3820	*0·51
BF152	0·56	MJE3440	*0·51	OC201	*0·29	2N1309	*0·24	2N2926O	0·10	2N3823	*0·29
BF153	0·46	MPF102	*0·43	OC202	*0·29	2N1613	*0·20	2N2926R	0·10	2N3903	0·29
BF154	0·46	MPF104	*0·38	OC203	*0·26	2N1711	*0·20	2N2926B	0·10	2N3904	0·31
BF155	*0·71	MPF105	*0·38	OC204	*0·26	2N2147	*0·73	2N3053	*0·18	2N3905	0·29
BF156	*0·49	OC19	*0·36	OC205	*0·36	2N2148	*0·58	2N3054	*0·47	2N3906	0·28
BF157	*0·56	OC20	*0·65	OC309	*0·41	2N2218	*0·20	2N3055	*0·42	2N4287	0·18
BF158	0·56	OC22	*0·47	OCP71	*0·44	2N2219	*0·20	2N3402	*0·29	2N4288	0·18
BF159	0·61	OC23	*0·49	ORP12	*0·60	2N2220	*0·22	2N3403	*0·29	2N4289	0·18
BF173	*0·22	OC24	*0·57	ORP60	*0·60	2N2221	*0·20	2N3404	*0·29	2N4290	0·18
BF176	0·36	OC25	*0·39	ORP61	*0·60	2N2222	*0·20	2N3405	*0·43	2N4291	0·18
BF179	*0·31	OC26	*0·30	TIP29	*0·44	2N2368	*0·18	2N3525	*0·77	2N4292	0·18
BF180	*0·31	OC28	*0·51	TIP30	*0·52	2N2369	*0·15	2N3614	*0·69	2N4293	0·18
BF181	*0·31	OC29	*0·51	TIP31A	*0·56	2N2369A	*0·15	2N3615	*0·76	2N5172	0·12
BF194	0·12	OC35	*0·43	TIP32A	*0·68	2N2646	*0·48	2N3616	*0·76	2N5457	*0·32
BF195	0·12	OC36	*0·51	TIP41A	*0·68	2N2904	*0·18	2N3646	0·09	2N5458	*0·32
BF196	0·15	OC41	*0·20	TIP42A	*0·81	2N2904A	*0·21	2N3702	0·12	2N5459	*0·41
BF197	0·15	OC42	*0·25	TIS43	*0·31	2N2905	*0·21	2N3703	0·12	40361	*0·41
BF257	*0·46	OC44	*0·16	UT46	*0·28	2N2905A	*0·21	2N3704	0·13	40362	*0·51
BF258	*0·61	OC45	*0·13	ZN414	*1·11						
BFY53	*0·18	OC70	*0·15	2N696	*0·13						
BSX19	*0·16	OC71	*0·15	2N697	*0·14						
BSX20	*0·16	OC72	*0·15	2N698	*0·25						
BSY25	*0·16	OC74	*0·15	2N699	*0·36						
BSY26	*0·16	OC75	*0·16	2N706	*0·11						
BSY27	*0·16	OC76	*0·16	2N706A	*0·12						
BSY28	*0·16	OC77	*0·26	2N708	*0·14						
BSY29	*0·16	OC81	*0·16	2N914	*0·15						
BSY38	*0·19	OC81D	*0·16	2N918	*0·31						

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Pak No.	Description	Price
U 1	120 Glass Sub-min. General purpose Germ. diodes	0·60
U 4	30 Germanium transistors like OC81. AC128	*0·60
U 5	60 200mA sub-min. silicon diodes	*0·60
U11	20 PNP Sil. planar trans. TO-5 like 2N1132. 2N2904	*0·60
U15	20 NPN Sil. planar trans. TO-5 like 2N696, 2N697	*0·60
U19	20 Silicon NPN transistors like BC108	*0·60
U26	30 Fast switching silicon diodes like IN914 Micro-Min.	0·60
U29	10 1 Amp SCR's TO-5 can. up to 600 CRS/25-600	*£1·20
U32	25 Zener diodes 400mW DO-7 case 3-36 volts mixed	0·60
U36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	*0·60
U45	7 3A SCR. TO66 up to 600 PIV	*£1·20
U46	20 Unijunction transistors similar to TIS43	*0·60
U48	9 NPN Sil. power transistors like 2N3055	*£1·20

Code No's mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
BA100	*0·10	BB104	*0·15	OA10	*0·14	OA91	*0·07
BA116	*0·21	BY100	*0·16	OA47	*0·07	OA95	*0·07
BA126	*0·22	BY126	*0·15	OA70	*0·07	OA200	*0·07
BA148	*0·15	BY127	*0·16	OA79	*0·07	OA202	*0·07
BA154	*0·12	BY128	*0·16	OA81	*0·07	1N914	*0·06
BA156	*0·14	BY164	*0·51	OA85	*0·09	1N916	*0·06
BA173	*0·15	BYX38/30	*0·43	OA90	*0·07	1N4148	*0·06

THYRISTORS

PIV	0·6A TO18	0·8A TO92	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
10	*0·13	*0·15	—	—	—	—	—	—	—	—
20	*0·15	*0·18	—	—	—	—	—	—	—	—
30	*0·19	*0·22	—	—	—	—	—	—	—	—
50	*0·22	*0·28	*0·20	*0·25	*0·36	*0·36	*0·48	*0·51	*0·54	*1·18
100	*0·25	*0·30	*0·25	*0·25	*0·48	*0·48	*0·51	*0·57	*0·58	*1·43
150	*0·31	*0·38	—	—	—	—	—	—	—	—
200	*0·38	*0·44	*0·25	*0·30	*0·50	*0·50	*0·57	*0·62	*0·62	*1·63
400	—	—	*0·30	*0·39	*0·55	*0·57	*0·82	*0·71	*0·77	*1·79
600	—	—	*0·39	*0·48	*0·69	*0·69	*0·78	*0·99	*0·90	—
800	—	—	*0·58	*0·65	*0·81	*0·81	*0·92	*1·22	*1·39	*4·07

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PIV	300mA (DO 7)	750mA (SO 16)	1 Amp Plastic		1·5 Amp (SO 16)	3 Amp (SO 10)	10 Amp (SO 10)	30 Amp (TO 48)
50	0·05	0·06	IN4001	0·05	0·07	0·14	0·19*	0·56*
100	0·05	0·07	IN4002	0·06	0·09	0·16	0·21*	0·69*
200	0·06	0·09	IN4003	0·07	0·12	0·20	0·23*	0·93*
400	0·07	0·14	IN4004	0·08	0·14	0·28	0·35*	1·25*
600	0·08	0·16	IN4005	0·09	0·16	0·33	0·42*	1·76*
800	0·11	0·18	IN4006	0·10	0·18	0·35	0·51*	1·94*
1000	0·13	0·28	IN4007	0·11	0·23	0·44	0·60*	2·31*
1200	—	0·32			0·28	0·54	0·69*	2·88*

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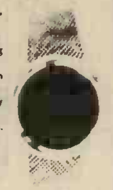

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MCT2	Opto-iso transistor	38

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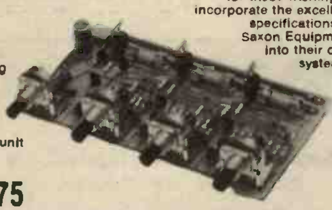

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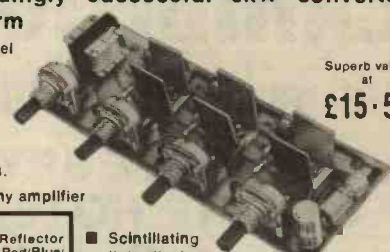

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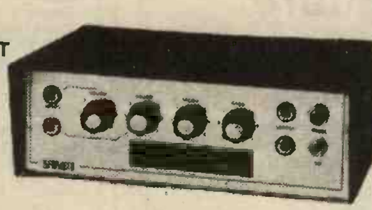

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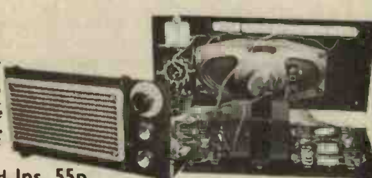

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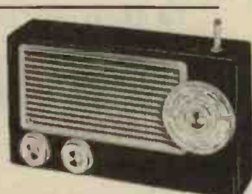

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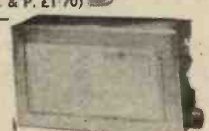

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This compact Tuner Amplifier gives you full medium wave and V.H.F. coverage and FM stereo. With inputs for your turntable and tape recorder. It has rotary tuning, Volume, Balance, Bass and Treble controls and push button selection switches for Phono/tape FM Stereo, FM mono, Medium wave and A.F.C. has built-in stereo beacon and switched headphone socket.

Technical Specifications
15 transistors, 11 diodes, integrated circuit.
Power output 8 watts. Size of tuner amplifier: 4" x 10" x $15\frac{1}{2}$" approx. Finished in selected rosewood veneer with brushed aluminium front panel and matching controls.

£29.00 +p & p £1.50

SPECIAL OFFER As above but with a BSR C123 Turntable in matching teak veneered plinth and a pair of 'Compact' easy to build speakers (see opposite panel). **£39.00** +p & p £3.00

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BSR DECKS WITH PLINTHS AT FANTASTIC REDUCTIONS

MP60 TYPE *(illustrated)*. Less Cartridge — **£16·00** p & p £1·50

C141 *(not illustrated)*. Auto. with cue fitted stereo cartridge — **£12·00** p & p £1·50

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All Plinths finished in matching Teak veneer

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Easily put together with just a few basic tools.
Specification (each speaker): Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20–20,000 Hz. Size 20" × 11" × $9\frac{1}{2}$" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.

£22.00 pair complete +£5.20 p & p.

Complete with crossover Components and circuit diagram

EMI 350 KIT

£7.25 +£1.20 p & p.
Complete with crossover Components and circuit diagram

System consists of a 13" × 8" approx. woofer with a 3" tweeter, crossover components and circuit diagram. Frequency response: 20 Hz to 20 KHz. Power handling 15 watts RMS into 8 ohms. (Peak 30 watts.)

RT-VC *

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System 1a. £69.00

The new 20+20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.
The VISCOUNT IV has a comprehensive range of controls — volume, bass, treble, balance, mono/stereo, mode selector, and scratch filter.
Front panel socket for stereo headphones. And a host of sockets at the rear — for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.
SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion @ 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. — 3 millivolts @ 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. — 50 millivolts @ 50 K ohms (R.I.A.A.); 3, 4, 6. Tape Tuner/Aux. — 140 millivolts @ 50 K ohms (flat frequency response); 5. Microphone — 3 millivolts @ 50 K ohms (flat frequency response).
CONTROLS: Push button ON/OFF, stereo/mono, scratch filter. 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. Frequency response: 25 Hz to 25 KHz @ full rated output. Signal to noise ratio: better than −50 dB on all inputs. Tone control range: Bass ±15 dB @ 50 Hz; Treble ±12 dB @ 10 KHz.
Power requirements: 200-250V A.C. mains @ 60 watts. Approx. size: $15\frac{1}{4}$" × 3" × 10".
MP60 type deck with magnetic cartridge, de luxe plinth and cover.
Two Duo Type IIa matched speakers — Enclosure size approx. $19\frac{1}{2}$" × $10\frac{3}{4}$" × $7\frac{3}{4}$" in simulated teak. Drive unit 13" × 8" with 3" tweeter. 15 watts handling. 30 watts peak.
Complete System with these speakers **£69.00** + £6.50 p & p.

System 2. £85.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers — Enclosure size approx. 27" × 13" × $11\frac{1}{2}$". Finished in teak simulate. Drive units 13" × 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range — 20 Hz to 18,000 Hz.
Complete System with these speakers **£85.00** +£7.60 p & p.

PRICES: SYSTEM 1a
Viscount IV R103 amplifier £27.50 + £1.90 p & p.
2 Duo Type IIa speakers £30.00 + £6.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover £22.00 + £3.30 p & p.
Total if purchased separately: £79.50
Available complete for only: **£69.00** + £6.50 p & p.

PRICES: SYSTEM 2
Viscount IV R103 amplifier £27.50 + £1.90 p & p.
2 Duo Type III speakers £46.00 + £7.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover £22.00 + £3.30 p & p.
Total if purchased separately: £95.50
Available complete for only **£85.00** + £7.60 p & p.

Scotland and the Orkneys P & P Surcharge System 1a £1.75 System 2 £3.50

PE

THE OLD ORDER CHANGETH

IT IS the nature of some changes to hurt a bit and strike at established traditions; even so in electronics. In the good old days an electronic circuit was a circuit, and was seen to be so! It could be analysed quite easily, from input to output, every part recognizable and its function readily determined. Now we frequently have to content ourselves with the knowledge of the overall function of some circuit or portion thereof, and remain in ignorance of the precise manner by which particular functions are achieved.

Anyone returning to electronics after a few years abstinence must be considerably shaken when they first encounter some of today's circuit diagrams, with those frequent blank and anonymous areas bearing little more than the legend "IC1" *et seq*. Yet there is nothing that really need alarm the more traditionally minded enthusiast and constructor—or for that matter, the beginner.

Electronics is a changing world, that it would be idle to deny. The home constructor certainly has to be more selective in the kind of projects he tackles, that is one major change which has come about in this field. It is patent that some projects are no longer truly viable in home constructor terms—for practical or economic reasons. The pocket calculator gave the first example of the great commercial possibilities of large scale circuit integration when applied to mass production of a piece of equipment for the consumer market. Very quickly it became obvious that the home constructor had little to gain from attempting to build a calculator for himself; in any event the nature of things decreed that, in nine out of ten cases, a manufacturer's kit would have to be resorted to. Thereupon, it became an assembly job rather than a bonafide constructor job. No technical knowledge was necessary nor was it likely to be acquired during the process of assembling such a kit. On the credit side, the skill of the constructor in handling microscopic devices and in performing extremely delicate soldering operations was put to the test. If he came through this with flying colours, the completed instrument was living proof of his competence which could be overtly paraded before wondering and admiring friends.

Today, the foregoing could be said to apply to the digital wristwatch—but even more so. With this latest example of microelectronics in the consumer market, the scale of operations is further reduced and the degree of dexterity demanded of the assembler must therefore be correspondingly greater.

One thing that never changes is the fascination generated by the new and novel. That first digital wristwatch, like that very first radio of old, simply *has* to be built: for the experience, for the fun, for the very sense of personal achievement. For some it is an irresistable challenge. Often it is a form of baptism, since for some, assembling a kit could be their first real practical involvement with electronics. But they must not confuse kit assembly with normal constructing activities which embrace an infinite variety of projects—with or without the use of i.c.s. They should realise that many typical constructor projects have no commercial counterpart and that remains, in spite of other changes, one of the great advantages and rewards of this hobby.

F.E.B.

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synchronome

By A. BRIAR

THE Synchronome is an accented beat metronome which can provide duple, triple and quadruple times at the turn of a switch. It utilises six TTL integrated circuits plus a few discrete components. The unit is completely self contained and may be driven by battery or mains.

MAELZEL'S METRONOME

The mechanical metronome has been in existence virtually unchanged since the eighteenth century. The original design was the brainchild of Maelzel (1772–1828) and to this day such indications at the head of a piece of music as M.M. = 100 mean that the crotchet beat should be taken as the speed of Maelzel's metronome set to 100 beats/minute.

Whilst there is no dispute with the ability of the metronome to perform its function reliably there is still, however, room for improvement.

The basic metronome provides only beats. A more expensive refinement is the one that provides accented timing so that a bell operates on every second, third or fourth beat.

Whilst the purist or traditionalist may scorn the use of an electronic device to do the job the mechanical metronome has done since the time of Beethoven, the Synchronome offers an advanced design to bring musical tempo into the twentieth century.

OPERATION

The complete block diagram is shown in Fig. 1. The timing source is an oscillator running at one hundred times its required speed so that a degree of stability can be maintained. The square wave output is divided by the necessary factor of one hundred and fed at its correct rate to a monostable

We would like to thank Chappel's of New Bond St for the use of the metronome shown on this and the front cover pages

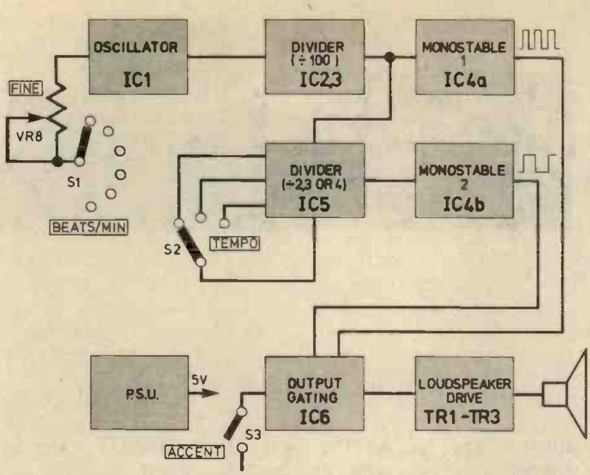


Fig. 1. Block circuit of Synchronome

circuit (Monostable 1). This will give an output pulse of predetermined duration every time it is triggered by a positive transition. The output is fed to the loudspeaker drive cricuit via a gating arrangement (which will have no effect on the pulse until accented timing is selected).

The output of the main divider circuit is also fed to a further divider chain. This circuit will divide the signal by a further factor of two or three or four in conjunction with a gate dependent upon the position of the "Tempo" selection switch. The reset output of the gate to the divider is also fed to a second mono (Monostable 2) which has a much wider pulse width than the first. Now, if "Accent" is selected, then this wider pulse (when present) inhibits the narrow pulse from the first mono and routes itself instead to the loudspeaker drive circuit.

The loudspeaker drive circuit converts the square wave inputs to it to current pulses which pass through the speaker itself.

CIRCUIT

The full circuit is shown in Fig. 2. 74 series TTL has been used for all the integrated circuits in the Synchronome for simplicity.

The oscillator uses a 7413 Schmitt trigger with six switched ranges which are all independently variable; in addition, there is a fine frequency adjustable resistor which can vary the speed incrementally on any range. The frequency of oscillation is dictated by capacity and the total feedback resistance.

The oscillator output is fed to two conventional 7490 divider circuits to obtain the final division by one hundred. The reset inputs to the 7490s are held to the logical low state to ensure that the correct sequence is obtained.

A single chip, the 74123 dual retriggerable monostable is used for generating both the narrow and wide pulses. The output pulse width is a function of the timing capacitor and resistor for each stage. Ideally, the timing resistor should be in the range 5–50 kilohms though these values are not over critical in this application.

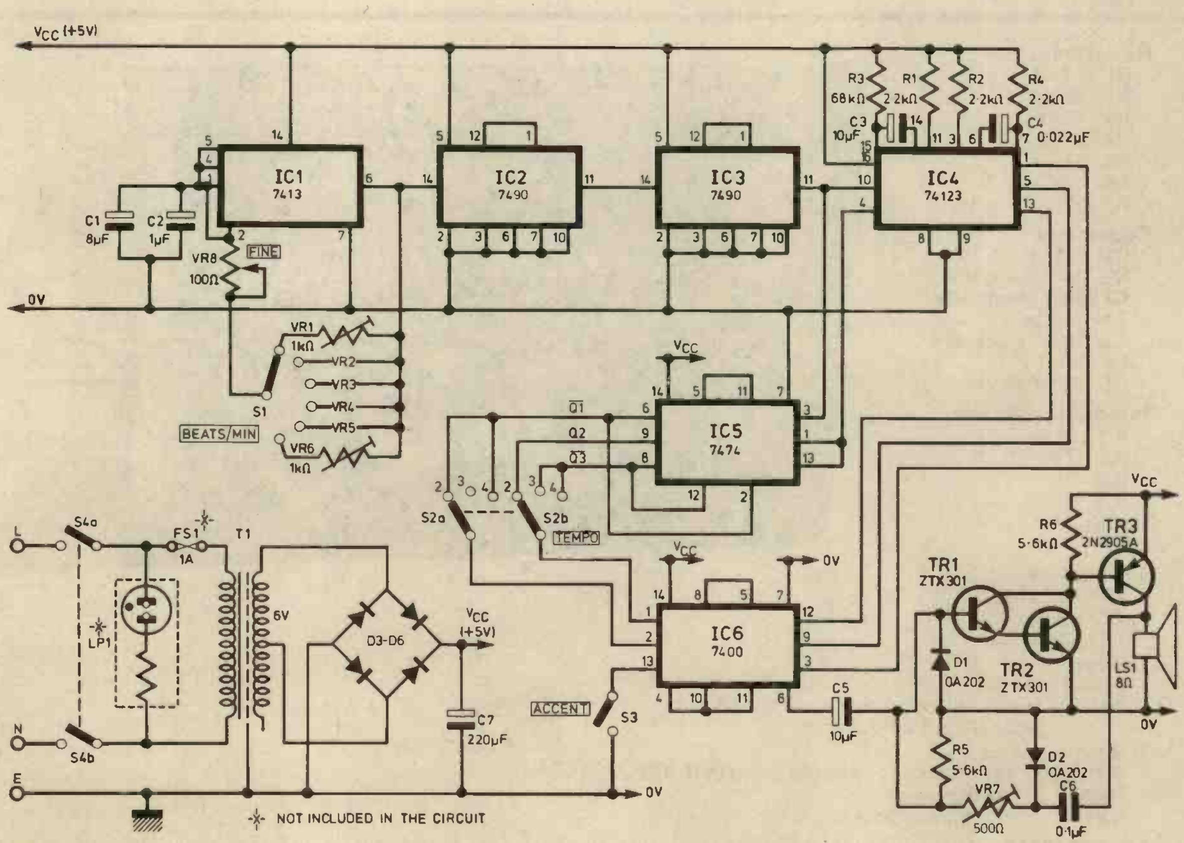
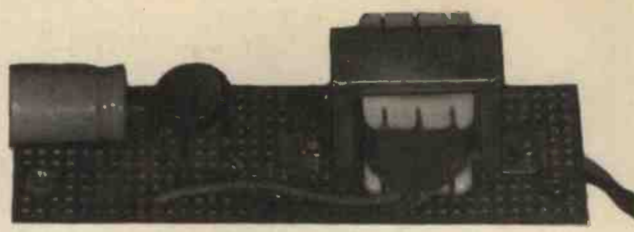


Fig. 2. Complete circuit



ACCENT SELECTION

The chip used here is the 7474 dual D type flip flop; however, the configuration may seem slightly strange to some readers. Since it is required to use these flip-flops as a divider circuit rather than as a conventional latch (which would be their normal function) each of the flip-flops needs to be "back primed" by feeding the NOT Q output back to the D input. In so doing, the 7474 will act as a counter provided that the input is fed in as the clock pulse. The Q and NOT Q outputs of each stage are fed to the "Accent" selection switch so that duple, triple or quadruple time may be selected. The selected outputs are fed to the two input NAND gate to provide the reset pulse for both flip flops.

The negative reset pulse is also fed to the 74123 to generate the wider accent pulse.

OUTPUT GATING

If "Accent' is switched off then the 7400 enables the narrow pulse from the 74123 to reach the loudspeaker driver stage and also inhibits the wide pulse from getting through. When "Accent" is selected then the 7400 will inhibit the narrow pulse and substitutes the wide pulse to the loudspeaker drive circuit.

COMPONENTS . . .

Resistors
R1 2·2kΩ
R2 2·2kΩ
R3 68kΩ
R4 2·2kΩ
R5 5·6kΩ
R6 5·6kΩ
All ¼W carbon

Capacitors
C1 8μF elect. 10V
C2 1μF elect. 10V
C3 10μF elect. 10V
C4 0·022μF
C5 10μF elect. 25V
C6 0·1μF
C7 220μF 25V

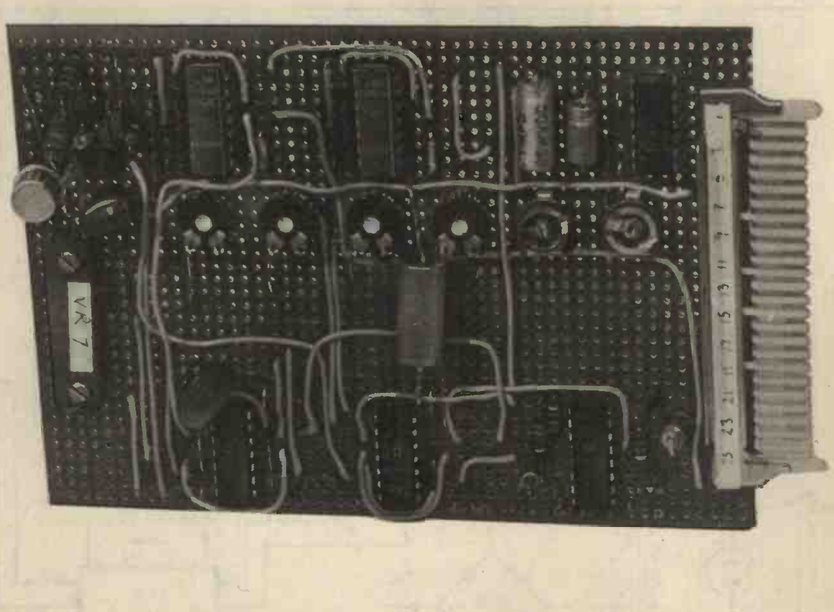
Integrated circuits
IC1 7413
IC2 7490
IC3 7490
IC4 74123
IC5 7474
IC6 7400

Transistors
TR1 ZTX301
TR2 ZTX301
TR3 2N2905A

Diodes
D1–D2 OA202
D3–D6 Mains silicon bridge rectifier (1A p.c type) (R.S. Components)

Potentiometers
VR1–VR6 1kΩ miniature skeleton presets (6 off)
VR7 500Ω trimpot
VR8 100Ω linear potentiometer

Loudspeaker
LS1 8Ω, 2in miniature loudspeaker



Switches
S1
S2 4-pole 3-way
S3

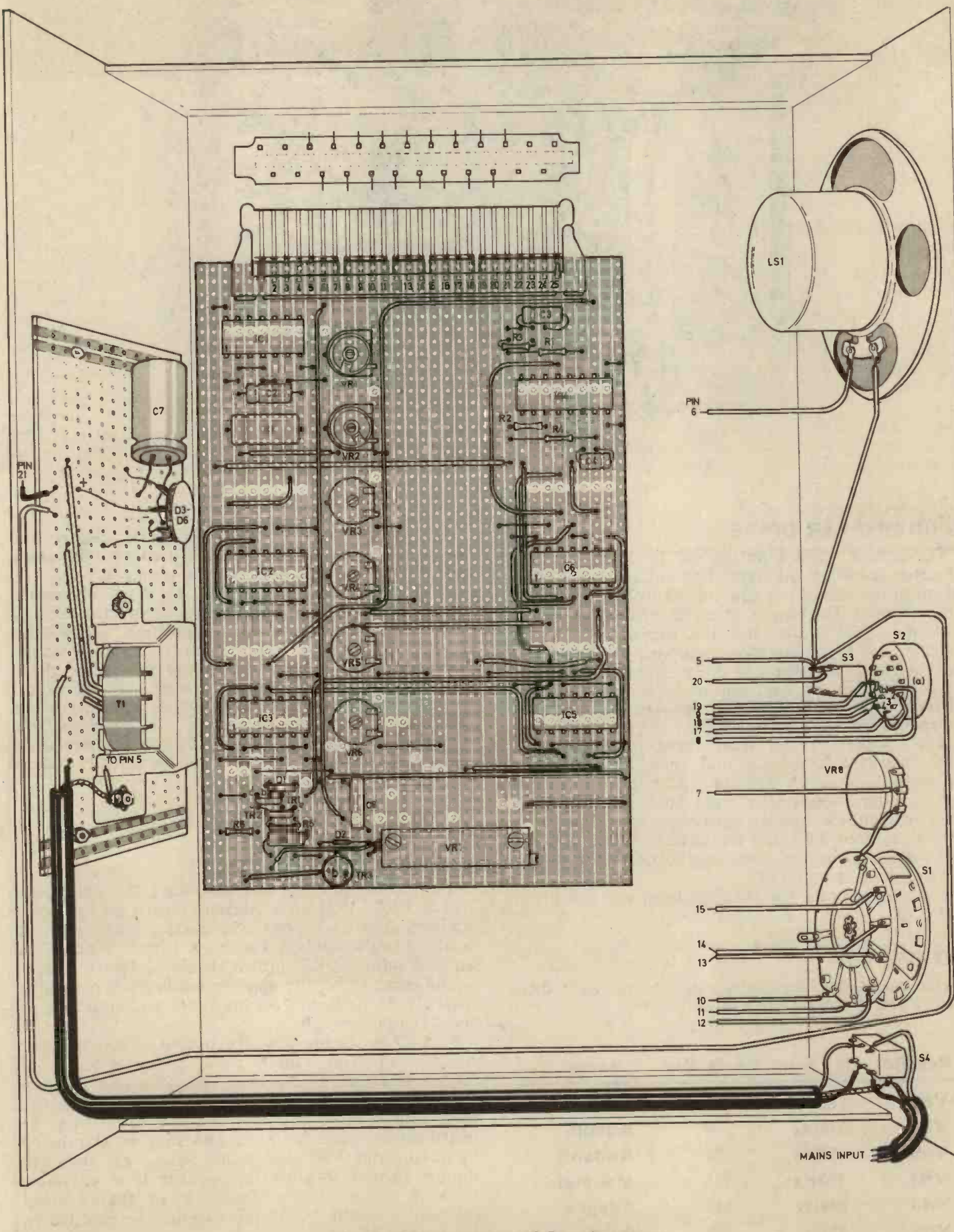
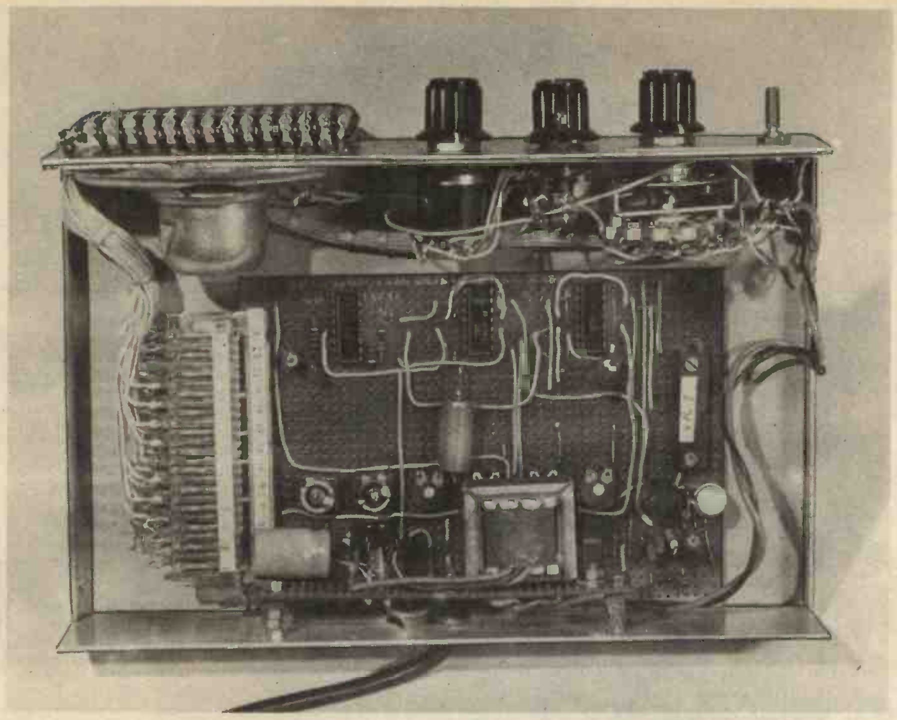


Fig. 3. Wiring details of Synchronome



LOUDSPEAKER DRIVE

The square wave input to the loudspeaker drive circuit is fed via a differentiating circuit to TR1 and the negative transitions are cut off by D1. TR1 and TR2 form a Darlington pair to drive the output transistor TR3 which has the loudspeaker as its collector load. In addition, feedback is introduced via VR7 and the setting of this is given in the initial adjustment but its function is to enable sufficient current drive to reach the speaker to give the desired sound.

If a speaker greater than about three inches is used then the complete unit may be run quite successfully by a 6V battery. The prototype ran for six hours continually from four HP7 batteries but, by using a smaller speaker, more current is needed through TR3 and the speaker to achieve the same effect. It is for these applications that a 5V power supply is required.

Assembly details for the Synchronome are given in Fig. 3.

SETTING UP

The six ranges can be set up to suit individual needs but a suggested set is given below:

Resistor	Osc Freq	Beats Min	Name
VR1	83Hz	50	Largo
VR2	117Hz	70	Adagio
VR3	150Hz	90	Andante
VR4	192Hz	115	Moderato
VR5	240Hz	144	Allegro
VR6	313Hz	188	Presto

These ranges are flexible to a certain degree but by operation of the fine frequency control the exact rate for the individual user can be obtained.

It is important to note that when the individual ranges are being set up, the fine frequency control VR8 should be set at its mid-position. Ideally the oscillator should be set up using a frequency counter or an oscilloscope but, should neither of these be available, then the output circuit may be set up first and then the individual ranges adjusted using a watch with a second hand. If this latter method is adopted then it is advisable to finally check each range over a period of about two minutes to ensure a degree of accuracy.

OUTPUT CIRCUIT

For setting up the output circuit the only control is VR7. With the "Accent" switch on the "off" position adjust VR7 until the correct clicking sound is heard in the loudspeaker. Now switch "Accent" to on and adjust VR7 until a distinctly lower, longer sound is heard on the appropriate beat. When satisfied, check the sound on the other two positions of the "Tempo" switch.

If VR7 is set too low, the output circuit will self oscillate on every input pulse giving a series of loud whines, so ensure that VR7 is set to its mid-position initially. When using a loudspeaker greater than about three inches a double click may be heard on the accented beat. This may be eliminated by taking out VR7 altogether but to get sufficient output current through the speaker it is advisable to keep some positive feedback so that a fixed resistor of about 1·5 kilohms should be inserted in place of VR7. ★

PEAK LEVEL INDICATOR

By J. T. TIERNAN

A stereo add-on unit for better tape recording

TO THE inveterate hi-fi hobbyist the steady flow of circuit designs in the many hi-fi and electronics magazines is a source of constant pleasure and interest, but, by the very nature of such things, it is unlikely that the design fits your requirements to a tee. More often than not you find yourself wanting to combine specific sections of different designs into a single unit, and whilst the modular nature of many recent designs makes this none too difficult, there can, obviously, be problems.

One particular source of concern relates to the matching of signal input and output levels between different circuits or complete equipments. Problems of this nature are often more apparent than real, but the dynamic conditions of designs which involve frequency conscious networks: pick-up preamplifiers, tone controls, and, particularly, steep cut filters, can be difficult to determine, and their characteristics can change beyond recognition when driven at, or near, overload level.

It was with such worries in mind that this simple, but effective, peak level indicator was designed. In its original form it is incorporated in an audio preamplifier, set to indicate signal levels 6dB below output clipping, and it has given sterling service for several months. The overall arrangement of the preamp functions and the position of the indicator is shown in Fig. 1.

The design has an obvious application in tape recorders, as a recording level indicator; and, with a calibrated input attenuator, it could give service as a compact a.c. voltmeter or signal detector.

For the purpose of this article a stereo indicator has been made up as a separate unit.

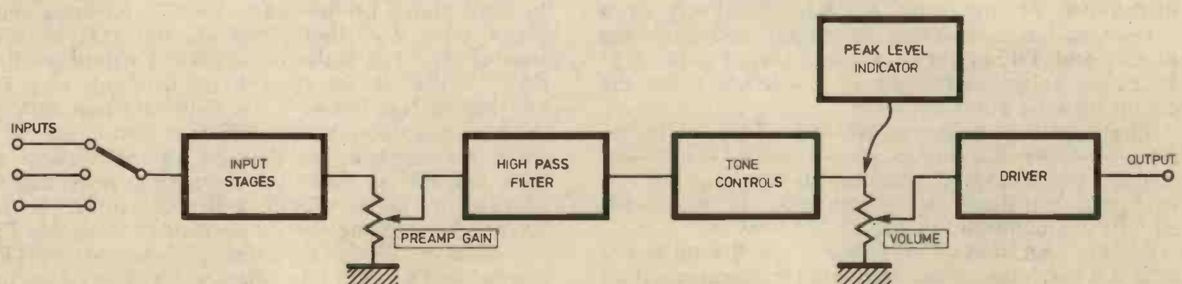
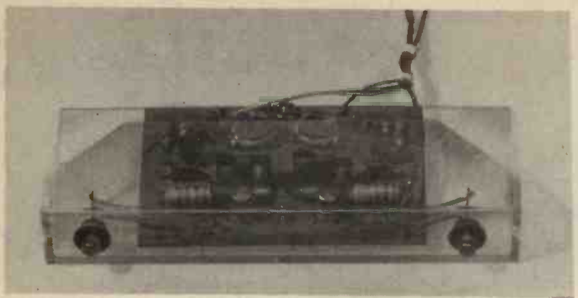


Fig. 1. Block diagram of a typical audio preamplifier showing the suggested connection point for peak level indicator



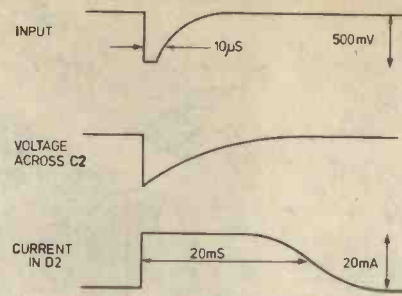


Fig. 2(a). Diagram illustrating threshold discrimination

PERFORMANCE

The unit has a fast attack/slow decay response and will activate an l.e.d. indicator when the input threshold level is exceeded. With the component values specified its performance is as follows:

Input Sensitivity (max)	**500mV**	
Threshold Discrimination	**< 1%**	**(5mV @ 400mV RMS 1kHz sine wave input)**
LED Active Period	**20mS**	**(10μs transient input)**

Fig. 2 illustrates the test conditions.

The 10μs input pulse represents a 50kHz audio transient, demonstrating a bandwidth capability well in excess of that needed for audio applications; and a 20ms l.e.d. output pulse has excellent visual impact.

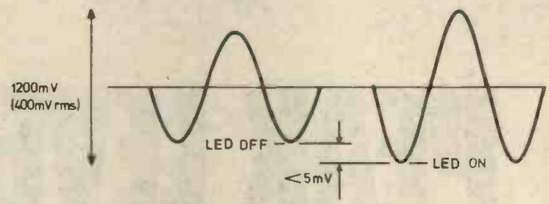


Fig. 2(b). Diagram showing transient response of the peak level indicator

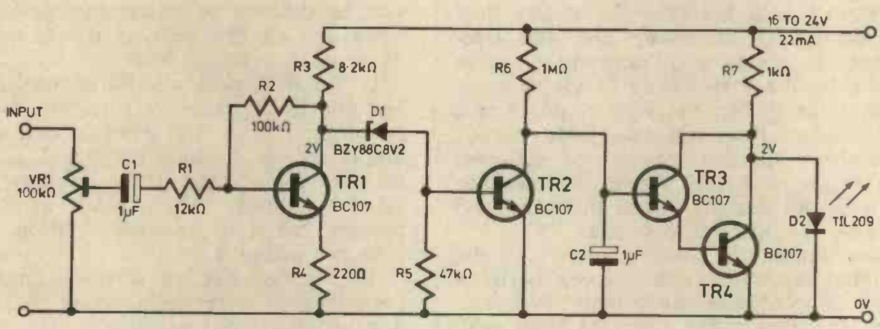


Fig. 3. Circuit diagram of the mono version of the peak level indicator

CIRCUIT DESCRIPTION

The circuit of a single channel peak level meter is shown in Fig. 3. TR1 is a conventional amplifier stage, biased near to saturation, with gain largely determined by the ratio R2/R1. TR2 acts as a current switch, controlling the charge and discharge of C2; and TR3/4 forms a high current gain stage acting as a bypass for the l.e.d. current when the circuit is in the quiescent state.

The bypass arrangement has been adopted to ensure a steady current is drawn from the power supply, whatever the circuit's state, and thus no switching transients are transferred to associated circuits via (common) power supply lines.

Circuit operation is as follows: In the quiescent state TR1 is fully conducting with its collector sitting at about 2V, and, because of the Zener diode (D1) coupling, TR2's base is effectively grounded. TR2 is passing no current and C2 (1μF tantalum) will have acquired a positive charge via the 1MΩ collector load of TR2.

The Darlington connected transistors TR3/4 are forward biased by the charge on C2 and draw about 20mA from the supply rail via the 1kΩ collector resistor R7. The collector of TR4 is sitting at about 0·5V, which is insufficient to forward bias D2, and the voltage across C2 is held at about 1·1V by the base-emitter voltages of TR3/4.

On the negative portion of an input cycle the base current in TR1 will fall, and, provided the subsequent rise of TR1's collector voltage is sufficient to overcome the Zener diode threshold, TR2 will conduct. C2 is very quickly discharged by TR2; current in TR3/4 is immediately cut off; and current through R7 is diverted to D2 which lights up.

continued on page 240

PEAK LEVEL INDICATOR

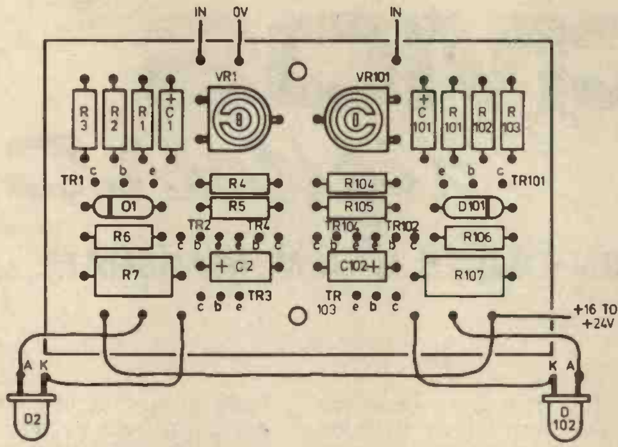


Fig. 4(a). Layout of the components of the printed circuit board. For a mono version the board can be split down the middle and only half used

COMPONENTS . . .

Resistors

R1	12kΩ	R5	47kΩ
R2	100kΩ	R6	1MΩ
R3	8·2kΩ	R7	1kΩ ½W ± 10% carbon
R4	220Ω		

All ¼W ± 5% carbon film except R7

Potentiometer

VR1 100kΩ sub miniature horizontal preset

Capacitors

C1 1μF 16V tantalum
C2 1μF 35V tantalum

Semiconductors

TR1–TR4	BC107C (4 off)
D1	BZY88C 8V2 8·2V 400mW Zener
D2	TIL209 light emitting diode

For a stereo version twice the number of components specified above are required

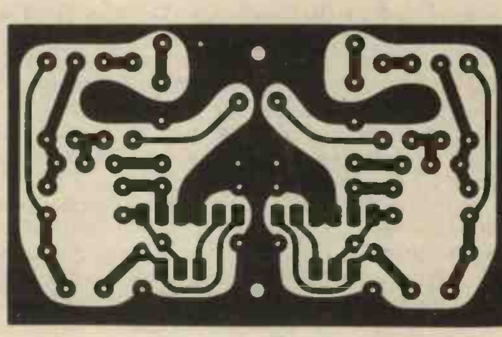
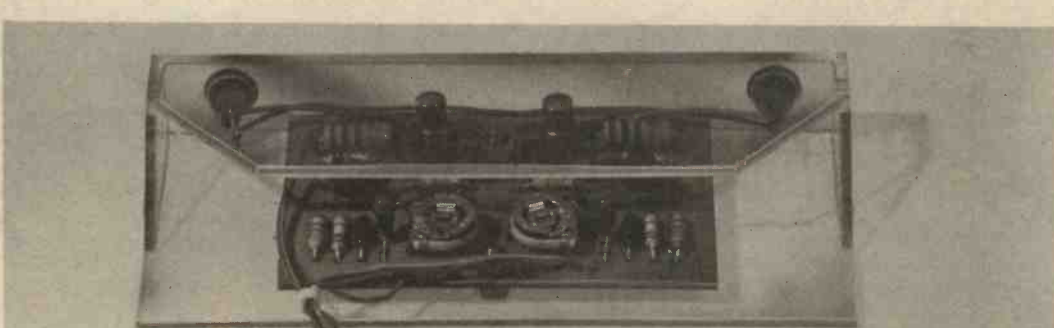
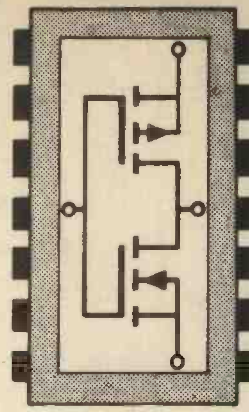


Fig. 4(b). Full size printed circuit master of the peak level indicator



The completed stereo peak level indicator mounted on a piece of casette tape case

Using CMOS *digital* I.Cs



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

PART 3

THE previous parts in this series have described the basic building-blocks from which all CMOS devices are constructed—the complementary MOSFET pair and the transmission gate.

This part will cover the range of gate packages available in CMOS.

LOGIC GATES

The two basic types of gate in the CMOS family are the NOR and NAND, and these two functions have the added advantage that spare gates can be used as inverters in linear applications. However, it is often the case that the design of a circuit will be greatly simplified by resorting to other functions, and so a full list of the types available is given in Table 3.1, with the pin diagrams in Fig. 3.1. Note that the supply pins are always conveniently placed at opposite corners of the package.

Worthy of mention are the two special gate packages shown in Fig. 3.1(e) and (f). The 4501 contains two 4-input NAND gates and a 2-input NOR gate with true/complement output. By making the connections shown dotted in Fig. 3.1(e) the gate will work as an 8-input NAND or AND gate with the output taken from pin 15 or 14 respectively. Note that pin 14 should not be used as an input to the inverter. The 4572 contains 4 inverters, a 2-input NOR gate and a 2-input NAND gate, making it possible to construct any 2- or 3-input function.

INVERTERS AND BUFFERS

The various types of inverter and buffer packages available are shown in Fig. 3.2. The 4069 is a standard unbuffered hex-inverter for use where buffering is not needed, or where it would lead to excessive power dissipation in some linear applications. The other types shown all have high-current buffered outputs, and are useful for driving displays or other logic families.

The two basic buffers are the 4049 hex inverting type and the 4050 hex non-inverting type. On these devices the V_{CC} terminal can be at any voltage up to V_{DD}, enabling them to be used for logic level conversion.

The 4049 and 4050 have replaced the earlier 4009 and 4010 which needed two supply connections.

Table 3.1. Full range of CMOS logic gates

	FIGURE	NOR	NAND	OR	AND	EXCLUSIVE OR	EXCLUSIVE NOR
QUAD 2-INPUT	Fig. 3.1 (a)	4001	4011	4071	4081	4070 4030 4507	4077
TRIPLE 3-INPUT	Fig. 3.1 (b)	4025	4023	4075	4073	—	—
DUAL 4-INPUT	Fig. 3.1 (c)	4002	4012 4501	4072	4082	—	—
8-INPUT	Fig. 3.1 (d)	4078	4068 4501		4501	—	—

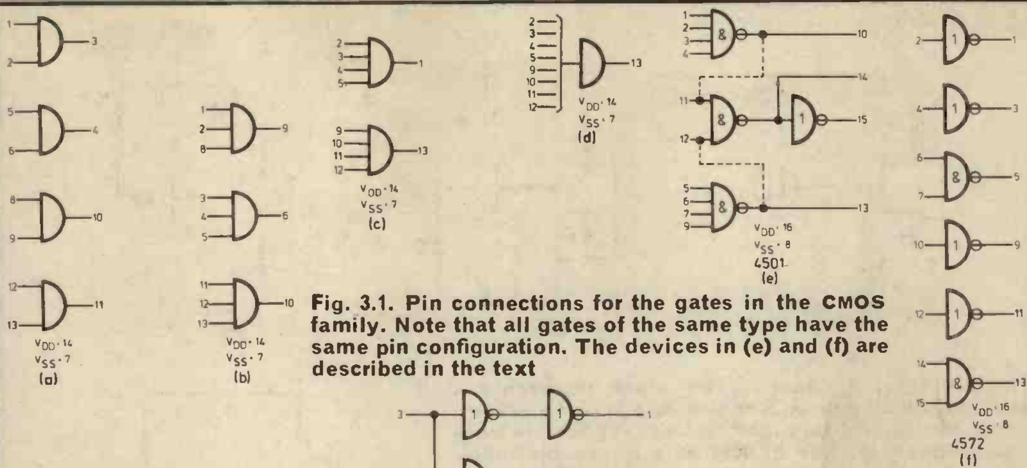


Fig. 3.1. Pin connections for the gates in the CMOS family. Note that all gates of the same type have the same pin configuration. The devices in (e) and (f) are described in the text

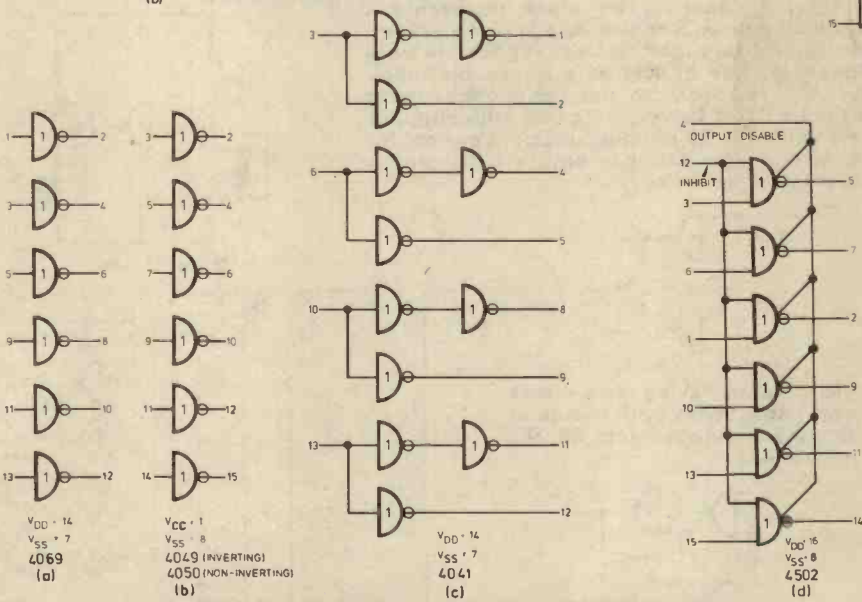


Fig. 3.2. Pin connections for the inverter and buffer packages. (a) Hex inverter. (b) Hex inverting and non-inverting buffers or level converters. (c) Quad true/complement buffer. (d) Strobed hex inverter buffer. Pin 4 is the three-state output disable, and pin 12 is the output inhibit

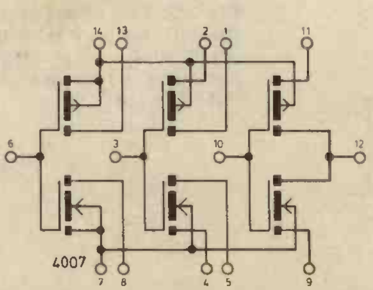
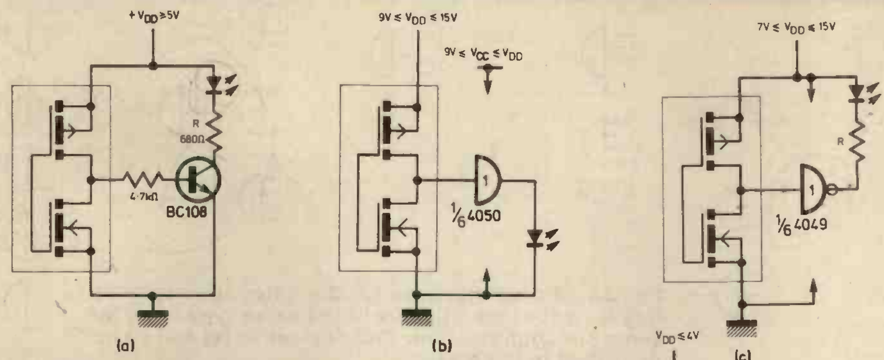


Fig. 3.3. Connection diagram for the 4007 dual complementary pair and inverter. The diode protection networks are not shown



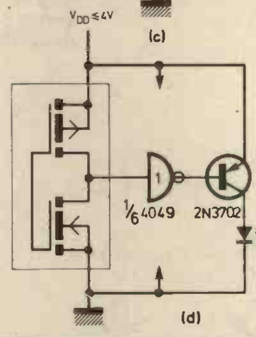


Fig. 3.4. Driving circuits. The block represents a standard CMOS output. Resistor R, where necessary, limits the current through the l.e.d. (a) Simple transistor driver. (b) Use of 4050 as a driver and level-converter; V_{CC} is chosen to give the correct current through the l.e.d. (c) Driver using 4049 with supplies of above 7 volts. (d) To provide sufficient current for the l.e.d. at very low voltages both a buffer and a transistor may be required

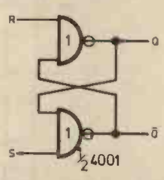


Fig. 3.5. R-S latch using two cross coupled NOR gates. With both inputs at logical "O" the previous state at the inputs is memorised

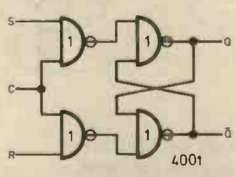


Fig. 3.6. Gated R-S latch uses one 4001 package. A logical "1" on the control input disables the R and S inputs

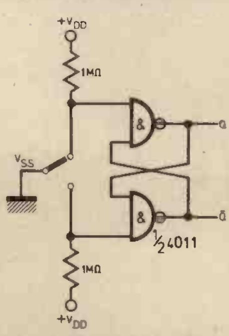


Fig. 3.7. Switch debouncer using an R-S latch. The resistors may be any large value. Alternatively NOR gates may be used, with the resistors going to V_{SS} and the switch to V_{DD}

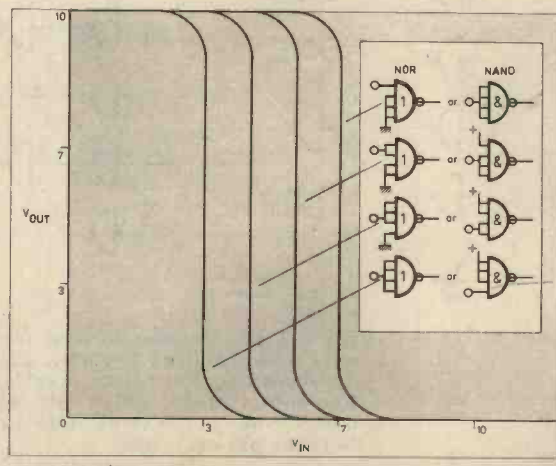


Fig. 3.8. The effect of paralleling inputs. Increasing the number in a NOR gate causes a decrease in the input 'low' noise margin and an increase in the input high noise margin. The reverse holds for a NAND gate

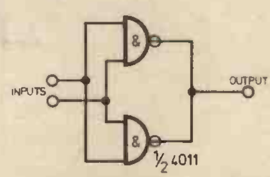


Fig. 3.9. Both source and sink current may be increased by paralleling whole gates or inverters from the same package. The speed performance will also be improved

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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
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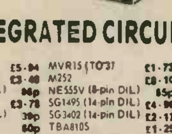

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1.2 ohm to 270 ohm: 5% E12 .... 15p

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BC149	15p	BF258	30p	ST2	35½p	2N3706	15p
BC168C	15p	BF259	27p	TIS43	35p	2N3707	17½p
BC169C	15p	BFX29	32½p	W005	27p	2N3708	10p
BC178	18p	BFX30	35p	W04	30p	2N3819	27½p
BC179	17p	BFX84	32½p	Z1J	84p	2N3866	88p
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BC183L	15p	BFX87	32½p	IN914	5p	2N3904	27½p
BC184L	15p	BFX88	34½p	IN4148	5p	2N5245	58p
BC212L	17½p	BFY50	17p	2A 50PIV Bridge	40½p	2N5459	64p

The 4041 is a quad true/complement buffer which provides both inverted and non-inverted outputs. Finally the 4502 strobed hex inverter buffer consists of six inverters with three-state outputs. Applying a logical "1" to pin 4 puts all six outputs at high impedance (greater than 10MΩ) making it possible for many packages to share the same output lines More than 50 three-state outputs can be "common bussed" in this way. Pin 12 is an output inhibit; a logical "1" switches the six outputs to "0".

One part does not really fit into any of the above categories; the 4007 dual complementary pair and inverter shown in Fig. 3.3. This part provides access to the individual transistor elements making it possible to construct circuits not catered for in the standard range. Furthermore, their device will replace discrete MOSFETS in many circuits, at a fraction of the cost.

OUTPUT DRIVE CURRENT

As mentioned earlier, CMOS gates have a d.c. fanout of more than 100 since CMOS inputs present a negligible resistive load. However, the driving capabilities of CMOS are not very great by other standards, most outputs only being able to sink one low-power TTL input load at 5 volts, and so some sort of interface will often be needed between the output and the external circuit.

For every device two drive currents are given; these are the "sink" current which flows through the *n*-type MOSFETS when the output is at logical "0", and the "source" current through the *p*-types when the output is at logical "1".

The source and sink currents will be equal only in devices which have symmetrical outputs, such as inverters and all parts in the B-series (which have two inverters before the outputs). The currents for other devices will depend on the arrangement of the MOSFETS at the output. These values represent limits, and the output of a gate can be shorted to V_{DD} or V_{SS} or to another output without causing any damage. This is because of the relatively high output impedance of a CMOS gate (typically in the region of 500 to 1 kilohms) and this limits the current to a safe level. High current buffers such as the 4049 can, however, suffer from supplies of more than circuits if operating from supplies of more than about 7 volts, as the overall package power dissipation will exceed the recommended 200mW, and so these types should be treated with greater care.

DRIVING CIRCUITS

Due to the complementary arrangement of CMOS outputs, the load may be connected between the output and either supply rail. Fig. 3.4 gives four circuits for driving light emitting diodes from a standard output, and these can easily be extended to other applications.

The output currents are very dependent on the supply voltage, and choice of driving circuit will often be dictated by this. With supplies of less than about 4 volts the base current of a driver transistor can exceed the standard output current of the CMOS device, and an intermediate buffer will be needed as in Fig. 3.4(d).

UNUSED INPUTS

In some logic families unused inputs will look after themselves. For example, in TTL any inputs left floating will be pulled up to a logical "1" level. This is not the case with CMOS due to the near infinite input impedance of a gate. A floating gate is at an undefined level and can give rise to erratic operation, and the input capacitance may charge up to the switching point causing high power consumption. The simple cure is to hold unused inputs at some defined logic level, either by joining them to a used input, or by connecting them to the non-significant logic level for that function.

Paralleling inputs results in a slight increase in speed due to the lower "on" resistance of the paralleled devices, although this is minimised by a compensating speed decrease due to the added capacitance. More important is that the output source or sink current of the device is increased in proportion to the number of inputs tied together; in NAND gates the source current is increased, whereas in NOR gates the sink current increases, so that a gate from a 4002 package with all inputs paralleled will sink 3·2mA at 5 volts, sufficient to drive one TTL load.

GATES AS LATCHES

A one-bit memory or R-S latch may be constructed from two NOR gates as in Fig. 3.5. Alternatively NAND gates can be used in a similar configuration. The information remains memorised when the R (reset) and S (set) inputs are both at the non-significant logic level, this being R = S = 0 for NOR gates. The control input in the circuit of Fig. 3.6 performs this function by holding the R and S inputs low. One common application of the R-S latch is the switch debouncer shown in Fig. 3.7, this time using NAND gates. The pull-up resistors, which can have any value up to several megohms, hold the inputs at logical "1" when not taken to "0" by the switch contact. This ensures that a noisy contact does not change the state of the output.

Next month: Linear use of CMOS with practical amplifiers and oscillators.

BY FRANK W. HYDE

TO MARS BY VIKING

The *Viking* missions to Mars is the highlight for 1976 and especially for America it marks a new milestone in Space History. These vehicles consist of two parts, the orbiter and the lander and represent the latest of the sophisticated techniques available. The lander part of the spacecraft will touch down on July 4. The whole operation will be repeated a few days later with the second spacecraft.

As a combined operation it will be unique for there will be four units at work at the same time, enabling a vast area of the red planet's surface to be observed from the orbiters and the local terrain investigated by the landers.

The two composite vehicles were dispatched into a minimum energy orbital trajectory and will be at their destinations when the planet is on the opposite side of the Sun from the Earth. Thus they will represent the unusual situation of being in operation but out of direct communication with Earth for about a month.

The orbiter is a very much enlarged version of *Mariner* spacecraft weighing about 2,300 kilogrammes compared with the *Mariner* which is about 1,000 kilogrammes. The lander is contained within the structure. The *Viking* composite unit contains larger propellant tanks and more powerful aids such as the computers.

The camera system is also an improved one in order that the pictures may be relayed more rapidly back to Earth than in the previous missions. This is an important point because the decision to make the actual landing will be determined by the terrain and this can only be made if mission control can see what is happening. With a communication time for the round trip of around 40 minutes per bit, the extent of the improved technique can be appreciated.

Three basic programmes are planned. The orbiters will carry on the detailed photography of the planet begun by *Mariner 9* at the 1971 opposition. Second, the spacecraft will study the physical conditions of the planet which will include the atmosphere and the geology and internal structure. Thirdly, the landers will look for life and/or biological processes.

EXPERIMENTS AND OBSERVATIONS

The radio and radar measurements will be directed to the size of the planet, the electromagnetic properties, atmospheric disturbance, density of the atmosphere, gravitational conditions, density of the planet and surface density.

The orbiters will observe the formation of clouds and their movements and the possible changes of the concentrations of water vapour. The landers will also record their local weather at the two points on the surface where they land.

Both orbiters and landers will photograph the geology giving details of structure, faults, stratification, types of rock and debris erosion and other conditions. The landers will sample the soil examining it for details such as minerals and the general composition by means of the scoops and subsequent processing within the lander craft.

The seismic measurements will afford data as to the structure of the planet and whether in fact it has a core, mantle and a crust like the Earth.

LANDING SITES

Four sites have been chosen for the landers and they have a primary and secondary importance. They are designated Prime A1 located at the area known as Chrise. In this area there are sand dunes of the order of hundreds of metres across with ripples. There are dust deposits with material washed down from the canyons to the south. This is also a possible area for fossil water.

The alternative or back up site is the area of Tritos Lacus which is similar to the Prime area but where the material is likely to have been carried north from the equatorial highlands.

Prime B1 is at Cydonia. This is a flat stretch of plains where it is possible that water may be present during the summer for a few weeks. The area is smooth, possibly basalt, covered with dust and sediment. The back up site is Alba which is close to a major volcanic region.

The orbiters carry advanced television cameras. At closest approach of the spacecraft to the planet on each orbit these cameras will have a resolution of 50 metres per television line at an altitude of 1,500 kilometres. Each picture from the lander cameras will take 20 minutes to complete. It will not be possible to resolve a moving object therefore from the landers. However, the optical system enables close-ups of the far horizon pictures to be sharp.

The landing sites will be selected from the orbiter pictures which will watch for any onset of dust storms that might endanger the landing sequence.

The twin cameras will survey the landscape and near to the site to determine where to dig for samples. The scoop will collect a load and transfer this to a funnel on the top of the vehcile. From here it will fall into various processing sections where the analysis will be performed and the data relayed via the orbiters to Earth.

The cameras can be used for black and white pictures, colour and infra-red over three spectral bands. Also, the two cameras can provide a stereo effect. They are extremely versatile and can look at parts of the spacecraft, nearby objects as well as the panoramic scene.

Perhaps this conveys some of the excitement of this mission, that machines controlled from a distance of some 230 million miles and a time lag of more than 20 minutes between order and execution is now a normal part of modern technology.

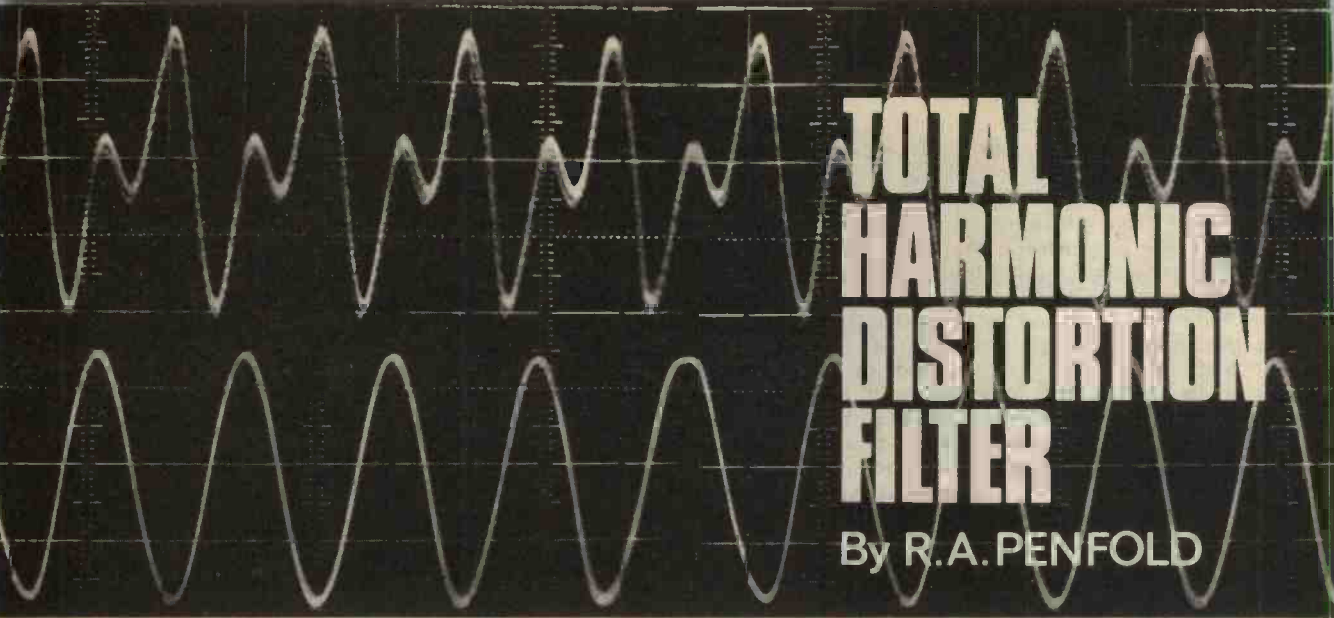
SOVIET ACTIVITY

In the excitement of the *Viking* programme it must not be forgotten that the USSR have two vehicles orbiting Mars and continuing to furnish data of the conditions. There will be expected an interchange of information from both projects.

A visit to the *Salyut 4* orbiting station was made on two manned occasions during its year in orbit and also one visit by an unmanned *Soyus 20* which was automatically linked up with *Salyut 4*. The complex is continuing to study near Earth space.

Another aspect of Soviet space spin-off concerns the material used for space suits. The USA were worried as to the suitability of the material used by the USSR for space suits and called for samples. The material is known as "Lola" and has a high heat resistance able to withstand temperatures up to 1,000 degrees C.

When the Americans made their tests it was found that the material was superior to the American material (which they insisted should be used on the combined task because of fire risk) in many ways not least the claim for Lola that it is stronger, has a good electrical insulator property and the almost casual claim that it is "only slightly affected" by a concentrated solution of 96% of sulphuric acid.



TOTAL HARMONIC DISTORTION FILTER

By R. A. PENFOLD

ONE of the most important parameters of an amplifier, perhaps the most important, is its level of distortion. It is therefore somewhat paradoxical that very few amateur electronic workshops are equipped to measure distortion.

The reason for this is almost certainly due to the high cost of a distortion meter, which is rather expensive even if home constructed. However, there must be many amateur workshops which are equipped with a high quality audio signal generator, and an oscilloscope and/or an a.c. millivoltmeter. These form the basis of distortion measuring gear, and few other items of equipment are required to enable distortion to be measured. In fact the only other major item of test gear that is required is a notch filter, and this article describes a very simple and inexpensive filter for use in measuring total harmonic distortion at 100Hz and 1kHz.

The unit is quite small and neat, and is completely self contained, power being supplied by an internal 9 volt (PP3) battery. As the current consumption is less than 2mA, the running costs are negligible, and even with extensive use the battery will have virtually its shelf life. The filter has been designed to be as simple to operate as possible, but prospective constructors should bear in mind that measuring distortion in amplifiers is necessarily a fairly complex process.

TYPES OF DISTORTION

There are two types of distortion for which figures are normally quoted in amplifier specifications: intermodulation distortion (i.m.d.), and total harmonic distortion (t.h.d.).

I.M.D.

I.m.d. is the more involved of the two and occurs when two or more signals are presented to a non-linear amplifier (any practical amplifier is non-linear to some degree). The distortion results in two main new frequencies being produced by the amplifier. If we take a simple example with only two input frequencies f_1 and f_2, the new signals are equal to $f_1 + f_2$ and $f_1 - f_2$, where f_1 is the higher of the two frequencies. The situation is little more complicated than this would suggest as the new frequencies interact with one another, and with the original two signals, and more new signals are produced. These then interact with one another, and so on, with a multitude of new frequencies being produced by the amplifier.

Measuring this form of distortion is, not surprisingly, very involved and probably beyond the scope of most amateurs.

T.H.D.

Total harmonic distortion is more straightforward and is the result of a single tone being processed by a non-linear amplifier. Here the distortion of the fundamental frequency produces harmonics at the output of 2f, 3f, 4f, 5f, etc. If, for example, a 1kHz tone is applied to an amplifier, signals at 2kHz, 3kHz, 4kHz, and so on, will be produced as a result of the t.h.d.

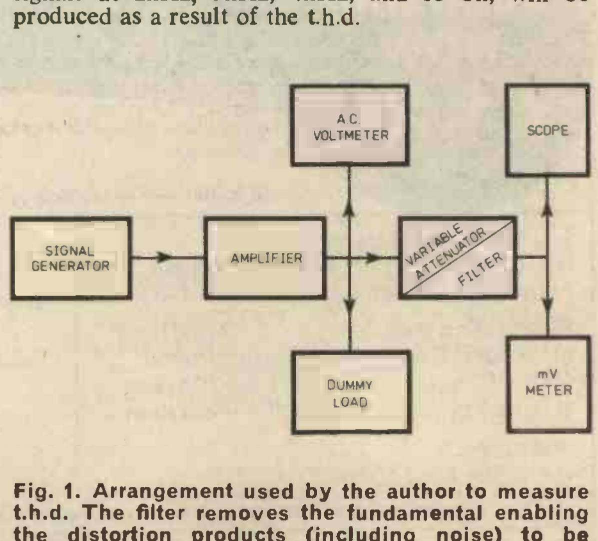


Fig. 1. Arrangement used by the author to measure t.h.d. The filter removes the fundamental enabling the distortion products (including noise) to be measured

MEASUREMENT OF T.H.D.

This type of distortion is much easier to measure, and the basic arangement used here is illustrated in Fig. 1.

A high purity sinewave is fed to the input of the amplifier from the signal generator. It is inevitable that the signal generator will have a certain amount of distortion on the output, and this distortion should be measured beforehand.

A dummy load resistor simulates the normal load impedance of the amplifier, and the voltmeter allows the output of the signal generator to be adjusted to give the appropriate power output level from the amplifier. The filter gives a narrow rejection notch at its operating frequency (we will assume this to be 1kHz in this example), and the signal generator is adjusted to this notch frequency.

The filter described here has two operating frequencies, and at the outset this is set to the one at which the distortion is not being measured so that the signal can pass unhindered. The attenuator is then adjusted to give a convenient reference level on the millivolt meter. 100mV or 1V r.m.s. will probably be the most convenient. 1V r.m.s. is about the maximum the filter can handle without clipping the signal and giving misleading results.

If the filter is now switched back to 1kHz it can be critically adjusted to give the lowest possible reading on the millivoltmeter. The signal generator frequency control will probably need some small adjustment as well, and the scope is very helpful in obtaining the correct settings. This procedure will be described in greater detail later.

CALCULATIONS

When these adjustments have been carried out properly the fundamental frequency will have been virtually eliminated, and only the distortion and noise will remain. From the reading on the meter the distortion factor can be calculated and is equal to:

$$\left(\frac{\text{Millivoltmeter reading}}{\text{Reference level}} \times 100\right) - D$$

(Where D is the percentage distortion of the signal generator.)

This gives the distortion factor as a percentage. The distortion factor is equal to the t.h.d. plus the noise present. The percentage of t.h.d. can be found by calculating the distortion factor, and the noise level as a percentage of the output level at which the measurement was made:

$$\left(\frac{\text{Output noise}}{\text{Voltage measured across dummy load earlier}}\right) \times 100$$

The percentage of t.h.d. is equal to the distortion factor minus the noise level.

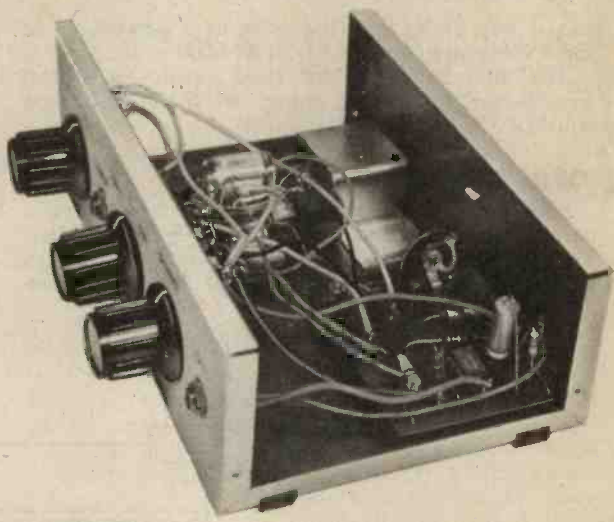
EXAMPLE OF A T.H.D. CALCULATION

The following example may help to make this a little clearer. Assume that we wish to measure the t.h.d. level of an amplifier delivering 2 watts r.m.s. into an 8 ohm load at 1kHz.

First the signal generator is set to 1kHz and adjusted to give a reading of 4 volts r.m.s. on the voltmeter. An 8 ohm (8·2 ohms will do) resistor is used as the dummy load. The filter is switched to the 100Hz position and the attenuator is adjusted to give a convenient reading on the millivoltmeter, say 1 volt r.m.s. The filter is then switched to the 1kHz position, and then both it and the signal generator are adjusted for the minimum fundamental output.

If, for instance, this leaves a reading of 15mV on the millivoltmeter and the signal generator has a distortion level of 0·2%, then the distortion factor equals (15 × 100/1,000)−0·2 = 1·5−0·2 = 1·3%.

The signal generator is then switched off and the millivoltmeter is used to measure the output noise of the amplifier directly at its output terminals. If



COMPONENTS . . .

Resistors

R1	22kΩ	R5	47kΩ
R2	150kΩ 5% or better	R6	4·7kΩ
R3	150kΩ 5% or better	R7	4·7kΩ
R4	100kΩ	R8	1·2MΩ

All resistors 10% carbon ¼W unless otherwise stated

Potentiometers

VR1 100kΩ lin carbon pot
VR2 100kΩ standard vertical preset
VR3 10kΩ lin carbon pot

Capacitors

C1 10μF 10V elect
C2 1nF polystyrene or mica, 5% or better
C3 10nF polystyrene or mica, 5% or better
C4 10nF polystyrene or mica, 5% or better
C5 1nF polystyrene or mica, 5 % or better
C6 20nF polystyrene or mica, 5% or better
C7 2nF polystyrene or mica, 5% or better
C8 16μF 10V elect

Integrated circuit

741C operational amplifier in 8-pin DIL package

Miscellaneous

Metal instrument case, Samos S3 (Doram)
3-way 4-pole rotary switch. Aluminium for battery bracket
Three control knobs. PP3 battery and battery clips to suit
Two 3·5mm jack sockets
0·1in matrix Veroboard

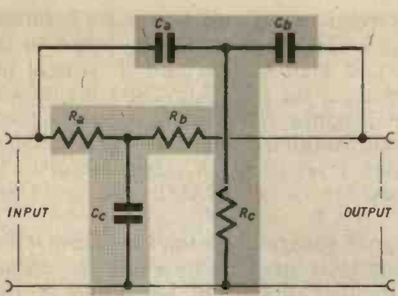


Fig 2. The basic "Twin-Tee" notch filter

this is, say 8mV, then the noise as a percentage of the 4 volt output level is $8 \times 100/4{,}000 = 0{\cdot}2\%$.

The total harmonic distortion equals the distortion factor minus the noise, which in this case equals $1{\cdot}3\% - 0{\cdot}2\% = 1{\cdot}1\%$ t.h.d.

TWIN-T NOTCH FILTER

Probably the most simple filter that will give a narrow rejection notch is the twin-T notch filter. The circuit of a twin-T notch filter is shown in Fig. 2, and it should be apparent from this how the filter derives its name.

In order to give a good performance the components used in the filter should have a tolerance of 5% or better.

One drawback of this filter is that it attenuates the second harmonic by almost 6dB, and would also significantly reduce the noise from the amplifier. This would give rather an optimistic assessment of an amplifier's performance.

PRACTICAL FILTER

It is possible to improve the performance of a filter by including it in either a positive or negative feedback loop of an amplifier, depending upon which aspect of performance one wishes to improve. Here we wish to obtain a flatter response near to the resonant frequency of the filter, and this is achieved by the use of negative feedback. The circuit diagram of a practical filter employing this technique is shown in Fig. 3.

VR1 is the variable attenuator, and from here the input signal is fed to the input of the twin-T filter via C1 and R1. There are two sets of capacitors in the filter, and these can be switched by S1 to give a notch at either 100Hz or 1kHz. S1 also operates as the on/off switch. The lower value resistor of the network is made variable so that the circuit can be adjusted for optimum results.

The ouput of the filter is fed to an amplifier using a type 741 i.c. operational amplifier. As a single supply rail is used, a potential divider formed by R6 and R7 is necessary to act as a centre tap on the supply to bias the non-inverting input of the i.c. The circuit operates as an inverting amplifier with R4 and R8 setting the gain at 12.

SECOND FEEDBACK LOOP

There is, however, another feedback loop via R5. Thus as the attenuation of the filter increases towards its resonant frequency, the negative feedback is reduced and the gain of the circuit is increased. This counteracts the losses in the filter and gives a flatter response.

At, and very close to, the resonant frequency of the filter, the losses in the filter are extremely large, and the feedback is unable to significantly compensate for these with the maximum closed loop gain of the 741 circuitry set at only 12 by the first feedback loop.

The overall response of the circuit is therefore exactly what is required. It is flat over (and beyond) the audio frequency spectrum, except for a narrow notch of extremely high attenuation at resonance. The overall gain of the circuit is a little more than unity.

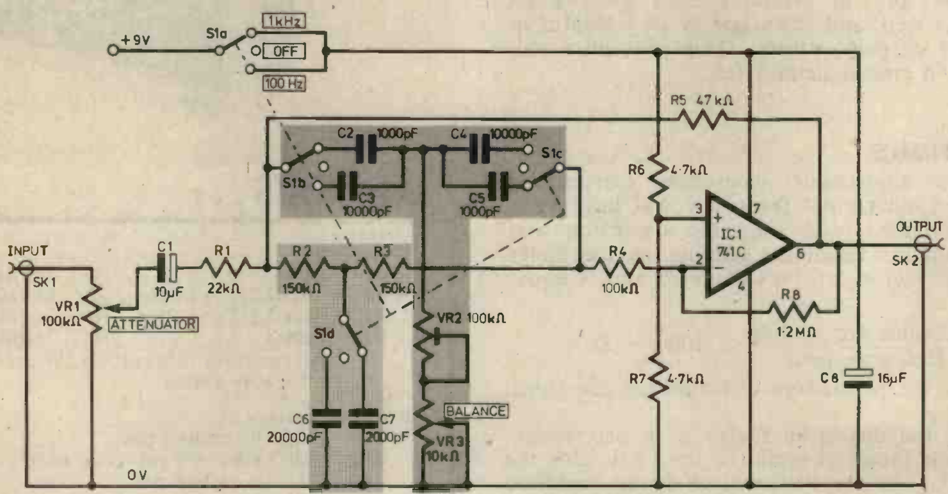


Fig. 3. Full circuit diagram of the filter

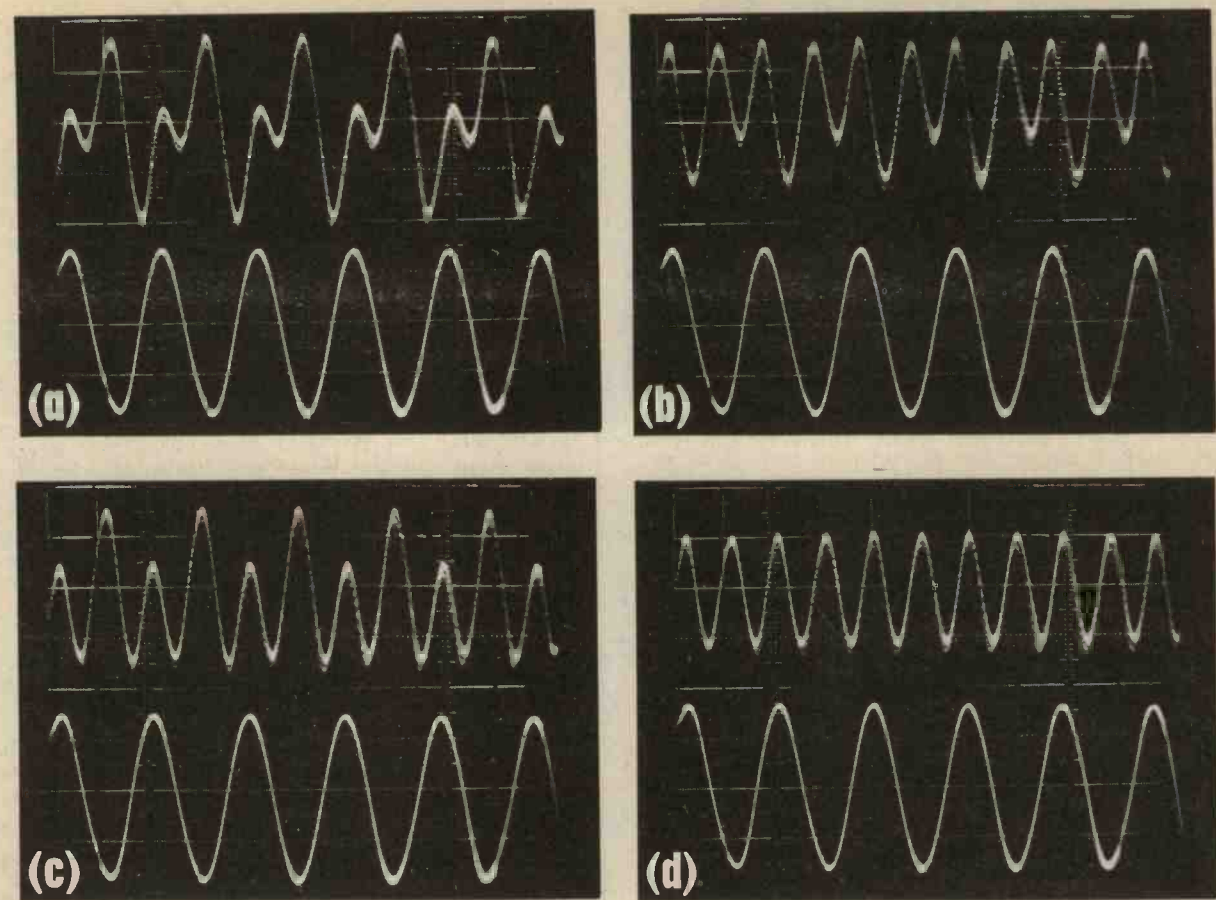


Fig. 5. Typical oscilloscope traces obtained using the filter: (a) balance control set roughly correct; (b) balance control adjusted to align tops of waveforms; (c) signal generator frequency then adjusted to align bottoms of waveforms; (d) distortion (predominantly second harmonic) and residual noise with fundamental notched out. The sinewave input is at 1kHz and the measured level of distortion is 1%

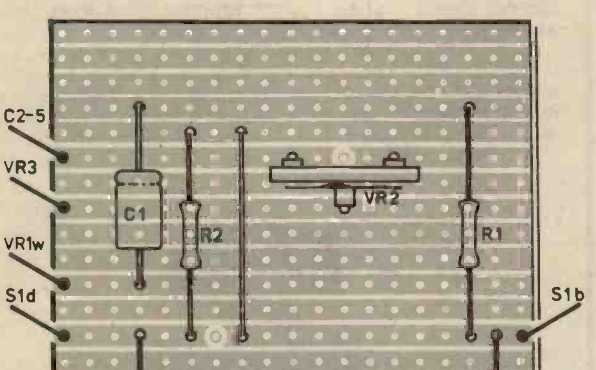


Fig. 4. Veroboard details and component layout

CONSTRUCTION

A ready made steel instrument case having outside dimensions of 150 × 100 × 50mm provides a suitable housing for the unit.

Most of the small components are mounted on a piece of 0·1in Veroboard having 24 strips by 19 holes. Full constructional details of this panel are shown in Fig. 4. No socket is required for the i.c. Veropins are used where connections are taken to the controls, sockets, etc. C2 to C7 were mounted on S1 on the prototype.

The general layout of the interior of the case is straightforward but make sure that the Veroboard panel is mounted in a position which enables easy access to the adjustment of VR2. A small mounting bracket for the battery is easily fabricated from a scrap of aluminium and glued in position.

ADJUSTMENT

Before the completed unit is ready for use, VR2 must be given the correct setting. To do this, connect a signal generator tuned to 1kHz to the input of the filter, and set the function switch of the filter to the 1kHz position. Set the slider of VR2

at the position which gives the lowest indication on an oscilloscope or millivolt meter connected to the output of the filter. VR3 should be set at its midway setting during this operation.

Now adjust the signal generator frequency control slightly either side of its initial setting in an attempt to obtain a still lower reading from the output indicator. Then readjust VR2 for the lowest possible output. Continue this procedure until no further improvement can be obtained. VR2 then has the correct setting.

USING THE FILTER

The rejection notch of the filter is very narrow and the adjustment of the input frequency and the balance control of the filter is quite critical. If the filter's output is being monitored by an oscilloscope, the following procedure can be adopted in order to quickly arrive at the correct settings of these controls.

With the controls set at roughly the right settings a waveform something like that of Fig. 5a should be obtained. The balance control is then adjusted so that the tops of the waveforms of the fundamental and first harmonic are aligned, as shown in Fig. 5b. The input frequency is then adjusted to align the bottoms of the waveforms (Fig. 5c). The balance control is then once again used to align the tops of the waveforms, as this whole sequence is repeated several times until the fundamental is almost completely suppressed, leaving only the noise and distortion (Fig. 5d).

NECESSARY EQUIPMENT

It is not absolutely essential to have an oscilloscope to monitor the output, but obviously this greatly simplifies and speeds adjustment of the equipment, and is the only way of being completely sure that the fundamental has been adequately suppressed. Also, it is not absolutely essential to have a millivoltmeter to measure the output, as most oscilloscopes will be capable of measuring the filter output level. If the distortion incudes a large amount of second harmonic distortion, however, it may be difficult to gauge the r.m.s. output level as it will not be a definite fraction of the peak to peak level, as is the case with a sinewave signal.

The signal generator needs to be a good quality type and should really have a distortion level less than 0·2% if accurate measurements are to be possible. The generator's distortion factor is measured using the set-up of Fig. 1, but of course with no amplifier intervening between the filter and the signal generator. ★

PE KIT REPORT

INTEGRATED injection logic (I^{2}L) is a fairly recent technology which many might have heard of in relation to the microprocessor.

In the beginning the areas of application envisaged embraced many of the products now made in CMOS, MOS and some low power TTL. Wristwatches were an obvious area of involvement since two of the advantages of I^{2}L are low power and low voltage requirement such as provided by small Mallory cells.

The recently announced Sinclair "Black Watch" kit utilises an I^{2}L i.c. and lays at once that bane to all MOS users—static electricity! There are actually no handling precautions necessary so it was with a gay heart *and* a nylon shirt that I got to constructing this.

ASSEMBLY INSTRUCTIONS

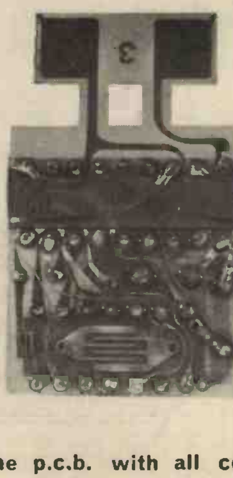
At £17·95 it's obvious that an awful lot of people will have a go at this kit so simplicity in assembly instruction is paramount.

A component list allows you to first check the kit contents and to familiarise yourself with their shapes and identities. Tool requirements are next; soldering iron (suitably earthed), small wire cutter, fine-nosed pliers and non-metallic trimming tool.

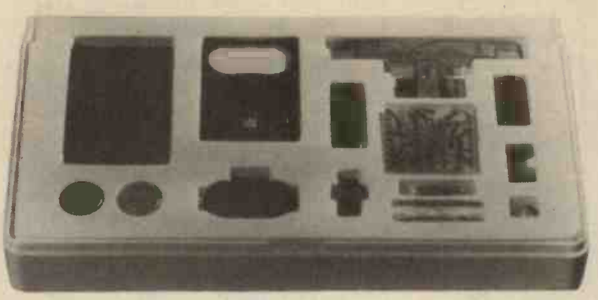
It should go without saying that anyone attempting an assembly of watch dimensions should have a steady hand and reasonable eyesight. An extension lamp and watchmaker's eyepiece is an ideal aid to this.

Of course, the iron is the most important tool. The bit should be small, $\frac{3}{32}$in is the best size. Recommended types are the Weller Marksman, Adcola Adamin or Antex CN. These should be earthed.

It is at this point, when you have piece-parts and tools, to really read the instructions. Besides those on assembly there are some on using the watch which have important figures and there is also a separate addendum on bending details for a copper shield which can be easily overlooked.



Underside of the p.c.b. with all components assembled



sinclair BLACK WATCH

PUTTING IT TOGETHER

Since there is no circuit diagram, the only concern is relating, with the correct orientation, the component parts to the p.c.b. provided. This little square is your work area and familiarisation with its copper geometry is to advantage. After preparation with varnish (solder and grease are also provided) the trimmer and capacitor are added. There is no need to pre-tin anything as the copper, leads and solder all showed a great affinity. When soldering in the quartz crystal an urgent iron is needed as overheating can be detrimental.

DISPLAY AND I.C.

The display has 14 pins and it is important to get the orientation right and this means picking out pin 1. An arrowed scale-of-two enlargement parades this in the instructions. All subsequent handling of the p.c.b. should be with care as the plastics lens can easily be scratched.

And so on to the 18 pin d.i.p. i.c. The massive indent solves the orientation problem. Again a quick iron is needed. Part of the assembly time on this is spent in wrapping around a flexible p.c.b. which mates with one line of pins and provides contact pads for the batteries and touch pads for hours/minutes and minutes/seconds displays. This can be seen in the photograph.

It remains to check whether the electronics are "go". A bulldog clip is needed to make connection to the Mallory cells. You can't confuse the polarities as the clip, cells and p.c.b. are all shown in graphic perspective union in the literature. It remains to make metallic contact with the touch pads.

My watch worked first time which is an endorsement to the excellence of the parts and the instructions. Obviously there will be people who will be disappointed at this point either through faulty components or an excess of zeal. Whatever—Sinclair provide a service guarantee for a charge of £3·50; this does not cover the cost of replacement parts, refundable if their components are at fault. The completed watch is covered by a one year guarantee.

ADJUSTMENT

After a 24-hour "burn-in" the copper shield is box-fashioned and slid over the module. The watch can now be accurately adjusted against a time signal (TIM or radio). At the trimmer, approximately 10 degrees of rotation will produce a change of one second a day.

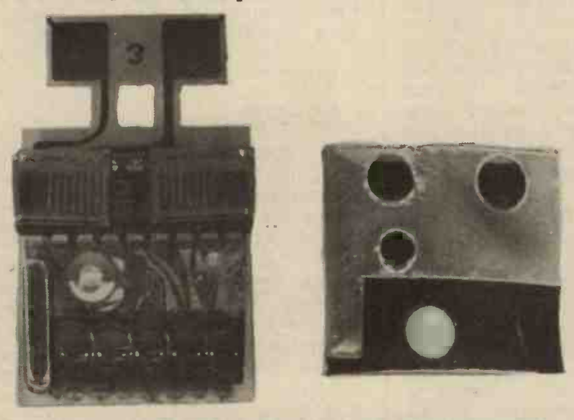
The module is now ready for case assembly which is simple and adequately described in the literature.

SIZE

In common with most digital matches, the "Black Watch" does cover a large area of the wrist. This with its box styling and plastic structure would seem to make it liable for easy damage.

The conventional analogue watch is reassuring with its protective shockproofing and waterproofing and the habit of assessing a watch by these criteria dies hard.

However—accuracy is what timekeeping is all about and Sinclair does guarantee this to within a second a day with the possibility of improvement with adroit twiddling of the trimmer. G. G.



The assembled watch module and copper surround. It is essential that all components are closely seated on the p.c.b. and all lead ends cropped short or the copper screen will not fit. It is expected that the screen will be omitted from future kits with circuit modification.

£17·95 inc VAT

INDUSTRY NOTEBOOK

By Nexus

COMMUNICATIONS

This year's Communications '76 Exhibition and Conference at the Metropole Convention Centre, Brighton, will be the shop window for what the British do best in electronics—communications. And so they should, having been first in the field.

The event is in June and already there are more exhibitors than for the last show in 1974 and they have booked more than double the floor space so that an additional hall in the Centre has been taken to accommodate the latecomers.

Ninety-nine learned papers are to be read. This, unhappily, means parallel sessions with up to three papers being presented simultaneously in different locations, leading to a measure of frustration. There are to be four incoming trade missions consisting of senior communications executives from 40 different countries and they will tour British industry as well as attend the exhibition.

Among the social events is a reception by Brighton Corporation's Mayor and Mayoress in the historic Royal Pavilion. Will it all lead to substantial new business? There will be well over 100 exhibitors and all expect to do well.

QUICK TUNING

With so much emphasis these days on satellite and microwave link communications, high-frequency radio tends to take a back seat but I am pleased to report that h.f., on which so many of us cut our teeth, still has plenty of life, not only operationally in the congested h.f. bands but also in new business. Marconi Communications has recently announced a new h.f. amplifier to be known as the H1140. It is a further development of the Marconi Self Tuning (MST) range and gives a mean or p.e.p. output of 10kW over the range of 1·6MHz to 30MHz. Input requirement may be any frequency within the range at any level between 50mW and 150mW.

The key feature, however, is that it tunes itself to any frequency in typically three seconds with no knob twiddling. Of course, Marconi is not alone in providing this type of feature which enables quick band changing either to overcome propagation variations or for security reasons.

Ten of the new h.f. amplifiers have been sold through NATO for installation at the Crimond Naval station to the north of Aberdeen. Due for delivery early in 1977, they will be used in a five-pair configuration to beef up NATO communications for Allied navies in Northern Waters. A subsequent NATO order, announced only a week later, is for low frequency drivers and amplifiers for Crimond. The first order was worth £400,000, the second £200,000.

Nice business for starters, and the NATO endorsement is excellent for future business of which Marconi expects plenty.

TV SAT-HOME LINK

The European Space Agency is pressing on with feasibility studies on direct colour-TV reception in the home from satellites. At present TV via satellite comes in to big receiving complexes like Goonhilly, then relayed to your local TV station and re-transmitted from there. The idea is that individual viewers should be able to receive the TV transmission direct from the satellite.

Well, there's nothing really to stop you doing that now if you are prepared to invest a million pounds or so in building a steerable 85ft diameter dish antenna in your garden, together with cooled parametric amplifiers and all the rest of the paraphernalia associated with space communications.

The reason why the big dishes are necessary is because of the comparative feebleness of the power transmitted from space, dictated by the type of payload put in orbit and the available power supplies. It follows that if you reduce the size of the earth dish to something that could be mounted on the roof or outside a window, the collecting area for the signal is so much reduced that, for the same results, the satellite must generate much more power.

So the drive is now on to get more powerful transmission from space, the target being 2kW of prime power and this brings its own problems, in the space environment, of thermal dissipation and equipment protection. Marconi Space and Defence Systems, who have a study contract from the European Space Agency, report that European development of high power travelling wave tubes is well advanced with 1kW already achieved in the allocated band of 11·7 to 12·5GHz.

The home receiver will have a mass-produced dish some 2½ft in diameter, expected to be plastic with a metallized reflective coating on the business side. There will, of course, also have to be an amplifier and frequency conversion equipment to feed a standard TV set.

POLICEMAN'S LOT

The policeman's lot is not a happy one. With terrorism added to rising figures for what we might call conventional crime, the workload is escalating and the need for quick response greater than ever. It is no wonder that police forces are investing in computerised command and control systems of a complexity approaching that used in military defence headquarters. The problems are the same in kind, differing only in detail.

Among the new installations now being fitted are one for the Suffolk Police and one for the Metropolitan Police. Suffolk is to use a system based on a GEC 4080 computer and the Metropolitan force one based on Data General hardware. Contractors, respectively, are Marconi Space and Defence Systems and International Aeradio Ltd.

Both systems make extensive use of visual display units as the interface with the computer and the IAL system, called RADIAL, also projects a map of the incident area for instant and accurate location data on which to base action.

LASERS

A recent building exhibition in London showed a remarkable penetration of laser technology into what is normally regarded as an industry conservative in outlook. There were laser plumb-lines, lasers for pipe-laying and trench digging, for distance measuring and for floor and ceiling alignment.

Another popular application is in meteorology and, in the electronics industry itself, Teradyne reports that there are now more than 30 automated laser trimmer systems, for hybrid microcircuitry, of their manufacture installed in Europe. Biggest users, however, are still the defence forces for range-finding, target-marking and weapon guidance.

Next Month...

Don't miss the variety of interests covered in this BUMPER ISSUE—

including Special 8 PAGE SUPPLEMENT

SOUNDS EXTRAORDINARY

Surveys the various sound effects units currently in use. Defines terms, explains operation and outlines the circuit arrangements used to create these amusing, amazing, and sometimes quite startling, effects

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A most useful and easy to use instrument invaluable to all who work with logic circuits. Seven segment l.e.d. gives precise indication of steady state logic, and pulse decimal point indicates high speed switching

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An add-on unit for electronic musical instruments such as organs and synthesisers to give a wide range of interesting effects. Four controls give a multitude of different envelope shapes which will greatly enhance the range of sounds within your capability

SHOOT

Fun for all the family with this fascinating game to test your speed of re-action. All you have to do is to "hit" a moving light as it moves along a row of light emitting diodes, but each time you "miss" the game gets harder

PRACTICAL

ELECTRONICS

APRIL ISSUE ON SALE MARCH 12, 1976

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It is in *your* interest to place a firm order with your newsagent—in advance. Back numbers are not available, so make sure of your copy now!

SEMICONDUCTOR UPDATE

□ □ □ By R.W. COLES

1720R
1723R
MC14419
8038

THE BIG RED "ONE"

Ever since l.e.d. displays of the seven-segment variety first saw the light of day, they have suffered from one serious drawback—size—or rather, lack of it! The usual size range for early devices was about 2·5mm to 7·5mm character height, which meant that a good pair of eyes and/or a magnifying lens were required for easy reading.

Of course, there are applications which require this diminutive sort of display, but manufacturers have been constantly aware of their inadequacies in this department and have been striving to compete with the larger Minitrons and Nixie tubes for the lucrative slice of the market which includes all those of us whose vision is not quite what it used to be!

The first step in the right direction came in the form of the 15mm "Jumbo" devices which use the light-pipe technology to channel the light from single-point source l.e.d. chips into fair sized segments. This light-pipe success has now been followed by an even bigger 25mm display which is easily visible over a 20m viewing distance.

This new "King-size" device is made in the U.S.A. by a firm called Industrial Electronic Engineers Incorporated but is available in the United Kingdom from the rather more familiar "Perdix Components Ltd." It is produced as a common anode type **(1720R)** or a common cathode type **(1723R)** and comes in a 14-pin package with 15mm row spacing so that it can go into a standard 24-pin d.i.l. socket. Each segment is lit from not one but two l.e.d. chips in series so that the forward voltage per segment is about 3·3V at 20mA.

KEY CODER

It is the modern trend to replace conventional knobs and switches with a calculator style keyboard. This approach can cut out a lot of hardware for the extra cost of a handful of logic and analogue chips, and lends itself well to the all-powerful l.s.i. technology with its promise of extremely low prices for large quantities.

Signal generators, even power supplies, can now be obtained with an l.e.d. display and a functional key-pad as the only external sign of the "goodies" within. To select, say, a frequency and output level on a signal generator of this type, one would simply punch in an appropriate string of digits to get an instant response, with no necessity for knob twiddling at all!

This is all very well for the larger manufacturer, but the sad fact is that the nuts, bolts, and dial-cord approach has still been the only solution for us amateurs, or has at any rate, until now. The range of c.m.o.s. logic systems produced by Motorola has been mentioned before in this column, and a new addition to this range, the **MC14419**, looks like being the start of a breakthrough which will result in keyboards sprouting in the most unlikely places.

The MC14419 is the answer to the keyboard-fancier's dreams, since it combines in one easy-to-use 16-pin d.i.l. package:

A 16 key-to-binary encoder.
A rollover protection circuit.
A delay circuit for key de-bouncing.
A strobe pulse generator.

The key switches required are of the simple "push-to-make" type arranged as a 4 × 4 matrix, and with a full sixteen keys to play with, there is plenty of scope for control functions, decimal points, and arithmetic operators in addition to the ten numeric keys normally employed.

VERY FUNCTIONAL

My next offering is an integrated circuit which has been around for about a year now, but, surprisingly, has not had the coverage it deserves.

I am referring to the **8038** function generator introduced by Intersil, and even if you have heard of it before I am sure that you will agree that it is worth a second look (Fig. 1).

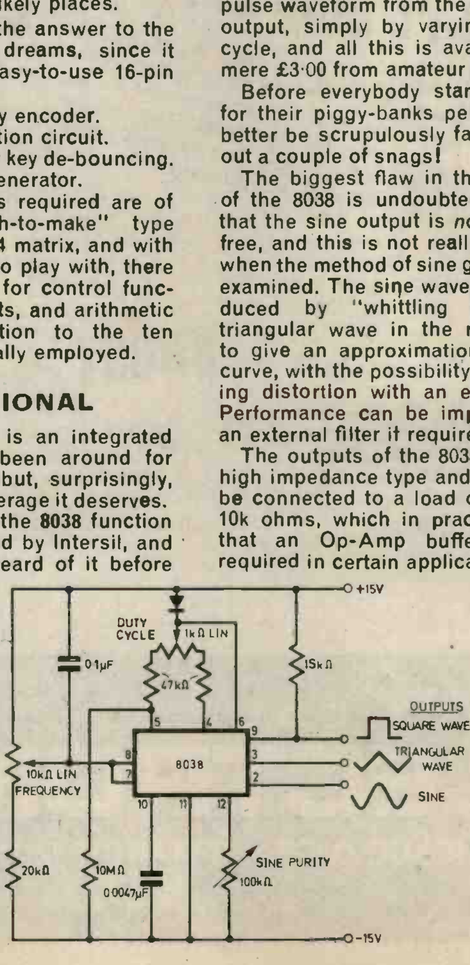
The 8038 is a chip with universal appeal for electronics enthusiasts, because whether you are a "Logic person" or an "Audio person" you will find it hard to resist a single integrated circuit which gives simultaneous sine, square, and triangular wave outputs over the frequency range 0·001Hz to 1MHz. If those features are not enough to make you an instant fan, then perhaps the fact that a voltage controlled input is provided to facilitate frequency modulation or frequency sweeping, will do the trick. For the sacrifice of the sine output you can also generate a sawtooth from the triangular output and a pulse waveform from the squarewave output, simply by varying the duty cycle, and all this is available for a mere £3·00 from amateur suppliers.

Before everybody starts reaching for their piggy-banks perhaps I had better be scrupulously fair and point out a couple of snags!

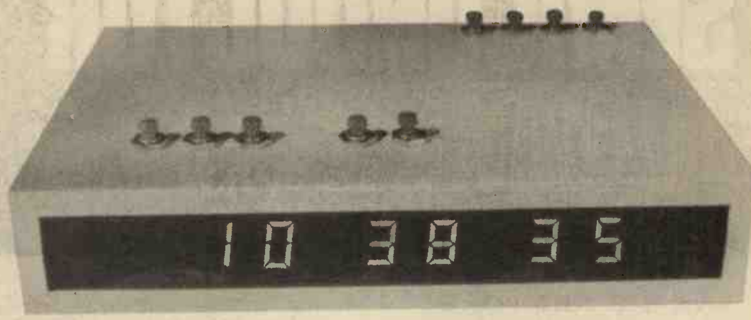
The biggest flaw in the operation of the 8038 is undoubtedly the fact that the sine output is *not* distortion free, and this is not really surprising when the method of sine generation is examined. The sine waveform is produced by "whittling away" the triangular wave in the right places to give an approximation of a sine curve, with the possibility of minimising distortion with an external pot. Performance can be improved with an external filter if required.

The outputs of the 8038 are of the high impedance type and should not be connected to a load of less than 10k ohms, which in practice means that an Op-Amp buffer may be required in certain applications.

Fig. 1



CAR/ CARAVAN CLOCK



PART TWO ADDITIONS TO THE BASIC DESIGN

★ *Mains operation plus Latch and Controller facilities*

By M. Fischer*

A simple and attractive mains only digital alarm clock can be constructed using the clock PCB (PCB2) and the display PCB (PCB3) included in last month's car clock. The changes in design involve the addition of three rectifier diodes and a 50Hz diode to PCB2 changing the value of segment current limiting resistors (R29–R35), and of course adding a mains transformer.

POWER SUPPLY DESIGN

Two supply lines are required providing 14V at 20mA and 6V at 500mA as seen in Fig. 12. The capacitors are needed in both versions.

For the V + (4) supply, when pin A of T1 nears its maximum positive voltage with respect to pin C, diodes D3 and D1 conduct to charge C1, providing a half-wave rectified and smoothed 14V for the MK50253 positive supply.

For the V + (2) supply, D1 and D2 cause a full wave rectified voltage at V + (2) with respect to 0V, with a peak voltage of approximately 7V. The current flowing between V + (2) and 0V is so large that C2 provides little smoothing and the ripple voltage is about 5V. This causes a 100Hz ripple in the display brightness, which is, however, invisible to the human eye.

If V + (2) and V + (4) had been obtained from, say, a single full wave rectified and smoothed supply, as has been the case in most other clock designs, four rectifier diodes would have been required instead of three, and C1 would have had to be increased to 2,500μF. This would have changed the peak current through T1 from 0·5A to about 5A, which would have required a transformer with a rating of about 12VA rather than 6VA.

CHOICE OF TRANSFORMER

There are several 6V-0-6V, 6VA miniature transformers on the market but constructors are warned that those tried got fairly hot in mid-summer, even with no load. The various manufacturers told us that, in order to build a miniature transformer with

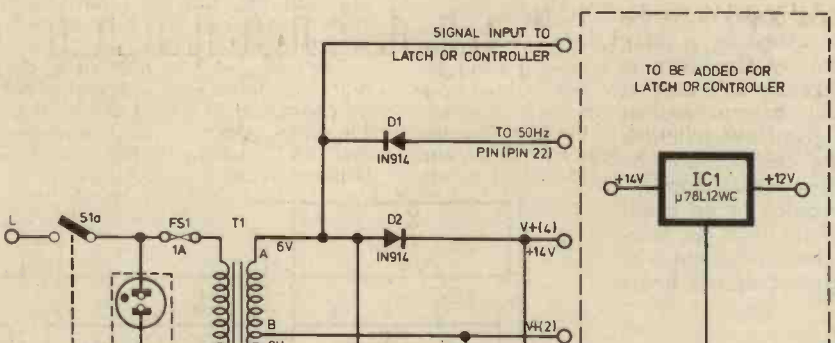


Fig. 12. Mains p.s.u. and added regulator for Latch and Controller circuits

COMPONENTS . . .

POWER SUPPLY

Capacitors
C1–C2 100μF elect. 25V (2 off)

Semiconductors
IC1 μA 78L12WC (if required)
D1–D4 1N914 (4 off)

Transformer
T1 6-0-6V, 6VA miniature mains transformer (Sintel, 53b Aston St., Oxford)

Switches
S1—Double pole mains on/off.

*Sintel

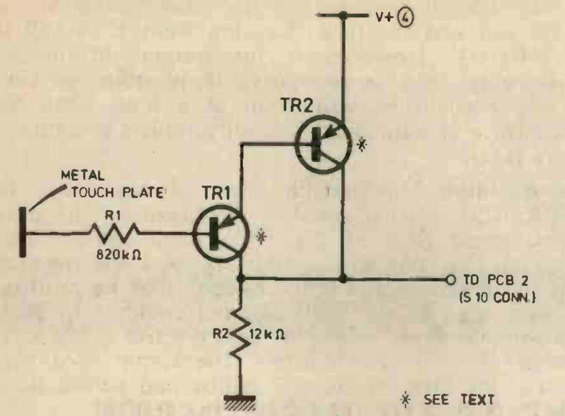


Fig. 13. Touch switch snooze control

a low variation in output voltage with load, the transformer has to be made "loosely", and hence runs hot. As this application can tolerate large percentage changes in transformer voltage, we have had some wound on a high-efficiency core, with low loss windings. This transformer runs remakably cool, and we do not recommend that constructors use any other if building the clock in the case specified.

TOUCH SWITCH SNOOZE

Those who want the magic of a touch switch snooze control can mount the components shown in the circuit diagram in Fig. 13 on a small piece of Veroboard.

When the touch plate is touched with a finger, the 50Hz signal picked up by the body causes the Darlington pair TR1 and TR2 to switch on and off at 50Hz, providing positive pulses for the snooze control. The touch plate can be any metal object such as a screw, etc. When the snooze is activated, the alarm tone disappears for about ten minutes.

These are two functions which allow the mains clock to be used as more than a simple clock.

DISPLAY LATCH

The Display Latch adds a digital memory to the clock so that, when a button is pushed or a relay contact is closed, the time shown by the clock is stored in a memory, without affecting the normal operation of the clock. Switching is provided so that at any time, either the time given by the clock chip or the time contained in the memory can be displayed. So far we have used this in two applications. In the first, the unit was needed as an event timer to record the exact time of faults in an electrical sub-station. In the second the instrument was needed to record the finishing time of sailing boats in a boat race.

CONTROLLER

The Controller turns the digital clock into a time switch. Typical applications in mind were to use a dual unit to control a Video Tape Recorder with a facility for a warm-up period, and an alarm to sound three times a day to remind personnel at a mail-order components company to get the mail to the local Post Office in time for the various collections.

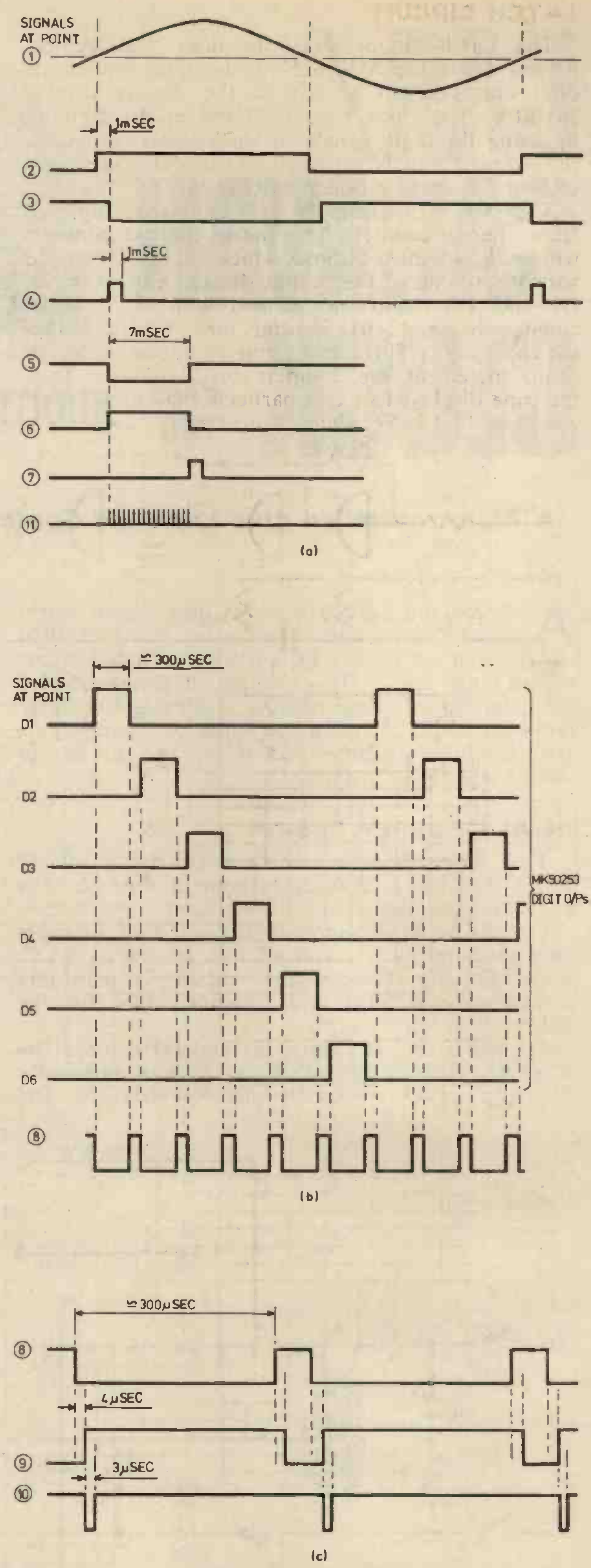


Fig. 14(a). Signals at points marked on Latch circuit (b) Signals at IC5/6 and (c) enlarged view of these at (8), (9), (10)

LATCH CIRCUIT

The Latch circuit takes the digit and segment drivers from the MK50253 and supplies alternate digit and segment signals to the display driving circuitry. The clock time is stored in the memory by using the digit signals to write seven bit words, the segment signals, into two CD4039AE's used as a six word × seven bit memory (Fig 14).

The MK50253 outputs are signals multiplexed from internal counters. This means that the counters will be incremented at times which are not correlated with the timing of the output signals. For example, D1 and D2 might be scanned with the internal counter being 12:01:59 and then before D3 is switched on, a 50Hz transition could occur which could increment the counters to 12:02:00. Thus the time displayed in this particular D1 to D6 scan would be 12:02:59, which is incorrect.

In normal practice this does not matter as the eye just sees the time changing from 12:01:59 to 12:02:00. However, if the output information is being held in memory, it is quite possible that it could be written in at a time when the sequence of outputs is misleading, unless precautions are taken.

A little experimenting has shown that the MK50253 internal counters increment on the positive going edge of the 50Hz input signal. This means that one can confidently load the memory if the loading starts long enough after the positive-going edge to allow the internal counters to settle down and finish before the next positive going 50Hz edge, 20 milliseconds later. The circuit used here loads the memory for a 7 millisecond period starting 1 millisecond after the edge in question.

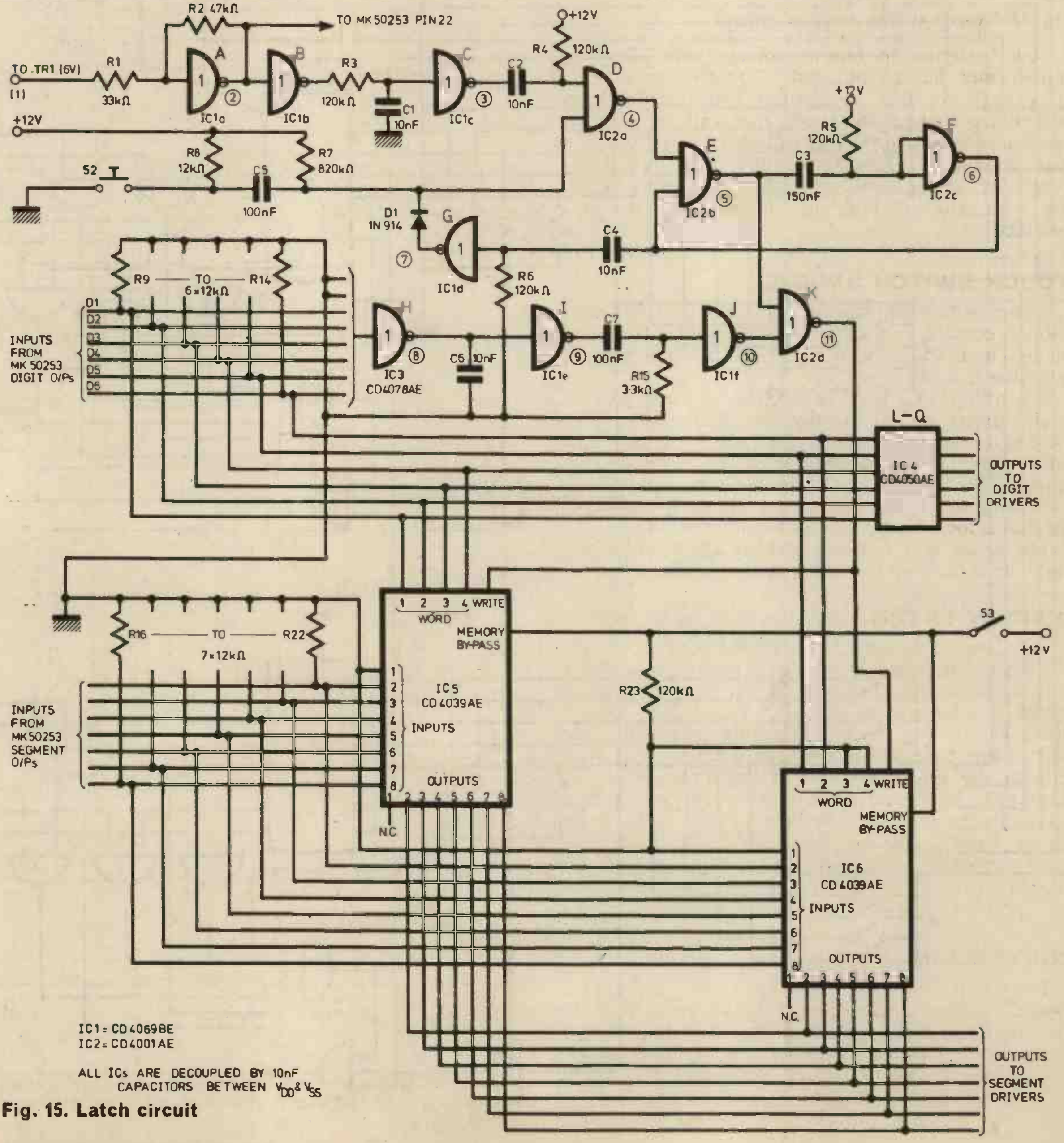
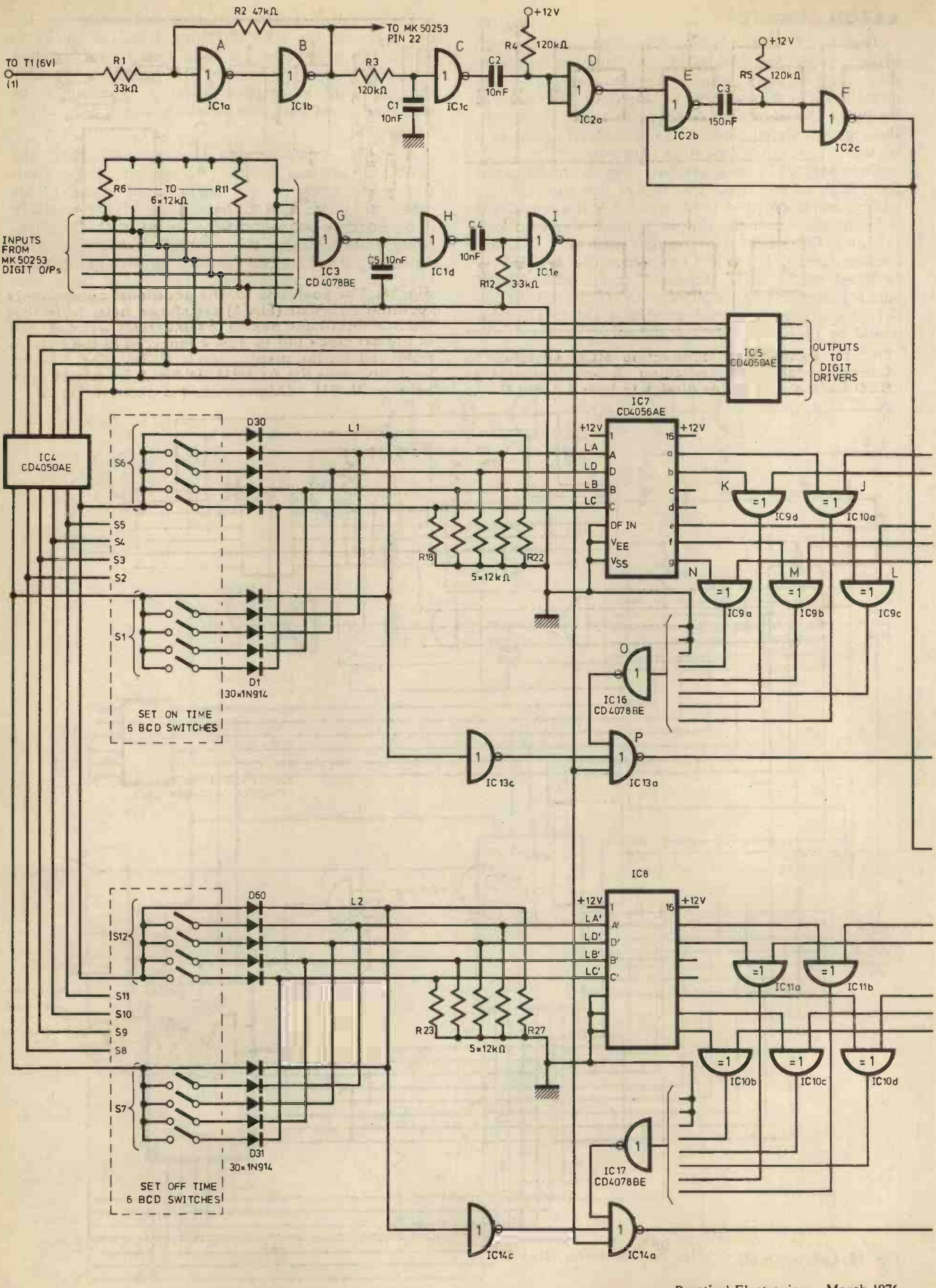


Fig. 15. Latch circuit



TO T1 (6V) (1)
R1 33kΩ
R2 47kΩ
TO MK 50253 PIN 22
R3 120kΩ
C1 10nF
C2 10nF
R4 120kΩ
+12V
C3 150nF
R5 120kΩ
IC1a
IC1b
IC1c
IC2a
IC2b
IC2c
R6 TO R11 6×12kΩ
INPUTS FROM MK 50253 DIGIT O/Ps
IC3 CD 4078BE
C5 10nF
IC1d
C4 10nF
IC1e
R12 3·3kΩ
IC5 CD4050AE
OUTPUTS TO DIGIT DRIVERS
IC4 CD4050AE
IC7 CD4056AE
IC8
IC9a
IC9b
IC9c
IC9d
IC10a
IC10b
IC10c
IC10d
IC11a
IC11b
IC13a
IC13c
IC14a
IC14c
IC16 CD4078BE
IC17 CD4078BE
D30
D1
30×1N914
D60
D31
30×1N914
L1
L2
R18
R22
5×12kΩ
R23
R27
5×12kΩ
SET ON TIME 6 BCD SWITCHES
SET OFF TIME 6 BCD SWITCHES

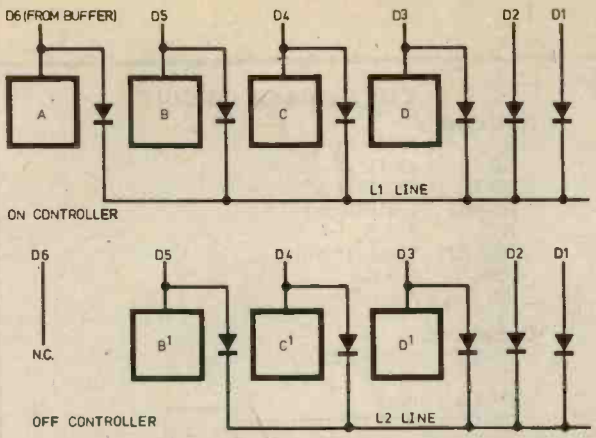


Fig. 17. Example of connecting BCD switches to Controller for on/off switching. A box indicates as BCD switch with series diodes to lines LA to LD

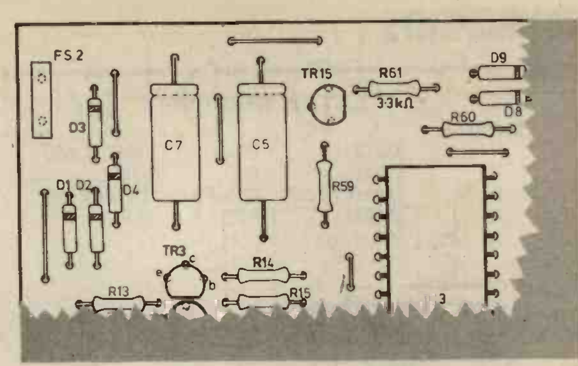


Fig. 18. The positions for the additional components required on PCB2 (Fig. 5) are shown here. Note that the rear right-hand pad on the underside was not used in the car clock but is now connected to the outside right pad on the display p.c.b. PCB4. The START l.e.d. becomes the ALARM ENABLE l.e.d. R61 is in series with S11. (Alarm circuit is given in Fig. 3)

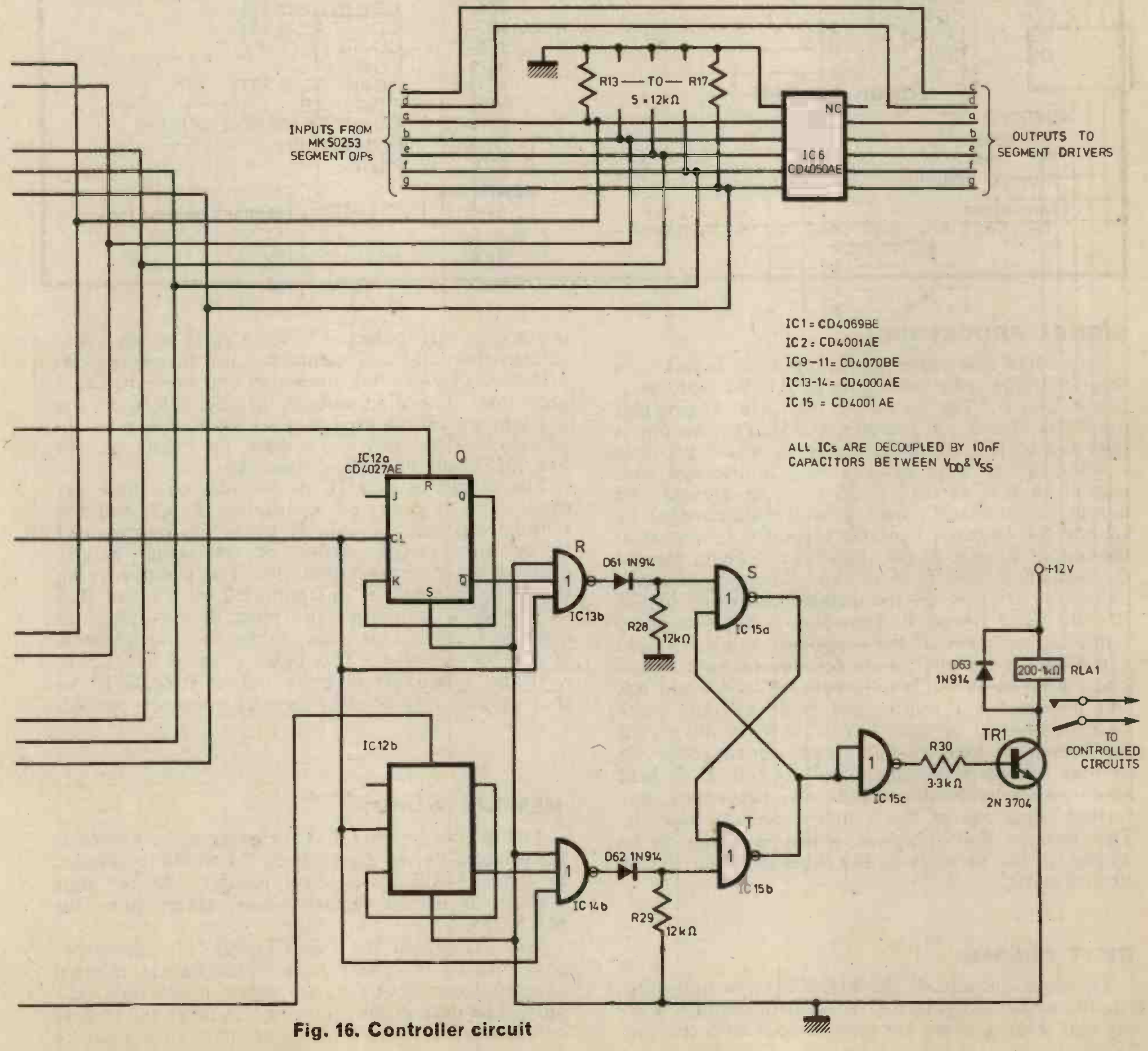


Fig. 16. Controller circuit

COMPONENTS . . .

LATCH CIRCUIT

Resistors

R1	33kΩ	R8–R14	12kΩ (7 off)
R2	47kΩ	R15	3·3kΩ
R3–R6	120kΩ (4 off)	R16–R22	12kΩ (6 off)
R7	820kΩ	R23	120kΩ

All 10% ¼W carbon

Capacitors

C1–C2	10nF (2 off)
C3	150nF ±10%
C4	10nF
C5	100nF
C6	10nF
C7	100nF
C8–C13	10nF (6 off) decoupling for i.c.s.

Semiconductors

IC1	CD4069 BE
IC2	CD4001 AE
IC3	CD4078 AE
IC4	CD4050 AE
IC5–IC6	CD4039 AE (2 off)
D1	IN914

TOUCH SWITCH

Resistors

R1	820kΩ
R2	12kΩ

10% ¼W carbon

Transistors

TR1–TR2 Any *pnp* small signal transistor—BC212 etc.

CONTROLLER CIRCUIT

Resistors

R1	33kΩ
R2	47kΩ
R3–R5	120kΩ (5 off)
R6–R11	12kΩ (6 off)
R12	3·3kΩ
R13–R29	12kΩ (17 off)
R30	3·3kΩ

All 10% ¼W carbon

Capacitors

C1–C2	10nF (2 off)
C3	150nF ±10%
C4–C5	10nF
C6–C22	10nF (17 off)

Semiconductors

IC1	CD4069 BE
IC2	CD4001 AE
IC3	CD4078 BE
IC4–6	CD4050 AE (3 off)
IC7–8	CD4056 AE (2 off)
IC9–11	CD4070 BE (3 off)
IC12	CD4027 AE
IC13–14	CD4000 AE (2 off)
IC15	CD4001 AE
IC16–17	CD4078 BE (2 off)
D1–D63	IN914 (63 off)
TR1	2N3704

Switches

S1–S12 BCD switches (as many as required)

Relay

RLA1 200Ω–1k 6–12V

SIGNAL PROCESSING

The 50Hz sine wave signal input (1) is fed to a Schmitt trigger gate consisting of R1, R2 and inverters A and B. The output of this gate (2) provides the 50Hz signal for the MK50253. This output is then fed to R3, C1 and inverter C, which provides a 50Hz square wave delayed by 1 millisecond with respect to that at (2). If S1 is being pressed, the output of inverter C, having been differentiated by C2 and R4, causes a 1 millisecond pulse to appear at the output of gate D (4). If S1 is not being pressed the output of gate D stays low. The 1 millisecond pulse then triggers the monostable consisting of C3, R5 and gates E and F, providing a negative going 7 millisecond pulse at the output of gate E (5) and a positive going one at the output of gate F (6). The output of gate F is differentiated by C4 and R6, and produces a 1 millisecond positive going pulse at the output of inverter G (7). If S1 is still closed the output of inverter G charges up capacitor C5 so that the corresponding input to gate D is held high, which holds its output low, preventing any further triggering of the 7 millisecond monostable. This ensures that the time which is going to be written in the memory is the time at which the S1 closure starts.

DIGIT PULSES

The digit outputs of the MK50253 are non-overlapping sequential pulses. The segment outputs' leading and trailing edges are synchronous with the corresponding digit pulses. The write pulse which writes information into the memory must therefore start after a digit pulse has gone high and finish before it goes low. The digit outputs of the MK50253 are fed into a CD4048 used as a six input NOR gate. Six 12 kilohm pull-down resistors are used as the MK50253 only pulls the outputs up.

The output of gate H (8) provides one pulse per digit. This is then fed to inverter I. C6 and the output resistance of gate H cause the output of I to be an inverted version of the signal at (8), delayed by 4 microseconds (9). The positive going edge of this signal is differentiated by C7 and R15 to provide a 3 microsecond pulse at the output of inverter J (10). This pulse fulfils the requirements of the "write pulse". This pulse is gated by gate K with the 7 millisecond pulse output of gate E, so that writing only occurs when S1 has been pushed.

MEMORY WORDS

The memory words that are going to be written in are selected by the digit signals D1 to D6 (connected to the CD4039 word select inputs), and the data written in is the segment data, taken from the MK50253.

With S2 closed the two CD4039's "memory bypass" inputs are held high. This causes internal switches to connect the data inputs to the data outputs. The data outputs are used to drive the display segment drivers (those of an ordinary mains clock).

Thus with S2 closed the display shows the ordinary time. With S2 open, the memory outputs will be the information selected by the word select inputs in the same way as during writing. Thus the display will now show the time stored in the memory.

A hex buffer (buffers L, M, N, O, P, Q) is used to buffer the signal to the clock digit drivers. No buffer is required on the CD4039 outputs as these have a high current sourcing capability. When no word of a CD4039 is being selected, its data outputs are left floating, which allows the two i.c. outputs to be wired in parallel as shown.

A plastic transistor-sized three terminal regulator μA78L12WC is used to provide 12V for the CMOS and also the V_{SS} supply to the MK50253.

CONSTRUCTION

Full constructional details are not given but the following notes should assist.

The units may be built on Veroboard, d.i.p. board, etc. All i.c.s should be decoupled between the V_{DD} and V_{SS} pins with a 10nF capacitor.

As the segment and digit drivers, and the MK50253 connections other than digit and segment outputs are identical to those of an ordinary mains clock, the Latch may be built as an addition to the latter. The 3·3 kilohm resistors in series with each segment and digit output can be mounted on the Veroboard rather than p.c.b. to provide input and output connections to the Latch.

As described the instrument has one display which displays either the time or the contents of the memory. If separate displays are wanted, display driving circuitry will have to be duplicated, and the original segment and digit information will have to be tapped off at the appropriate points and buffered before going to the drivers.

More than one Latch can be added to one clock, although separate displays or complex display switching will be required.

CONTROLLER CIRCUIT

The aspect of the Controller circuit which is common to the Latch circuit is the need to use only the outputs of the MK50253 when they are stable. For this reason gates A to I of the controller circuit perform the same functions as the corresponding gates in the Latch. The only difference is that the monostable consisting of gates E and F is fired every 50Hz cycle rather than only when a button has been pressed (Fig. 16).

The output at (1) consists of 7 millisecond pulses which define periods during which the MK50253 count will not change. The pulses at (2) are high at times when the segment and digit outputs of the MK50253 have settled down. During a particular digit time, say D1, the information present on lines LA, LB, LC and LD will correspond to the value selected by the BCD switch S1. This binary information is converted to seven segment information by the CD4056 BCD-to-seven-segment decoder. Five of these segments are then compared with the corresponding MK50253 segment outputs by EXCLUSIVE-OR gates. The comparison only needs to be made using the five segments shown as these uniquely determine the digit value.

The EXCLUSIVE-OR gates truth table is such that their output is a "1" when their inputs differ.

The outputs of the EXCLUSIVE-OR gates are combined by the NOR-gate "0". The output of this gate is low whenever the BCD switch value and the MK50253 value of a digit differ. This output is then gated by gate P by two signals. One is the inverted value of line 1 and serves to blank any "digits not equal" signal which occurs during a digit time for which no comparison is required. The other blanking signal is that at (2) which only allows a "digits-not-equal" signal to be passed once per digit time, after the MK50253 outputs, etc. have settled down.

At the beginning of a 7 millisecond pulse from (1), J-K flip-flop Q is clocked, and its Q output is set to "1". If the time indicated by the MK50253 is different to the time set by the BCD switches, during the following 7 milliseconds one or more "not-equal" pulses will apear at the output of gate P, resetting the flip-flop Q to "0". This will ensure that the output of gate R remains "0", as for it to be a "1", the "Q" output of flip-flop Q still has to be a "1" at the end of the 7 millisecond period, when (2) goes to a "0." If the two times are equal flip-flop Q's output "Q" will still be high when (2) goes low, and the output of gate R will set the alarm R-S flip-flop consisting of gates S and T, turning the controller output relay on. An identical system is used to clear this R-S flip-flop and turn the controller output off.

CONTROLLER NOTES

Some additional notes as for the Latch are in order. For example, more than one on-off Controller can be added to one MK50253 clock. That part of the circuit shown in dotted lines need not be repeated —the signal produced by it can be fed to several controllers in parallel.

The L1 and L2 lines and the diodes going to them tell the circuit which digits will be looked at to set or clear the output. This enables one to economise on BCD switches. For example, the following arrangement will switch on at an exact time defined in hours and minutes, and off up to several hours later, using a total of seven BCD switches (Fig. 17).

This controller will switch on at AB:CD:00 hrs, and switch off at the next XB':C'D':00 hrs, where X can be any value.

Where, in a given digit position, there is only a diode to the L1 or L2 lines, but no BCD switch, this circuit behaves as if there is a BCD switch with its value set to "0". Where no L1 or L2 diode is connected, that digit will be ignored by the controller. Substitutes can be used for the BCD switches shown. In some applications the BCD values can be hard-wired; in others d.i.l. pin headers and sockets can be used to set the times by "plugging" values in.

As shown, a single controller has two switching times, which sequentially switch an R-S flip-flop on and off. The controllers could be built with only one switching time, or with both switching times connected as switching on times, with a manual off.

NOTE: The toned area in Fig. 6 (last month) should be traced out and dropped in the centre cut-out in Fig. 7 (PCB2). The black lines from PCB1 to the tone area are the interconnecting wires to PCB2.

In Fig. 1, the V + (5) line to IC2 should be V + (3). ★

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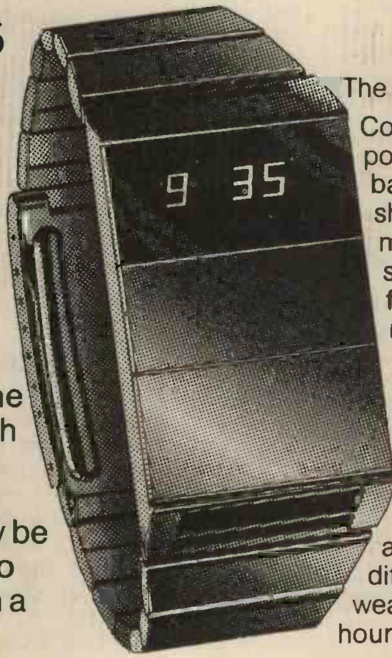
★ **guaranteed.** A correctly-assembled watch is guaranteed for a year. It works as soon as you put the batteries in. On a built watch we guarantee an accuracy within a second a day – but building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week.



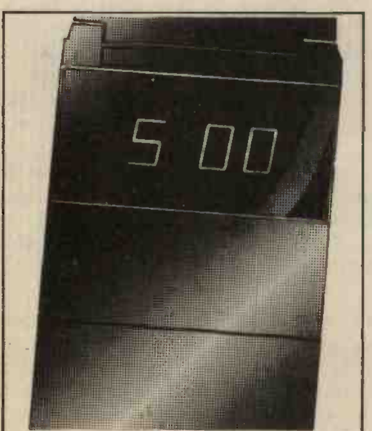
The Black Watch by Sinclair is unique. Controlled by a quartz crystal... powered by two hearing aid batteries...using bright red LEDs to show hours and minutes and minutes and seconds...it's also styled in the cool prestige Sinclair fashion: no knobs, no buttons, no flash.

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.

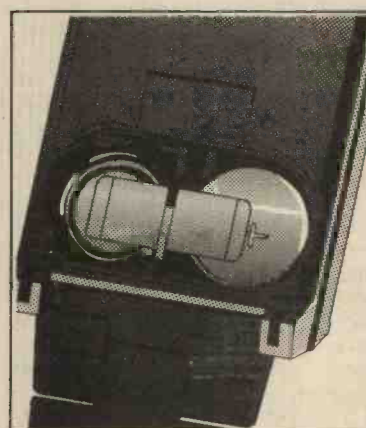
The special features of The Black Watch

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.



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?

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

TV SOUND ADAPTOR

MOST television sets do not employ a mains transformer and may not be connected directly to external amplifiers. There are some sophisticated commercial units which deal with television sound, but these are rather expensive. The circuit in Fig. 1 overcomes this problem economically and maintains the required electrical isolation of the television.

The input to the circuit is taken from the top of the television volume control. In this way, the signal presented to the external amplifier is independent of the television volume setting.

At this point, the signal has not been processed by the television audio circuitry, it does not suffer from the distortion associated with such circuits, and is suitable for reproduction through high quality audio systems.

The input impedance of this circuit is around 500kΩ, so it will not load the television audio circuits. After amplification, the signal is presented to the external amplifier through T1, the primary of which is the collector load of TR2.

Transformer T1 must be a mains type so that one may be confident that the insulation between the primary and secondary windings can stand accidental mains voltage, and provide the necessary degree of safety. The transformer can be any miniature mains type, the secondary winding should be preferably 24V or more, so that the signal is not attenuated too severely. The output impedance of this system is extremely low, allowing for a perfect match to any amplifier, and a long interconnecting cable.

For best result, R5 has to be the nearest value to the d.c. resistance of the transformer's primary winding. When R5 has been chosen correctly, the voltage at TR2 collector should be about 6V; if it is not R4 should be increased or decreased as necessary. The preset VR2 should be adjusted to the highest possible output without running into distortion.

The current consumption of the unit is around 1·5mA at 9V. The supply voltage V_s, can be tapped off the television audio board or tuner. The value of the resistor R_s should be chosen according to the formula:

$$R_s = \frac{V_s - 9}{1{\cdot}5}\,k$$

The circuit was tried on a few different TV sets, and was proved to be capable of producing sound of truly high quality.

M. Greenfield,
Leeds

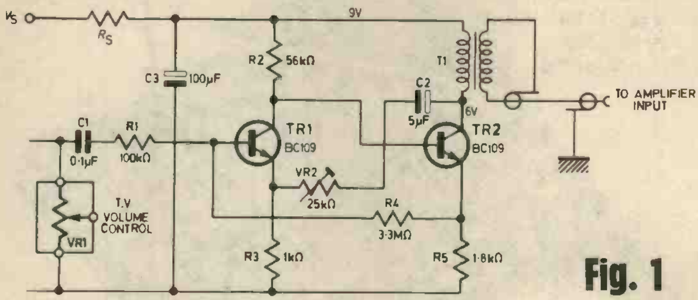


Fig. 1

B.F.O.

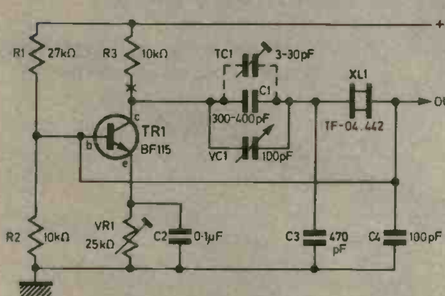


Fig. 1

READERS interested in short wave reception who at present use a b.f.o. with the normal coil arrangement may like this circuit which will enable them to achieve a higher stability oscillator.

The circuit shown in Fig. 1 is an oscillator based on the Pierce arrangement. The series resonant frequency of the crystal is 442kHz but it can be raised by adding series capacitance. About 500pF is required to achieve the popular working frequency of 455kHz. This is made up with a 350pF fixed capacitor and a 100pF trimmer in parallel for fine adjustment.

E. Vaughan,
High Wycombe.

RECIPROCATING TOUCH SWITCH

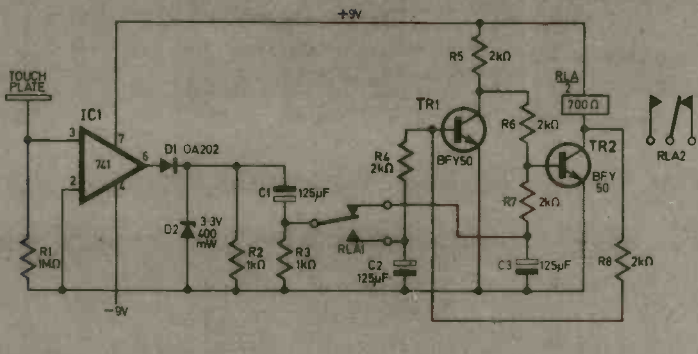


Fig. 1

DESIGNED to operate a bedside lamp (using the remaining contacts RLA2), the circuit shown in Fig. 1 uses an interesting form of bistable, which unlike conventional types, does not need a steep rising edge to trigger it. Despite its limitations (it will not operate at more than 0·8Hz), it does away with the need for a Schmitt trigger.

The Zener diode was found to be necessary to limit the input to three volts otherwise when a signal is applied to the touch plate the bistable becomes free-running.

Miss V. Mouricio,
Lingfield.

HIGH QUALITY STEREO PRE-AMPLIFIER

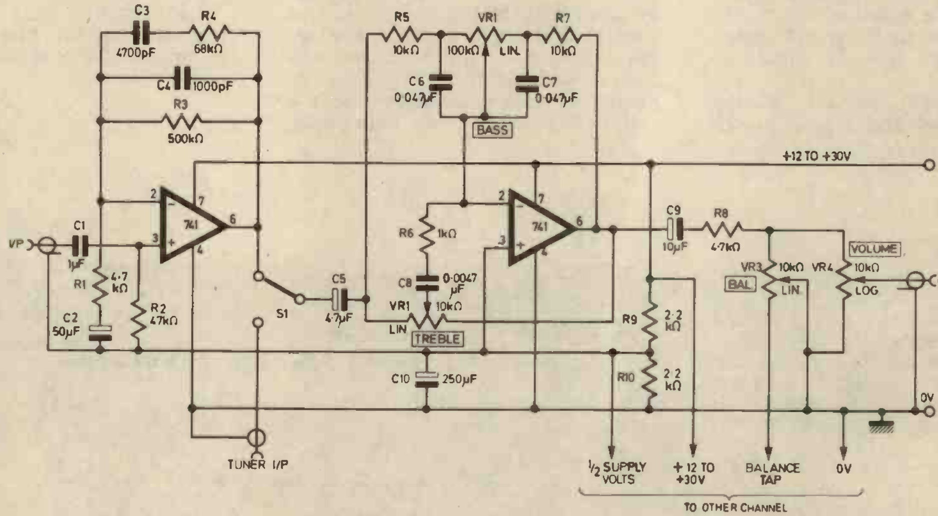


Fig. 1

MOST i.c. pre-amp circuits specify the use of specialised, and sometimes hard to obtain, integrated circuits. There is no reason, however, why the ubiquitous (and cheap!) 741 should not be employed in this application. Fig. 1 shows a circuit using these which does not require the normal dual power supply and will in fact operate satisfactorily on any single unregulated supply in the range 12 to 30V.

The circuit shown is for use with a magnetic cartridge. IC1 provides most of the overall gain and the network C3, R4, C4, R3 provides RIAA equalisation to within 1dB between 20Hz and 20kHz. IC2 is the active element of the tone control which provides ±10dB of control of bass and treble. An input level of 4mV gives an output of around 500mV at 1kHz with the tone controls flat. For use with cartridges other than magnetic, R2 should be adjusted to suit the manufacturer's loading recommendations, and R1 should be selected to give the required a.c. gain. A second switched input is provided for connection to a tuner, etc. and has a sensitivity of approximately 500mV.

The layout of the preamplifier is not critical provided that normal screening precautions are observed on all signal leads longer than 2 or 3 inches.

The prototype was built on Veroboard and gave excellent results with negligible hum, noise and distortion, even with 3 volts of ripple on the power supply.

M. W. Clarke,
Princes Risborough.

LIGHT OPERATED SWITCH AND MOTOR DRIVER

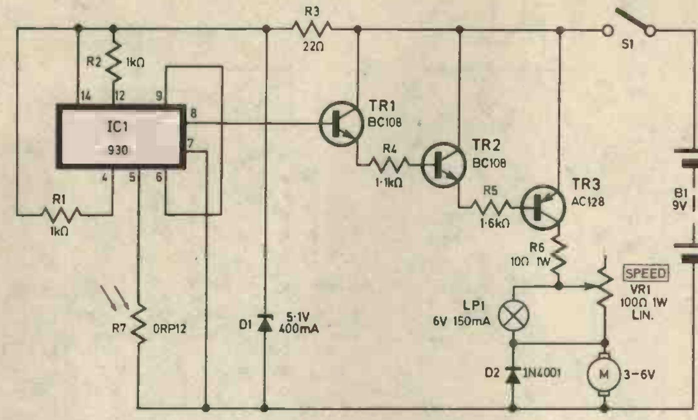


Fig. 1

THE purpose of this unit is to operate a motor when light stops falling upon the light dependent resistor. When light is falling upon the ORP12, it conducts and the gate is at "0" in positive logic. One of the gates is kept permanently at "1" by R1 and therefore since it is a NAND gate, the output is "1". The second NAND gate acts as an INVERT gate by having one of the inputs kept at "1" permanently, therefore the output is at "0".

The i.c. is a DTL 930 which needs a supply of 5V and this is achieved by using a Zener diode of 5·1V with a rating of 400mW, in conjunction with a 22 ohm resistor. This output is fed into the base of TR1. The base emitter voltage is kept at 0·6V by R4 and the base emitter voltage of TR2 is kept at 0·6V by R5. This resistor also drops the voltage for TR3 and provides base current.

TR3 supplies the current to drive the motor and lamp. R6 keeps the current to below the Ic max. of TR3. VR1 adjusts the speed of the motor and also the brightness of the lamp which is inversely proportional to the speed of the motor. In this case the motor is not turned on because of the "0" input to TR1.

With no light present on the ORP12 one of the inputs to the first NAND gate is at "1" and the other input automatically becomes "1". An output of "0" is produced and this is fed into the second NAND gate producing an output of "1" which is fed into the base of TR1. This transistor switches TR2 to the logic level and then TR3 starts to conduct, producing a current which drives the motor and lamp LP1. Due to greater current consumption of the motor the more the bulb light diminishes the faster the motor goes. Any motor of 3–6V can be used.

The lamp indicates if the circuit is working since sometimes the motor will not work until VR1 is set for high speed.

The operation may be reversed by connecting the base of TR1 to the output of the first NAND gate.

P. V. Saduikis,
Leeds, Yorks.

SIMPLE LOW VOLTAGE REGULATOR

THE circuit in Fig. 1 shows a simple regulator suitable for feeding the ZN414 radio receiver i.c. The ZN414 is very voltage conscious and both the diode and transistor drive circuits recommended by Ferranti do not stabilise the supply well enough to compensate for falling battery voltage with a consequent loss in gain. Also it is useful to be able to adjust the supply voltage to the i.c. in order to obtain the optimum gain/selectivity conditions.

TR1 operates in the emitter follower mode. When the voltage at the base of TR2 rises to 0·7V, TR2's base drive via R1 is reduced, holding the output to a value preset by VR1. Capacitor C2 is present to maintain stability.

M. J. Meaken,
Gatley.

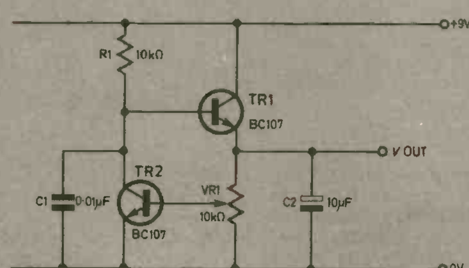
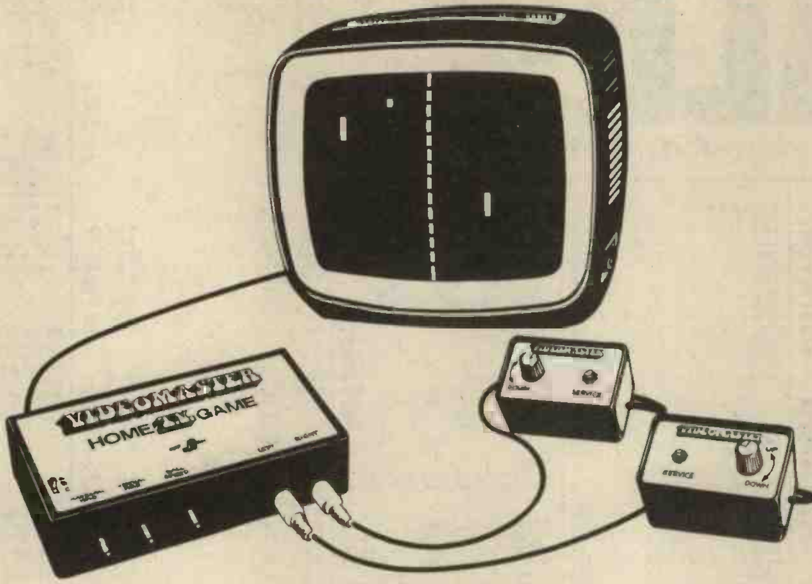


Fig. 1



FUSE MONITOR FOR CARS

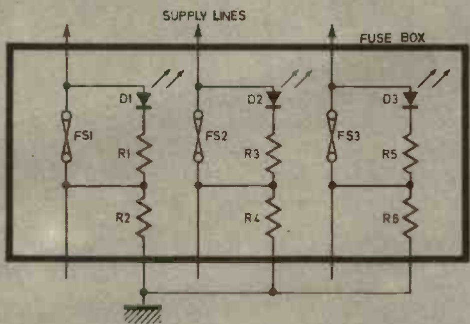


Fig. 1

FUSES have a nasty habit of blowing at very inconvenient times, such as when its dark, cold or wet. This simple arrangement can provide an easy-to-see monitor as to the state of the fuses and thus can save a lot of bother.

The circuit is very straightforward; light emitting diodes are used in series with 2·7kΩ resistors across the various fuses. A further 1kΩ resistor is connected from the chassis to R1. When the fuse is good the l.e.d. and R1 are shorted out and the l.e.d. remains off. However, when the fuse is open circuit, current flows through the l.e.d. and a fault is indicated. For positive earth operation the l.e.d. must be reversed.

A. Foster,
Germany.

DIGITAL COMBINATION LOCK

THE flip-flops (Fig. 1) have their outputs connected to the clear inputs of the next stage and the J and K inputs are left free. When flip-flop 1 (IC1a) is reset its Q output goes to logic 0. This resets the next stage and so on to flip-flop 4 (IC2b). With the Q output of IC2b at logic 0, the output is inactivated. This means that each flip-flop has to change state in turn (enabling the next stage) for the output to be activated.

To enter a chosen number, the number is set on the 1-pole 12-way switch and S3 is pressed. The two NAND gates eliminate switch bounce so that the flip-flops do not fire twice. If a number is entered twice its corresponding flip-flop will set all the flip-flops after it. If an unallocated number is entered then the alarm will sound, and can only be stopped by pressing the reset button, which also clears all the flip-flops.

N. M. de Smith,
London.

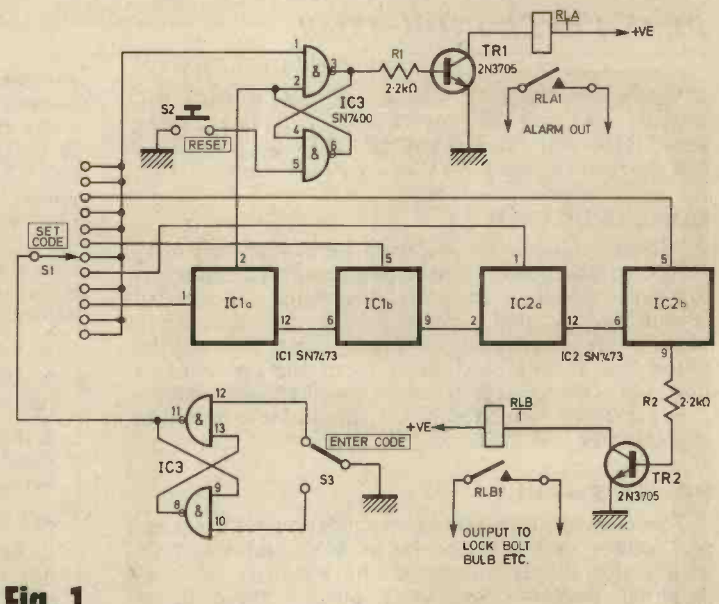


Fig. 1

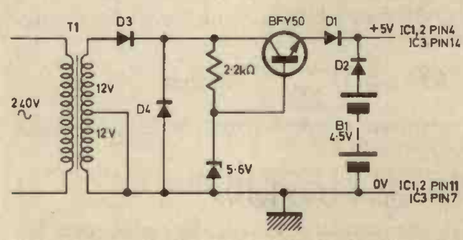


Fig. 2

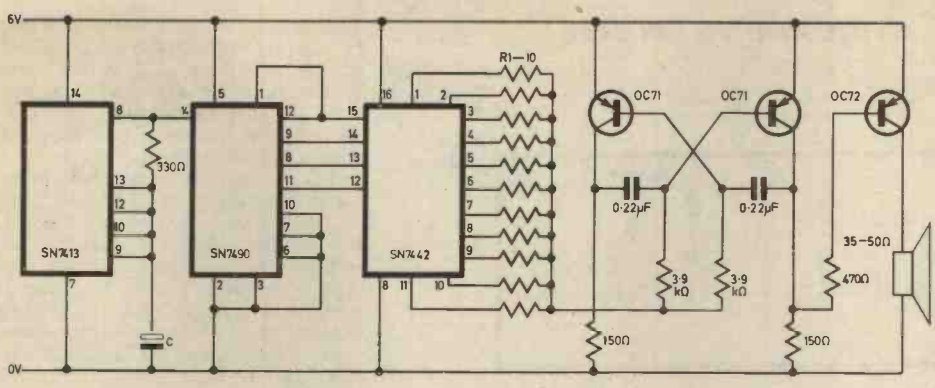


Fig. 1

THE circuit in Fig. 1 is similar to the Autotone published in P.E. about a year and a half ago.

The ring counter has been replaced by a triple i.c. system. An SN7413, R1 and C1 forms an oscillator which then drives a 7490 decade counter. This then feeds a 7442 decoder which sequentially pulls resistors R1-10 to earth. The frequency of operation of the astable (TR1 and TR2) is therefore determined by which resistor is grounded. The resistor values to provide reasonable operating frequencies of the astable were found to lie in the range zero to about 10kΩ. An absence of one of the resistors provides a break in the sequence.

TR3 provides an output suitable for driving a loudspeaker. It must be borne in mind that the sequence of notes will repeat themselves as the 7490 resets to zero after a count of nine, but interesting tunes can nevertheless be composed.

C. R. Batchellor,
Brentwood.

PEAK LEVEL INDICATOR

continued from page 204

When the negative voltage at TR1's base disappears TR1 and TR2 revert to their quiescent state; but TR3/4 will remain cut off (D2 "on") until C2 has charged to about +1V via the 1MΩ resistor.

CONSTRUCTION

All components are standard items and they may be accommodated on a printed circuit board measuring only 6·5 × 4cm (stereo version). The board layout and printed circuit pattern for the stereo version are illustrated in Fig. 4, and it must be noted that it will be difficult to fit the components unless the low wattage types, as specified, are used.

For long term reliability C2 should be a tantalum capacitor as specified.

POWER SUPPLY

The circuit will work to specification with a supply voltage in the range 16 to 24V, and this falls within the supply range of the majority of preamplifier designs. Sensitivity outside these limits may not be according to the specification, but a range of 12 to 30V can be accommodated by changing the value of R7:

$$R7 = \frac{\text{Supply volts}}{20}\ \text{kilohm}$$

The current required is approximately 22mA (44mA for stereo version).

SENSITIVITY IMPROVEMENT

At 500mV the sensitivity will be adequate for most monitoring applications, but it can be improved upon, if required, by modification of component values around TR1.

As mentioned earlier, the gain of the first stage is determined by the ratio R2/R1, and the value of R2 has been specified very conservatively to ensure that the stated sensitivity figure will be met, even with a relatively low gain transistor at TR1. But a decent BC107 will allow for a considerable increase in the value of R2, with a commensurate increase in overall sensitivity. To determine the optimum value:

1. Replace R2 with a 1MΩ variable resistor.
2. Vary R2 to set the voltage at TR2 collector to (no more than) +3V.
3. Measure the resultant value of the variable resistor and replace with the nearest preferred value fixed resistor below that measured.

There are two other methods:

1. Reduce the value of R1 (lower limit 470 ohms): this will give a significant increase in gain, at the expense of a lowering of the unit's input impedance, and it may need to be driven from a low source.
2. Replace the 8·2V Zener diode with a lower voltage type (minimum value equal to the voltage at TR1 collector plus 1·5V): at best this will only allow the gain to be doubled, and the threshold discrimination will be widened with consequent diminishing of the visual impact of the l.e.d. output.

The maximum sensitivities achieved with the original units were in the range 25 to 40mV. ★

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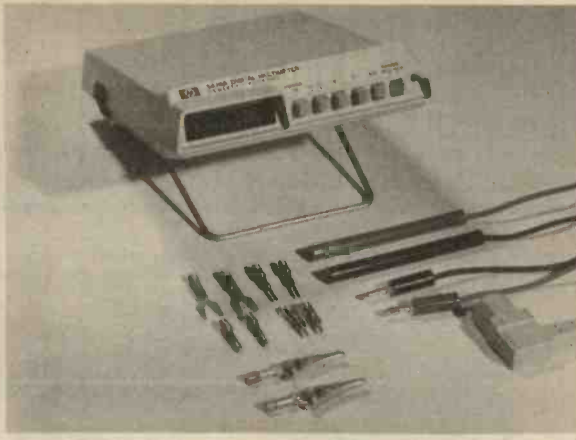
P.E. PRODUCT REVIEW

HEWLETT PACKARD

THE 3476A/B DIGITAL MULTIMETER



A new, competitively priced, 3½ digit, autoranging digital multimeter has been introduced by Hewlett Packard. The instrument is priced at £144 with built in mains unit or £175 with rechargeable batteries and charging facilities.

Capable of resolving 0·1mV d.c., 0·3mV a.c., the multimeter provides an order of magnitude of resolution greater than standard 3½ digit types. This is achieved by allowing the half digit to have three possible states: off altogether, 1 or 0. The first state is used when reading values such as 2·31, 23·1, 231 etc., the second when reading 0·1017, 1·017, 10·17, 101·7 etc., and the third when reading 0·0004, 0·0114 etc., the ½ digit therefore effectively being used as a fourth digit.

The multimeter can also measure resistance from 1Ω to 11MΩ and has a.c. and d.c. current ranges from 0·3mA to 1·1A and 0·1mA to 11A respectively. In order to prevent inadvertent switching into the current mode, a separate input socket is provided for current measurement. All the current ranges are fuse protected.

Access to the fuse is via a sliding panel on the side of the multimeter. The test leads are first removed, then, on sliding the panel to the side, both the active fuse and a spare pop out.

The principle of operation of the multimeter is based on the well known dual slope integration technique, all logic functions and analogue switching being contained in an N-MOS i.c. High accuracy and low temperature coefficient are achieved by the use of a thin film Tantalum Nitride resistor pack which is in fact mounted in the same package as the N-MOS chip. This contains most of the precision resistors required in the multimeter.

The 3476A/B in use

There is no "set-zero" control on the front panel as the control logic incorporated in the main i.c. automatically performs this itself, so it is claimed. Zero stability was indeed found to be good on the sample tested.

The autoranging feature is a great asset in a multimeter, the 3476A possesses this and also a facility for range holding to allow rapid readings of similar values to be taken.

Typical accuracy of the device on d.c. voltage is 0·5%; d.c. current 1%; resistance 0·6% (open circuit voltage less than 4 volts). The a.c. voltage and current accuracies were 1·5% and 2% respectively from 45Hz to 2kHz but the frequency response was rather disappointing at ±8% of reading +1% of range when the bandwidth is increased to 10kHz.

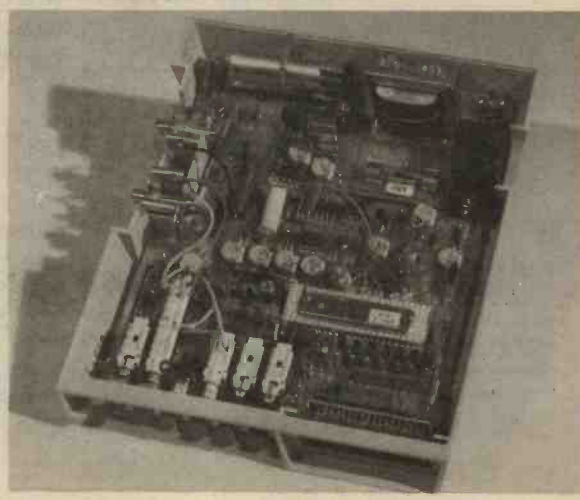
The multimeter lives up to the traditional Hewlett Packard reliability expectations. The sort of tests performed on the meter to check reliability include a 1,000V square wave applied directly to the input terminals to test ability to handle transients; 220V a.c. applied to any terminals with all combinations of push buttons, and also a test involving 10kV being discharged to all exposed metal to simulate static discharges.

The multimeter is obviously aimed at the upper bracket of the amateur market but provides good value for money, the autoranging feature and high resolution giving it distinct advantages over many in this area of the market.

R.W.L.

The 3476A and B (the 3476B includes rechargeable batteries) are available from Hewlett-Packard Limited, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.

Internal view showing i.c. containing both control logic and tantalum nitride precision resistor array



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.

It's An Advantage

Sir, — Mr Timson has largely missed the point in his letter "A Protest" (Readout, February issue). He will see from my article, "Christmas Lights Flasher" (December '75) in paras. 2 and 3, that the electronic flasher has many advantages over the bi-metal strip. These are much more reliable operation (bi-metal strips tend to stick closed), ability to control a wide range of load wattages at rates set by the user, and very important, it causes absolutely no interference to radio and TV.

All these extra features are typical of the type of improvements that electronics can offer over more traditional processes in so many fields—in much the same way that the typewriter that Mr. Timson used for his letter is an advance over the pen.

What would he say to a criticism of his machine for using so many cranks, levers and springs to replace the usually reliable and inexpensive ball point pen? It's because it's better Mr. Timson, that's what!

J. N. Watt,
Camberley,
Surrey.

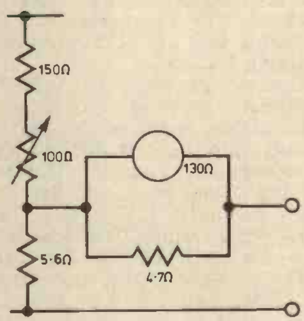
Engine Analyser

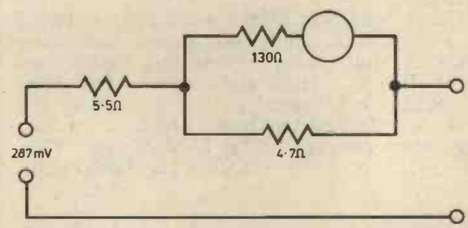
Sir.—I found Mr Biggs's comments (Readout, February issue) on my article "P.E. Engine Analyser" very interesting. As regards increasing the tachometer range this is quite possible for engines of less than eight cylinders. For instance the timing resistor values given for an eight cylinder engine would, if used on a four cylinder engine, allow the r.p.m. scale to be multiplied by two, giving a maximum of 5,000 r.p.m. Similarly the resistors for engines of less than four cylinders could be halved to bring these into line.

If each cylinder of a multi-cylinder engine has its own separate contact assembly then each cylinder must be treated as a single cylinder engine. Also for two stroke engines the factor of $\frac{1}{2}$ should be removed from the r.p.m. formulae in the second article and timing resistors will be half those for a four stroke engine to give the same meter calibration.

To reduce the resistance range of the continuity meter, the source impedance of the ohmmeter circuit must be reduced by shunting the meter. A circuit is enclosed which should give a reading of 10 ohms at half scale. This will result in an extra 40mA load on the 10V regulated supply but this should not cause any problems.

D. G. Haley,
Hemel Hempstead.





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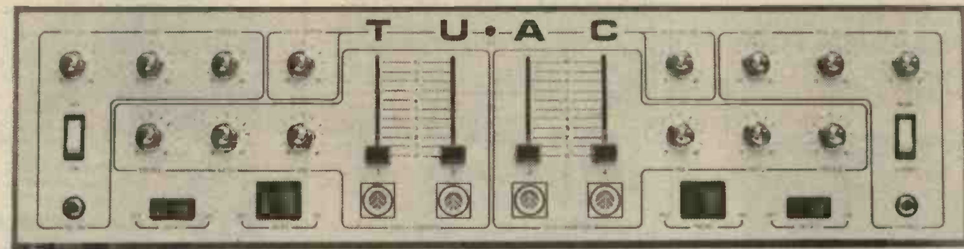

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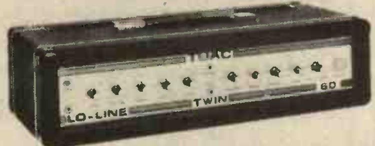

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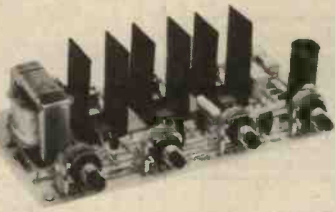

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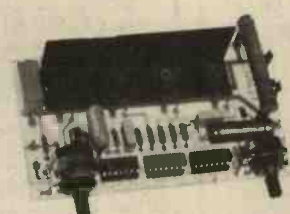

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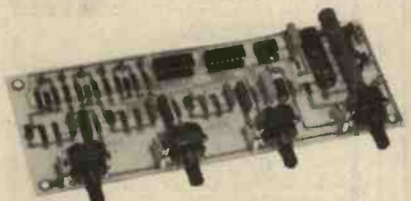

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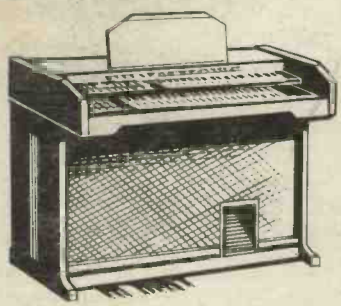

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