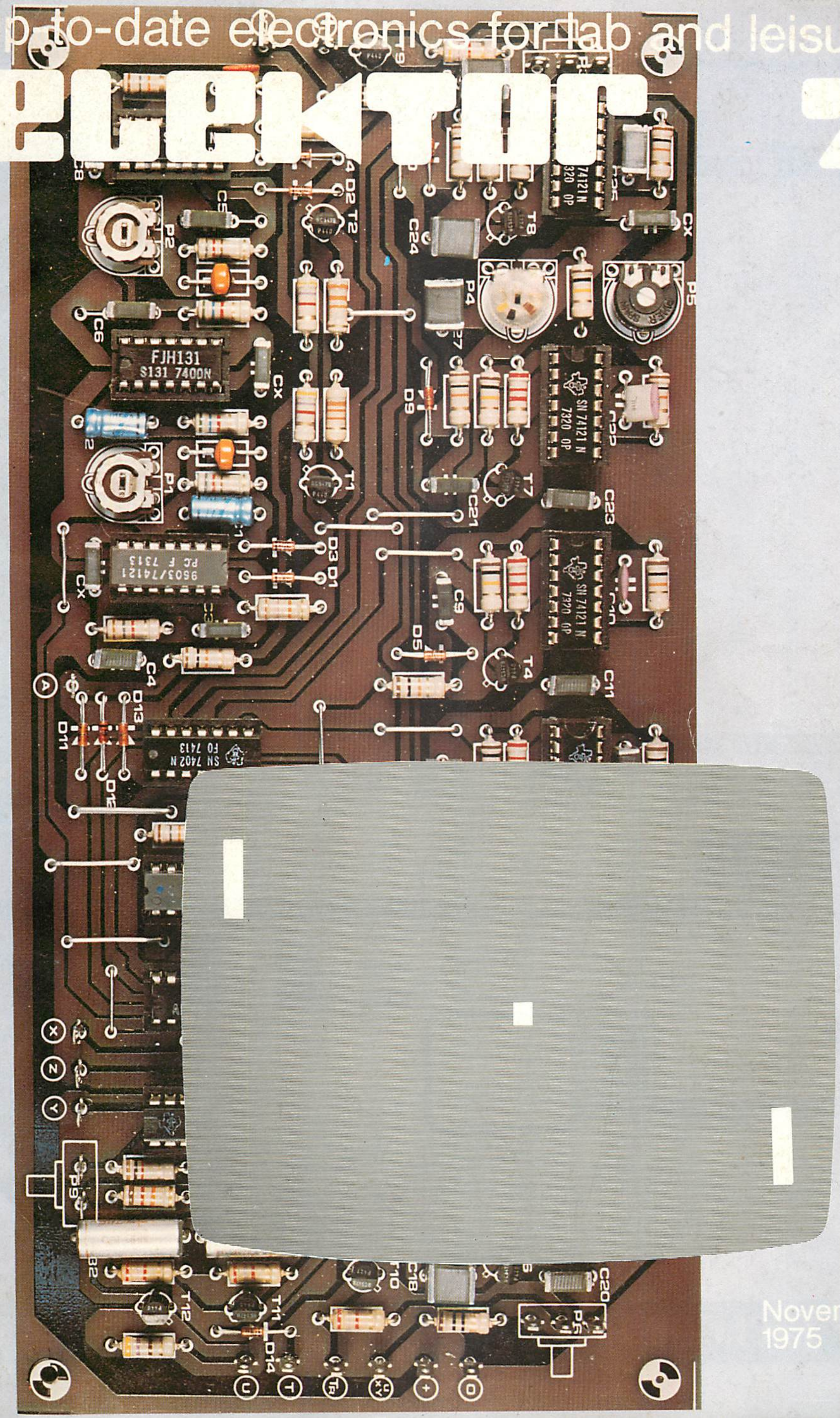
up-to-date electronics for lab and leisure

elektor

7



November 1975

35p

CHROMASONIC electronics

Dept. 9 56, Fortis Green Road,
Muswell Hill, London, N10 3HN.
telephone: 01-883 3705

C-MOS

	● 1-24	● 25-99	● 100up
CD4000AE	23p	19p	15p
CD4001AE	23p	19p	15p
CD4002AE	23p	19p	15p
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	23p	19p	15p
CD4012AE	23p	19p	15p
CD4013AE	69p	58p	46p
CD4014AE	£1.75	£1.46	£1.17
CD4015AE	£1.75	£1.46	£1.17
CD4016AE	69p	58p	46p
CD4017AE	£1.75	£1.46	£1.17
CD4018AE	£2.51	£2.09	£1.67
CD4019AE	80p	66p	53p
CD4020AE	£1.97	£1.64	£1.31
CD4021AE	£1.75	£1.46	£1.17
CD4022AE	£1.83	£1.53	£1.22
CD4023AE	23p	19p	15p
CD4024AE	£1.26	£1.05	84p
CD4025AE	23p	19p	15p
CD4026AE	£2.79	£2.33	£1.86
CD4027AE	98p	82p	65p
CD4028AE	£1.53	£1.28	£1.02
CD4029AE	£1.12	£1.76	£1.41
CD4030AE	71p	59p	47p
CD4035AE	£1.75	£1.46	£1.17
CD4040AE	£2.01	£1.68	£1.34
CD4042AE	£1.49	£1.24	99p
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	£2.51	£2.09	£1.67
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
C04085AE	£1.28	£1.06	85p
C04086AE	£1.28	£1.06	85p
CD4093AE	£1.56	£1.20	£1.04
CD4099AE	£2.95	£2.46	£1.96

74 TTL

	● 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	95p	83p	67p
7447A	95p	83p	67p
7448	85p	71p	57p
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	£3.56	£2.80	£2.10
7490	49p	40p	32p
7491	65p	55p	45p
7492	57p	46p	36p
7493	49p	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	£1.75	£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 (T0-99) 45p
709 (14 pin dip) 39p
710 (8 pin dip) 39p
710 (T0-99) 45p
710 (14 pin dip) 44p
711 (T0-99) 51p
711 (14 pin dip) 44p
720 (A.M. Radio) £1.76
723 (T0-99) £1.09
723 (14 pin dip) 74p
741 (8 pin dip) 36p
741 (T0-99) 43p
741 (14 pin dip) 36p
747 (14 pin dip) £1.04
748 (8 pin dip) 42p
748 (T0-99) 46p
748 (14 pin dip) 49p
753 (F.M. 1st. I.F.) £1.08

75491 88p ●
75492 £1.10 ●

Regulators 100 mA
78105WC (T0-92) 60p ●
78L12WC (T0-92) 60p ●
78L15WC (T0-92) 60p ●

Regulators 100mA
78L05AWC (TBA625A)90p ●
78L12AWC (TBA625B) 90p ●
78L15AWC (TBA625C)90p ●

Regulators 500mA
78M05HC £1.35 ●
78 M12HC £1.35 ●
78M15HC £1.35 ●
78M18HC £1.35 ●
78M24HC £1.35 ●

Regulators 1A
7805KC (T0-3) £2.09 ●
7812KC (T0-3) £2.09 ●
7815KC (T0-3) £2.09 ●
7818KC (T0-3) £2.09 ●
7824KC (To-3) £2.09 ●

Regulators 1A
7805UC (T0-220) £1.72 ●
7812UC (T0-220) £1.72 ●
7815UC (T0-220) £1.72 ●
7818UC (T0-220) £1.72 ●
7824UC (T0-220) £1.72 ●

ICL8038 £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
CA3401E (LM3900) 68p
CA3600E £1.44

CT7001 £5.34 ●

L005TI (T0.3) £1.46 ●
L036TI (T0.3) £1.46 ●
L037TI (T0-3) £1.46 ●
L129 (SOT-32) 85p ●
L130 (SOT-32) 85p ●
L131 (SOT-32) 85p ●

LM301 T (T0-99) 65p
LM301 S (8 pin dip) 59p
LM301A T(T0-99) 67p
LM301A S (8 pin dip) 59p
LM307 T (T0-99) 59p
LM307 S (8pin dip) 57p
LM308 T (T0-99) £1.96
LM308 S (8 pin dip) 98p
LM308A T (T0-99) £7.92
LM308A S (8 pin dip) £6.90

LM309K £2.34 ●
LM339 £2.25
LM370N £2.85
LM371 £2.08
LM372N £1.99
LM373N £2.99
LM377N £2.71
LM380 £1.25
LM381 £1.85
LM382 £1.66
LM703 68p

LM1820 £1.03
LM2111 £1.12
LM3900 69p

MC1303L £1.84
MC1306P 80p
MC1310P £2.39
MC1312 £2.42
MC1314 £4.13
MC1315 £4.62
MC1327 £1.12
MC1330P 83p
MC1339P £1.52
MC1350 64p
MC1351 88p
MC1352 88p
MC1357 £1.52

MC1358 (CA3065) £1.16
MC1375 £1.48

MC1455 (555T) 62p ●
MC1456CG £1.68
MC1458CPI 84p
MC1468G £2.18 ●
MC1495L £4.24
MC1496G 96p

MC3302P £1.50
MC3401P 74p

MFC4000B 87p
MFC4060A 79p ●
MFC6030A 79p ●
MFC6040 96p
MFC6070 £1.66

MM5314 £4.80 ●
MM5316 £9.99 ●

MVR5V (T0-3) £1.45 ●
MVR12V (T0-3) £1.45 ●
MVR15V (T0-3) £1.45 ●

NE540L £1.25
NE546A £1.16
NE555V 73p ●
NE556 £1.29 ●
NE560B £5.06
NE561B £5.06
NE562B £5.06
NE563 £2.96
NE565N £2.63
NE566V £1.87
NE567V £2.63

SL414A £2.09
SL415A £2.75
SL437D £7.50
SL440 £2.84 ●

SL610C £2.03
SL611C £2.03
SL612C £2.03
SL613C £4.31
SL620C £3.06
SL621C £3.06
SL622C £7.62
SL623C £5.57
SL624C £2.84
SL630C £1.87
SL640C £3.75
SL641C £3.75
SL645C £3.75
SL650C £9.85

SN75491N 88p ●
SN75492N £1.10 ●

SN76001N (TAA611) £1.82
SN76003N £3.30
SN76013N £1.98
SN76023N £1.98
SN76227N (MC1327) £1.89
SN76532N £1.88

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 75p
TAA570 £2.74
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

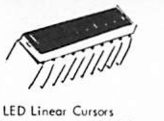
MINITRON

Minitron Filament Display bi-directional 0.36"
3015F 0-9 L/H d.pt.
3015G ± 1 £1.08 ●

SIEMENS LCD's

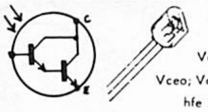
LIQUID CRYSTAL DISPLAY complete with socket and removable reflective backing; Ref AN4132R 13mm character height. Can be directly driven by National Semiconductors Alarm Clock chip MM5316. £13.99 ●

LINE-O-LIGHT



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

PHOTO-DARLINGTON



2N5777
Vceo; Vcbo 25v, Vebo 8v
Vceo; Vcbo 25v; VEBO 8v
hfe 2500; Ic 250 mA **35p.**

SPECIAL PURCHASE

enables

LIT707 90p; LIT747 £1.99
0.3" ● 0.6" ●

I.C. SOCKETS

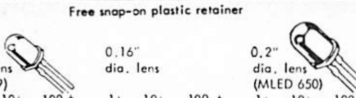
Pins	Dual-in-line 8	14	16	24	28	36	40	TO5 8	10
● Price	13p	15p	15p	26p	30p	39p	44p	31p	35p

NEW

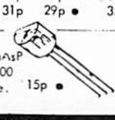
Litronix Double Digit Displays 0.5"; Common Anode + 2 R/H D.P.'s
DL721 gives ± 1.9
DL727 gives 0.0. to 9.9
Suitable for Clocks; Instruments; T.V. Channel Indicator
Our Price £4.75 each. ●

L.E.D.'s

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 ●



Low Cost Red GaAsP Motorola MLED 500 in a T092 package. 15p ●

NEW Opto-isolators
IL1 (4N25 or TIL116)
6 pin industry standard package.
2.5KV isolation £1.00 ●

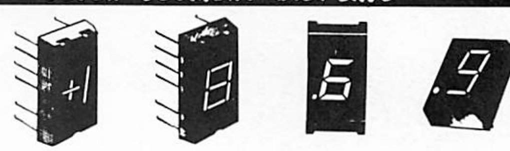
NOTICE

Postage & Packing Charges

With the recent increase in postal charges and a continuing increase in packaging costs we have been forced to review our policy.
Henceforward:
1. Orders valued at £5 or more will be post free.
2. All U.K. 'small package' orders will go first class mail.
3. Minimum postage & packing charge will increase to 20p.

SEVEN SEGMENT DISPLAYS

litronix
Xcitron
Monsanto



		COMMON ANODE R/H Dec. Pt.	COMMON ANODE L/H Dec. Pt.	COMMON ANODE ± 1	COMMON CATHODE R/H Dec. Pt.	Our Price
	RED	DL707R	DL707	DL701	DL704	£1.82 ●
0.3"	GREEN	MAN51	MAN52	MAN53	MAN54	£1.82 ●
	RED	MAN71	MAN72	MAN73	MAN74	£1.82 ●
	YELLOW	MAN81	MAN82	MAN83	MAN84	£1.82 ●
	ORANGE	MAN3610	MAN3620	MAN3630	MAN3640	£1.82 ●
	GREEN	XAN51	XAN52	-	XAN54	£1.49 ●
	RED	XAN71	XAN72	-	XAN74	£1.49 ●
	YELLOW	XAN81	XAN82	-	XAN84	£1.49 ●
0.4"	GREEN	MAN4510	MAN4520	MAN4530	MAN4540	£2.32 ●
	RED	MAN4710	MAN4720	MAN4730	MAN4740	£2.32 ●
	YELLOW	MAN4810	MAN4820	MAN4830	MAN4840	£2.32 ●
	ORANGE	MAN4610	MAN4620	MAN4630	MAN4640	£2.32 ●
		C.A. L/H Dec. Pt.	C.A. ± 1	C.C. L/H Dec. Pt.	C.C. ± 1	
0.6"	RED	DL747	DL746	DL750	DL749	£2.42 ●

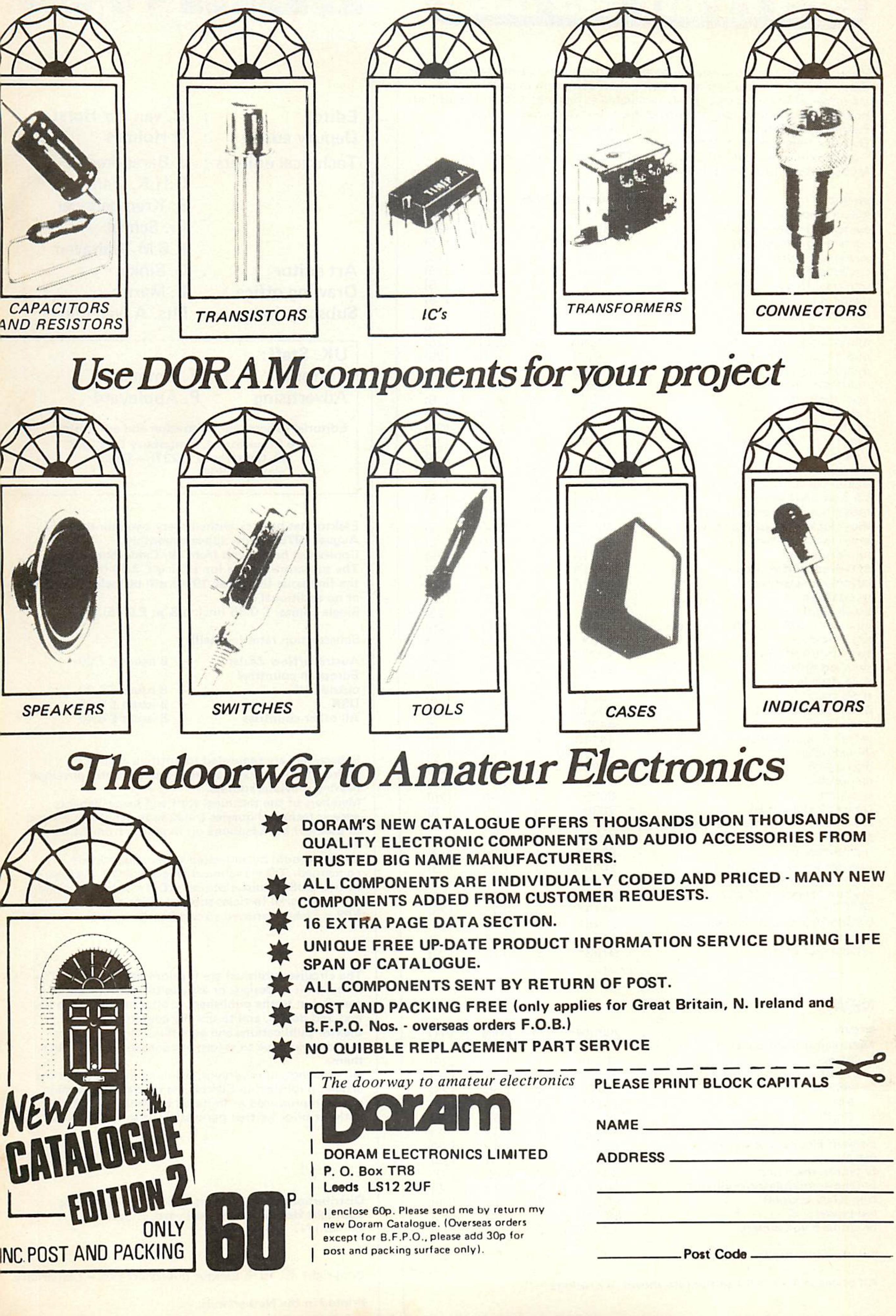
NOTE: MAN4000 series pinouts are 14 pin dil the same as MAN50;70 & 80 series.

VAT INCLUDED

Items marked with a ● include 8% VAT
Items unmarked include VAT at 25%

ADVERT. No.1. of Series B.

CALLERS WELCOME


CAPACITORS AND RESISTORS
TRANSISTORS
IC's
TRANSFORMERS
CONNECTORS
Use DORAM components for your project
SPEAKERS
SWITCHES
TOOLS
CASES
INDICATORS
The doorway to Amateur Electronics
DORAM'S NEW CATALOGUE OFFERS THOUSANDS UPON THOUSANDS OF QUALITY ELECTRONIC COMPONENTS AND AUDIO ACCESSORIES FROM TRUSTED BIG NAME MANUFACTURERS.
ALL COMPONENTS ARE INDIVIDUALLY CODED AND PRICED - MANY NEW COMPONENTS ADDED FROM CUSTOMER REQUESTS.
16 EXTRA PAGE DATA SECTION.
UNIQUE FREE UP-DATE PRODUCT INFORMATION SERVICE DURING LIFE SPAN OF CATALOGUE.
ALL COMPONENTS SENT BY RETURN OF POST.
POST AND PACKING FREE (only applies for Great Britain, N. Ireland and B.F.P.O. Nos. - overseas orders F.O.B.)
NO QUIBBLE REPLACEMENT PART SERVICE
NEW THE CATALOGUE EDITION 2
ONLY
INC. POST AND PACKING
60P
The doorway to amateur electronics
Doram
DORAM ELECTRONICS LIMITED
P. O. Box TR8
Leeds LS12 2UF
I enclose 60p. Please send me by return my new Doram Catalogue. (Overseas orders except for B.F.P.O., please add 30p for post and packing surface only).
PLEASE PRINT BLOCK CAPITALS
NAME
ADDRESS
Post Code

EPS print service

Many Elektor circuits are accompanied by designs for printed circuits. For those who do not feel inclined to etch their own printed circuit boards, a number of these designs are also available as ready-etched and predrilled boards. These boards can be ordered from our Canterbury office.
Payment, including £ 0.15 p & p, must be in advance.
Delivery time is approximately three weeks.
Bank account number: A/C No. 11014587, sorting code 40-16-11
Midland Bank Ltd, Canterbury.

circuit	number	issue	price	% VAT
edwin amplifier	97-536	6	1.20	(25)
austereo 3-watt amplifier	HB11	5	1.10	(25)
austereo power supply	HB12	5	0.55	(25)
austereo control amplifier	HB13	5	1.50	(25)
austereo disc preamp	HB14	5	0.65	(25)
universal frequency reference	HD4	5	1.10	(8)
distortion meter	1437	1	1.65	(8)
a/d converter	1443	3	0.90	(8)
tap sensor	1457	1	0.60	(8)
minidrum gyrator	1465A	2	0.80	(25)
minidrum mixer/preamp	1465B	2	0.55	(25)
minidrum noise	1465C	2	1.05	(25)
miniature amplifier	1486	6	0.55	(25)
light dimmer	1487	6	0.45	(8)
beetle	1492	4	2.20	(8)
equa amplifier	1499	1	1.20	(25)
electronic loudspeaker	1527	2	0.50	(25)
mostap	1540	2	1.05	(8)
car power supply	1563	4	1.25	(8)
digital rev counter (control p.c.b. only!)	1590	1	0.55	(8)
car anti-theft alarm	1592	4	1.40	(8)
mos clock 5314 clock circuit	1607A	1	1.15	(8)
mos clock 5314 display board	1607B	1	0.85	(8)
mos clock timebase	1620	4	0.70	(8)
minidrum tap	1621A	2	0.70	(25)
minidrum ruffle circuit	1621B	3	1.10	(25)
automatic bassdrum	1621C	3	0.55	(25)
microdrum	1661	2	0.95	(25)
aerial amplifier	1668	1	0.95	(25)
coilless receiver for MW and LW	3166	5	0.80	(25)
tap preamp	4003	4	1.80	(25)
twin minitron display	4029-1	2	1.40	(8)
twin led display	4029-2	2	1.40	(8)
twin decade counter	4029-3	2	1.40	(8)
recip-riaa	4039	2	0.50	(8)
disc preamp 76131	4040A	3	0.95	(25)
maxi display	4409	2	1.50	(8)
versatile digital clock	4414B	6	1.10	(8)
dil-led probe	5027A+B	2	1.85	(8)
big ben 95	5028	2	1.25	(25)
compressor	6019A	3	1.20	(25)
tv sound	6025	2	1.40	(25)
car clock (2 boards)	7036	6	1.75	(8)
car clock front panel (transparent red plastic)	7036-3	6	0.90	(8)
tup/tun tester	9076*	4	1.70	(8)
tup/tun tester front panel	9076/2A	4	1.90	(8)
p.c.b. and wiring tester	9106*	5	0.55	(8)
rhythm generator M 252	9110*	5	0.80	(25)
7400 siren	9119*	5	0.75	(25)
CA3090AQ stereo decoder	9126*	5	0.80	(25)
kitchen timer	9147*	5	0.75	(8)
capacitance meter	9183*	5	0.75	(8)

NEW:

circuit	number	issue	price	% VAT
tap preamp front panels:				
power	1626A	7	1.55	(25)
input	1626B	4	1.55	(25)
volume	1626C	4	1.55	(25)
tone	1626D	4	1.55	(25)
width	1626E	4	1.55	(25)
clamant clock, alarm	4015-13	7	1.30	(8)
clamant clock, time signal	4015-16	7	0.85	(8)
ota pll	6029	7	1.10	(25)
tv tennis, main pcb	9029-1A*	7	3.80	(8)
tv-tennis, modulator/oscillator	9029-2*	7	0.90	(8)
frequency counter	9033*	7	1.30	(8)
tap power	9072*	7	1.90	(25)
tv tennis 5-volt supply	9218A*	7	0.80	(8)

* with solder mask

All prices include VAT at the rate shown in brackets.

elektor

Volume 1 — number 7

Editor : W. van der Horst
Deputy editor : P. Holmes
Technical editors : J. Barendrecht
G.H.K. Dam
E. Krempelsauer
Fr. Scheel
K.S.M. Walraven
Art editor : C. Sinke
Drawing office : L. Martin
Subscriptions : Mrs. A. van Meyel

UK. Staff:
Editorial : T. Emmens
Advertising : P. Appleyard

Editorial offices, administration and advertising:
6 Stour Street, Canterbury CT1 2XZ.
Tel. Canterbury (0227) — 54430.
Telex: 965504.

Elektor has been published every two months until August 1975; it now appears monthly.
Copies can be ordered from our Canterbury office.
The subscription rate for 1975 is £ 3.60 (incl. p & p); the first issue (Nov/Dec 1974) will be included in this at no additional cost.
Single copies: £ 0.35 (incl. p & p: £ 0.45).

Subscription rates (airmail):

Australia/New Zealand	— 8 issues £ 7.20
European countries outside UK	— 8 issues £ 5.20
USA	— 8 issues £ 6.25
All other countries	— 8 issues £ 6.40

Subscribers are requested to notify a change of address four weeks in advance and to return envelope bearing previous address.
Members of the technical staff will be available to answer technical queries (relating to articles published in Elektor) by telephone on Mondays from 14.00 to 16.30.
Letters should be addressed to the department concerned: TQ = Technical Queries; ADV = Advertisements; SUB = Subscriptions; ADM = Administration; ED = Editorial (articles submitted for publication etc.); EPS = Elektor printed circuit board service.

Distribution: Spotlight Magazine Distributors Ltd., Spotlight House, 1, Bentwell road, Holloway, London N7 7AX.

Printed in the Netherlands.

contents

selektor 1109

tv tennis 1111
The popularity of television tennis games has prompted Elektor to produce a design than can easily be built by the home constructor for a modest cost. Although several designs have previously appeared on the market, it was felt that there was a need for a simple circuit using a minimum of components.

frequency counter 1121
Logic IC's are so cheap that it is possible to build a digital frequency counter for a very small outlay. The circuit described here is based on the popular 74 TTL logic family. The first part deals with the basic counter, and in a subsequent article additions to the instrument will be described.

humming kettle — J.P. Kuhler jr. 1129

active flash slave — R. Buggle 1129

tap-power 1130
This 'TAP-power' circuit has been specially designed for the TAP preamp system. It includes touch-controlled switches for turning the whole equipment on or off and for selecting the main power amplifiers or the headphone amplifiers, a power supply for the TAP pre-amp, simple headphone amplifiers and a disc preamplifier. N.B. See the 'Missing link' on page 1156.

clamant clock (1) 1134
Any horologist who keeps a digital clock in the same room as conventional clocks cannot but feel sad to see it sitting there, mute and reproachful amongst its more vociferous brothers, its only sound the feeble humming of the mains transformer. In this article we look at various ways of providing the digital clock with a voice, so that it can draw our attention to the fact that it is keeping time far more accurately than any mere mechanical clock.

lie detector — J. Jacobs 1143

brake lights for model cars — R. Zimmer 1143

universal ota pll 1144
Elektor has taken a lead in drawing attention to the possibilities of the PLL (Phase Locked Loop).
The Universal OTA (Operational Transconductance Amplifier) PLL described here is a printed-circuit module which can form the nucleus of many different types of receiver.

tv test pattern generator 1149
A television pattern generator is one of the most useful TV service aids. It simplifies checking of the video stages, adjustment of picture geometry, and perhaps most important, setting up of convergence in colour receivers. Using logic IC's for the generation of the test pattern allows the construction of a simple and reliable circuit.

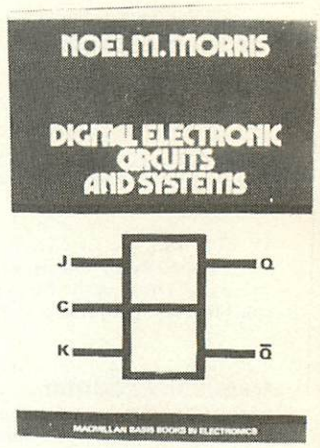
with a pencil point — W. Schmidt 1153

market 1154

BOOK CORNER

DIGITAL ELECTRONIC CIRCUITS AND SYSTEMS

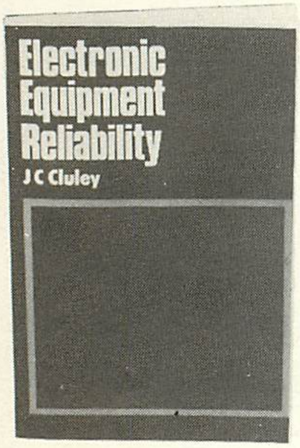
NOEL M. MORRIS



MACMILLAN BASIC BOOKS IN ELECTRONIC SERIES

Using the example of the electronic calculator to illustrate many of the systems, this text begins with a description of basic logic functions, including a full coverage of boolean algebra and Karnaugh maps. It then goes on to describe high-speed switching elements, logic gates, calculating functions, asynchronous and synchronous counters, shift registers and display decoding circuits.

£ 2.45



ELECTRONIC EQUIPMENT RELIABILITY

J.C. Clule

The principles of assessing the reliability of electronic equipment, including the mathematic background, component failure data, and methods to improve reliability, are described and e plained at a level suitable for degree and diploma students upwards.

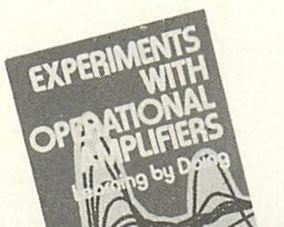
£ 2.6

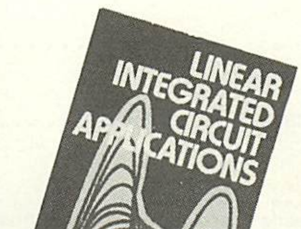
Experiments with operational amplifiers

by G.B. Clayton

This book covers a wide range of practical operational amplifier applications. It provides circuits which include component values, and suggest measurements that can be made in order to study circuit action.
The experiments will be useful for a large variety of measurement and instrumentation systems. The way in which performance errors are related to the characteristics of the particular amplifier used in a circuit are treated in an appendix.

Paperback . . . .£ 3.30
Hardcover . . . .£ 6.85





Linear integrated circuit applications

by G.B.Clayton

This book is concerned with the newe circuits now available, important fo such things as signal measurement an processing systems.
After first looking at how to use ope ational amplifiers as measurement ampl fiers and in active filter circuits, th book then deals with the more recentl introduced linar integrated circuit monolithic integrated circuit modu lators, four quadrant multipliers, timer waveform generators and phase locke loops.

Paperback . . . .£ 3.3
Hardcover . . . .£ 6.8

ORDER FORM

Please Supply the following (all prices include postage and packing)

.... copy/copies of Experiments with Operational Amplifiers by G.B. Clayton at £ 6.85 per copy (hard cover)

.... copy/copies of Experiments with Operational Amplifiers by G.B. Clayton at £ 3.30 per copy (paperback)

.... copy/copies of Linear Integrated Circuit Applications by G.B. Clayton at £ 6.85 per copy (hard cover)

.... copy/copies of Linear Integrated Circuit Applications by G.B. Clayton at £ 3. per copy (paperback)

.... copy/copies of Digital Electronic Circuits and Systems by Noel M. Morris £ 2.45 per copy

.... copy/copies of Electronic Equipment reliability by J.C. Cluley at £ 2.65 per cop

**To: Technical Book Services Ltd.,
Dept. 7,
25 Court Close
Bray
Maidenhead
Berks SL6 2DL**

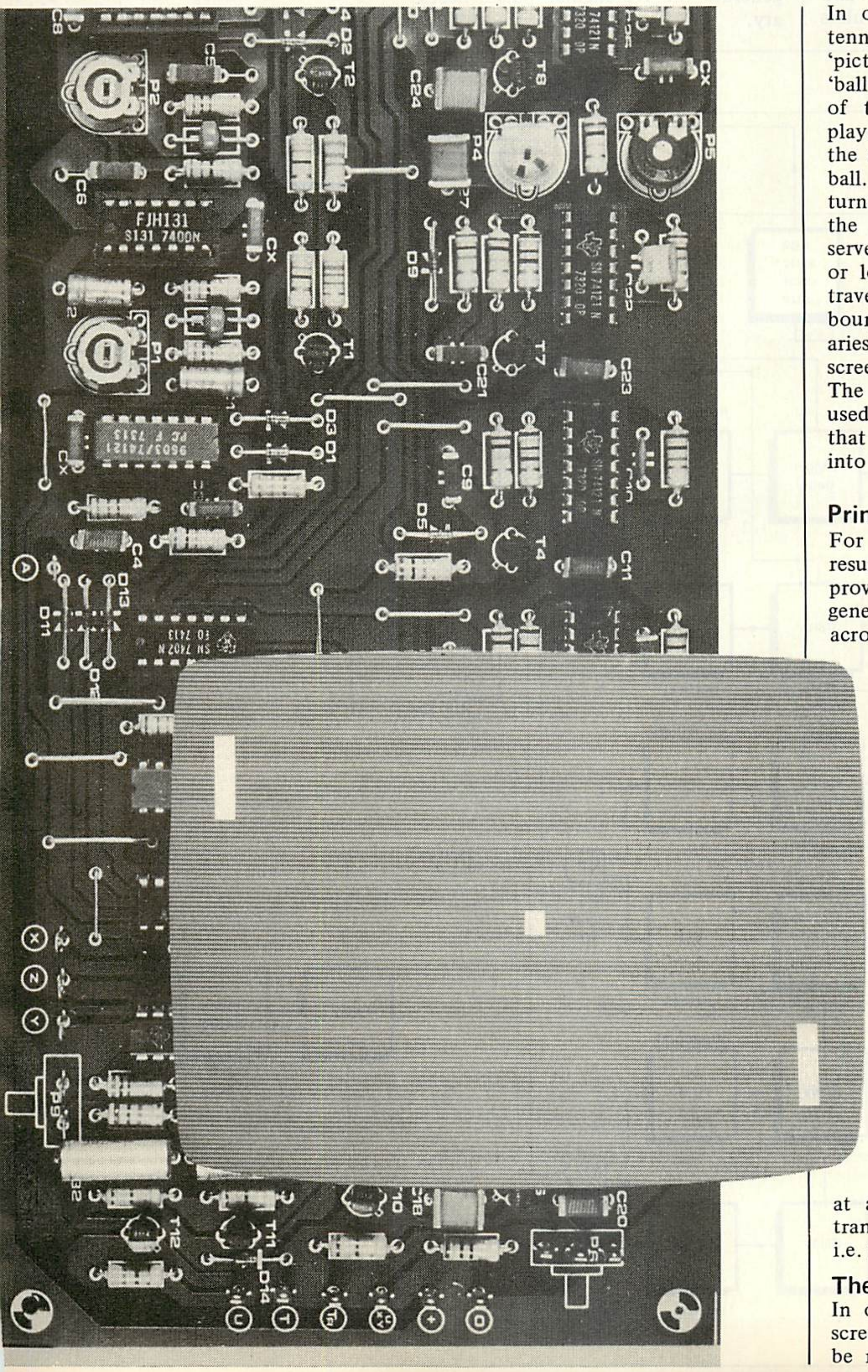
I enclose £__________

Name__________

Address__________

tv tennis

The popularity of television tennis games has prompted Elektor to produce a design that can easily be built by the home constructor for a modest cost. Although several designs have previously appeared on the market, it was felt that there was a need for a simple circuit using a minimum of components.



In order to keep costs down the TV tennis circuit generates the most basic 'picture' possible, i.e. two 'bats' and a 'ball'. The ball is 'served' from one side of the screen or the other and the players move their bats up and down the screen to intercept the path of the ball. If the ball strikes a bat it is returned, otherwise it leaves the side of the screen and a 'new ball' must be served. Should the ball reach the upper or lower edge of the screen during its traverse across the screen it will 'rebound'. The upper and lower boundaries are, however, not displayed on the screen.

The output of the TV tennis game is used to modulate a VHF oscillator so that the game may be plugged direct into the aerial socket of a television.

Principle of operation

For those not familiar with TV a brief resumé of the principles involved may prove helpful. A TV picture is, of course, generated by an electron beam scanning across the phosphor-coated face of a cathode-ray tube in a zig-zag fashion from top to bottom. At the end of each horizontal line the beam flies back to the left hand edge of the screen and starts the next line slightly lower down the screen. Each complete scan (frame) of the picture consists of either 405 or 625 lines, depending on the transmission standard. To reduce the bandwidth required to transmit the video information a complete frame is not transmitted in a single scanning of the picture, but is made up of two 'fields' containing half the number of lines in a frame. These two fields are interlaced with each other to make up a complete frame. Fields are transmitted at a 50 Hz rate, therefore frames are transmitted at half that rate, i.e. 25 frames per second.

The video waveform

In order to build up a picture on the screen the brightness of the trace must be modulated by varying the electron

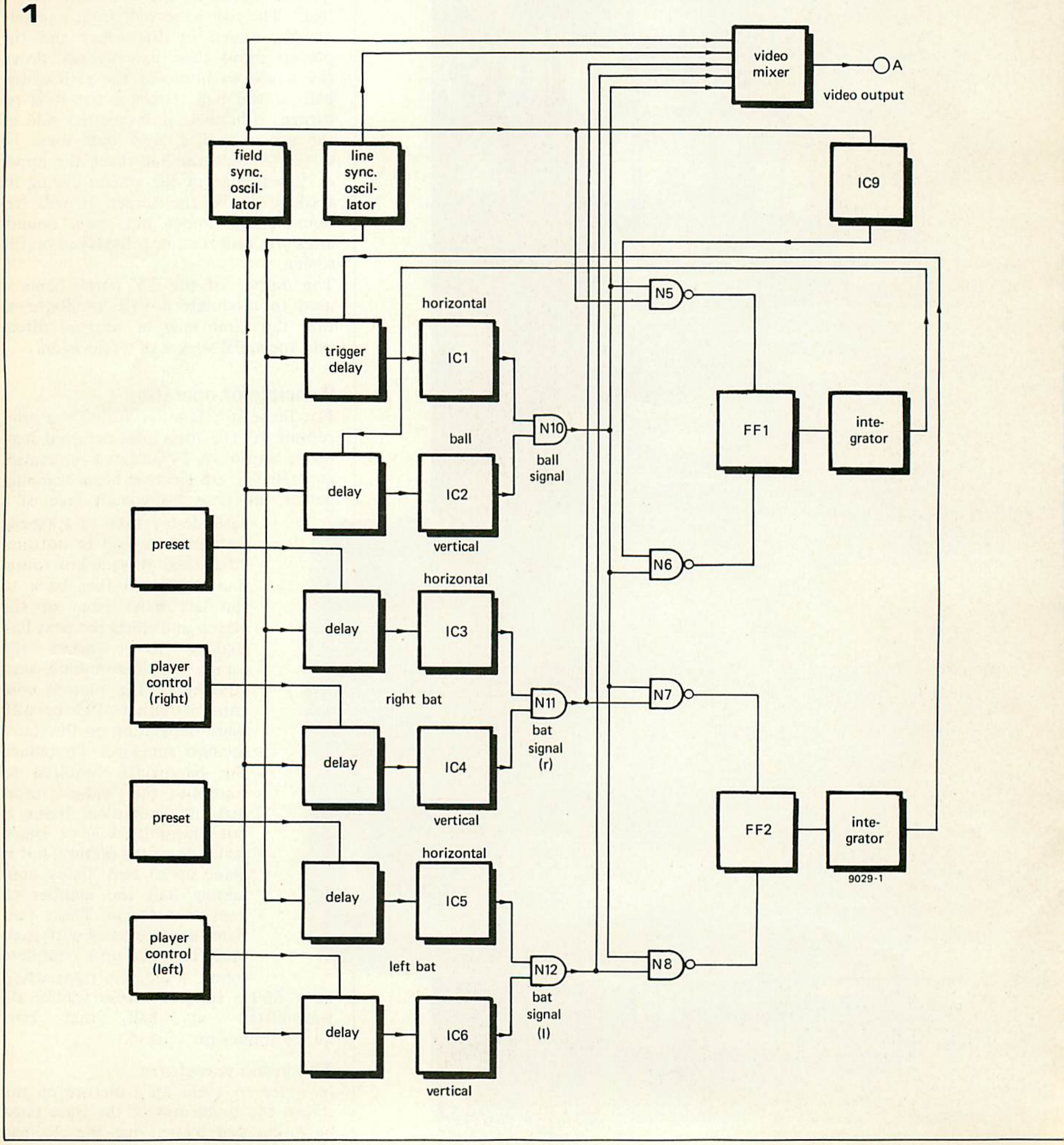
beam current. This is controlled by the amplitude of the video waveform. So that the scanning of the electron beam in the TV set is in synchronism with the received signal in order to build up the picture correctly, field sync. pulses are transmitted (at the end of each field) and line sync. pulses are transmitted (at the end of each line).
To distinguish sync. pulses from video information, sync. pulses are negative-going and confined to a voltage below that required for zero beam current (black level). Video information occupies a range of voltages above black level up to the voltage required to saturate the TV tube phosphor (peak white level). Circuitry in the TV distinguishes between sync. pulses and video information. Field sync. pulses also have a longer duration to distinguish them from line sync. pulses.
From the foregoing some of the requirements for the circuit become apparent. Firstly, the circuit must contain oscillators capable of generating field and sync. pulses at the appropriate frequencies (50 Hz and 15625 Hz respectively). Secondly, circuitry for generating the bat and ball waveforms, and for controlling the movement of these, is required. Fortunately, since we are concerned only with white bats and ball on a black background the only modulation required is peak white level or black level, so analogue circuitry is not needed to produce these waveforms, and digital logic circuits can be used to generate the rectangular pulses necessary.

Block Diagram

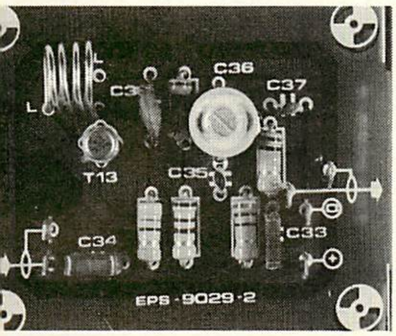
The operation of the circuit is be understood with the aid of a bloc diagram (figure 1). Sync. pulses fro the field and line oscillators are mixe in the video mixer and then fed to th modulator. They are also used to co trol the timing of the other waveform

All the video waveforms are generate using monostable multivibrators and a the generation of the 'bats' is simple this will be considered first. The lef hand player's horizontal bat generato IC5 is triggered continuously from th line sync oscillator. A presettable trigg delay is incorporated so that the puls appears a little time after the line syn pulse. This ensures that the bat appea some way in from the left hand edge c

1



screen. The right-hand player's izontal generator IC3 incorporates a ger delay so that this bat appears r the right-hand edge of the screen. ce the triggering occurs after every sync pulse the result would be a ver- l band of white the full height of the een. This is where the vertical bat gen- tor (IC6 left, IC4 right) comes in. s monostable is triggered from the d sync pulses via a delay which is tinuously variable by the player. s determines the vertical position of bat. The delayed pulse from the ver- l bat generator gates the pulses from horizontal oscillator so that they are y allowed through for the duration this pulse. The result is thus a verti- bar on the screen whose vertical ition can be varied by the player and

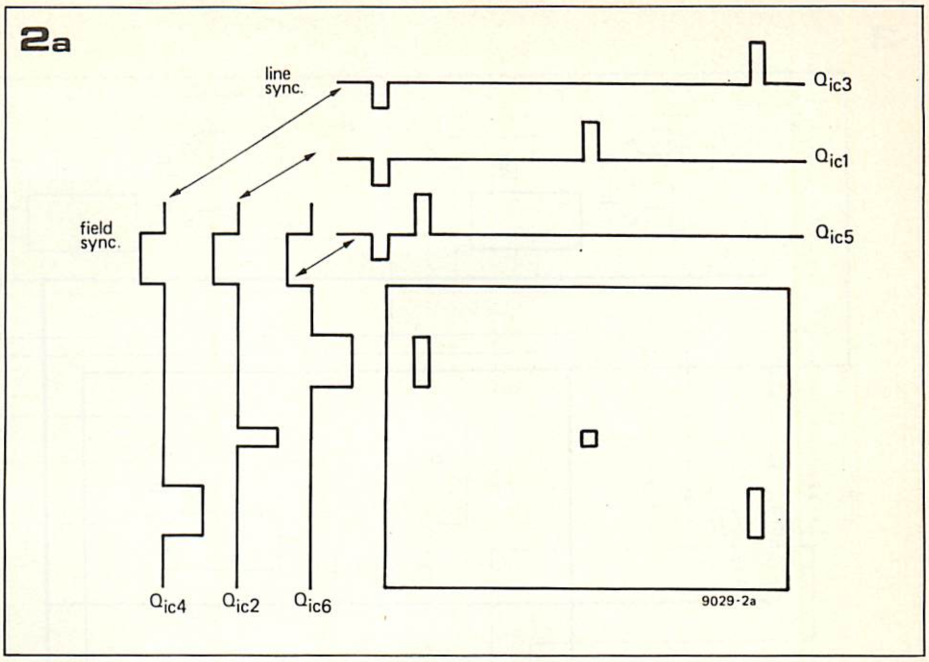


ose height (length of the bat) is ermined by the duration of the ver- l pulse. The same applies for both left- and right-hand bats.

ball is generated in a similar manner h two monostables (IC1 and IC2). wever, since the ball is continuously ving this in effect means that for vement to the right the horizontal ger delay is increasing all the time, for movement to the left it is de- ısing.

downwards movement the vertical ger delay is increasing, while for up- ds movement it is decreasing. Of rse it is necessary to reverse the ction of ball travel when the ball kes a bat or the upper and lower ndaries. This part of the circuit rates as follows:

horizontal ball pulse generator 1) is triggered via a delay by the line c pulses. The delay, and therefore horizontal position of the ball on screen, is controlled by the output an integrator, which is fed with a voltage and therefore generates a p which varies the trigger delay arly. The slope of the ramp (positive- negative-going) and hence the direc- n of ball travel is determined by state of flip-flop FF2. If FF2 is ially reset the ball will travel to the t. However, should the 'ball' out- and the right-hand 'bat' output h be high at the same time (i.e. the strikes the right hand bat) then the put of N7 goes low, resetting FF2 reversing the horizontal direction. en the ball strikes the left-hand bat n the output of N8 goes low, re- ting the flip-flop and causing the ball



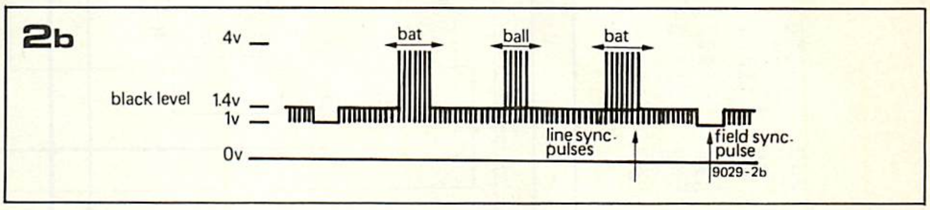


Figure 1. Block diagram of TV Tennis game (excluding modulator/oscillator).

Figure 2a. The horizontal and vertical waveforms are gated together as shown to produce the bat and ball display.

Figure 2b. The complete video waveform as seen on an oscilloscope.

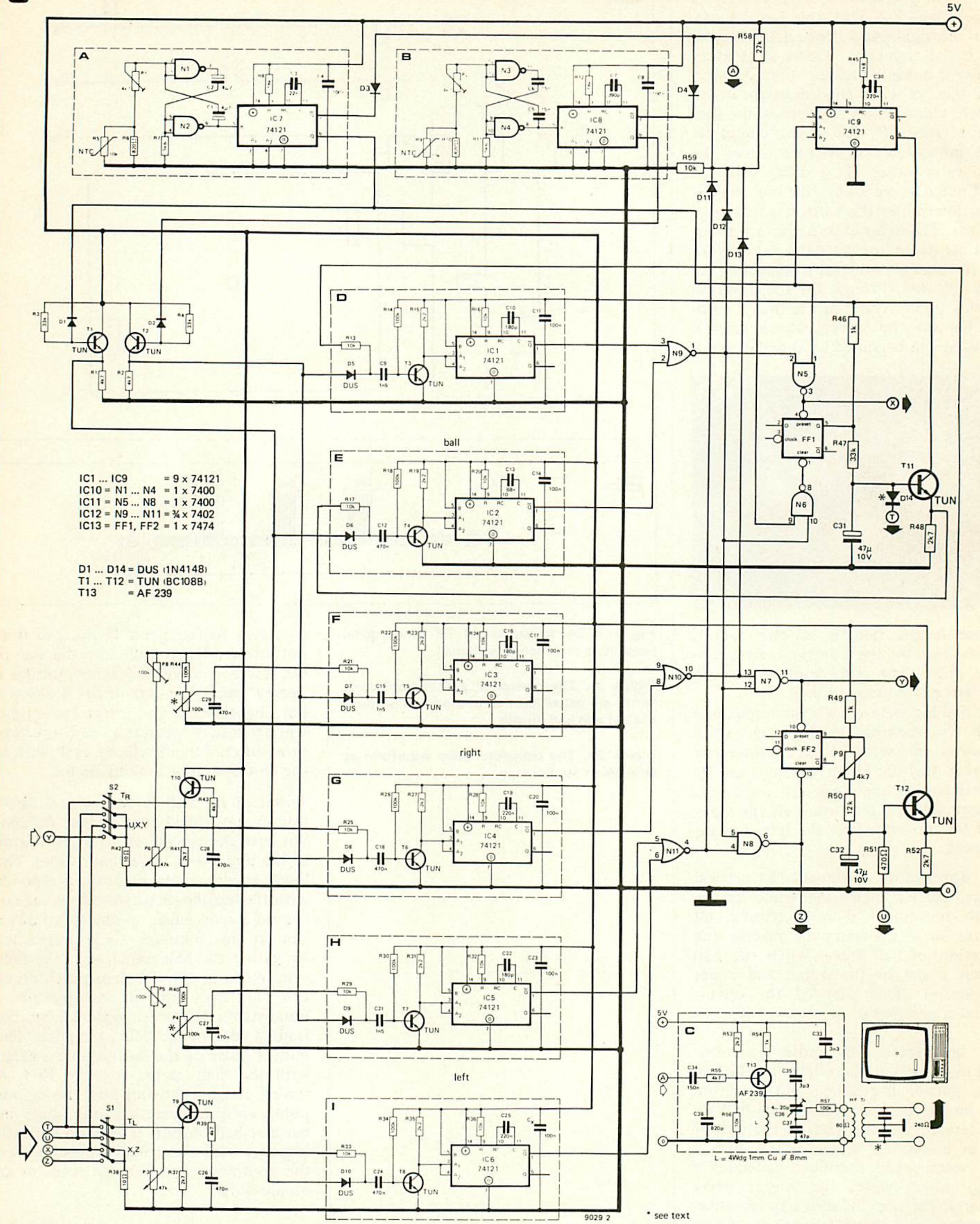
to travel to the right. If the ball does not strike a bat it will leave the side of the screen and will not return until it is 'served', since the state of the flip-flop is not changed and the integrator output will eventually saturate in one direction or another. Service will be dealt with in the description of the full circuit.

Travel of the ball in the vertical direction is controlled in a similar fashion, but here the change of direction occurs at the upper and lower boundaries. The lower border of the picture corresponds with the leading (negative-going) edge of the field sync pulse, so change of direction at this boundary is accomplished by gating the ball signal with the field sync pulse in N5. To change ball direction at the top of the picture a monostable (IC9) is triggered by the trailing edge of the field sync pulse. The output pulse of the monostable is gated with the 'ball' signal to reset FF1. A timing diagram showing how the various pulses are gated together to produce the bat and ball outputs is given in figure 2, together with the general appearance of the complete waveform as seen on an oscilloscope.

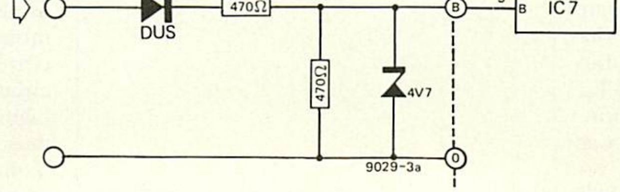
Complete Circuit

The complete circuit is given in figure 3. Field sync pulses are produced by the circuitry in box A, which consists of an astable multivibrator driving a monostable to produce pulses of the correct length. Box B contains similar circuitry, but operating at a much higher frequency, to produce line sync pulses. The $\overline{Q}$ outputs of these monostables (to produce the negative-going sync pulses) are fed via D3 and D4

3


5V
IC1 ... IC9 = 9 x 74121
IC10 = N1 ... N4 = 1 x 7400
IC11 = N5 ... N8 = 1 x 7400
IC12 = N9 ... N11 = ¾ x 7402
IC13 = FF1, FF2 = 1 x 7474
D1 ... D14 = DUS (1N4148)
T1 ... T12 = TUN (BC108B)
T13 = AF 239
ball
right
left
L = 4Wdg 1mm Cu ø 8mm
* see text
9029 2

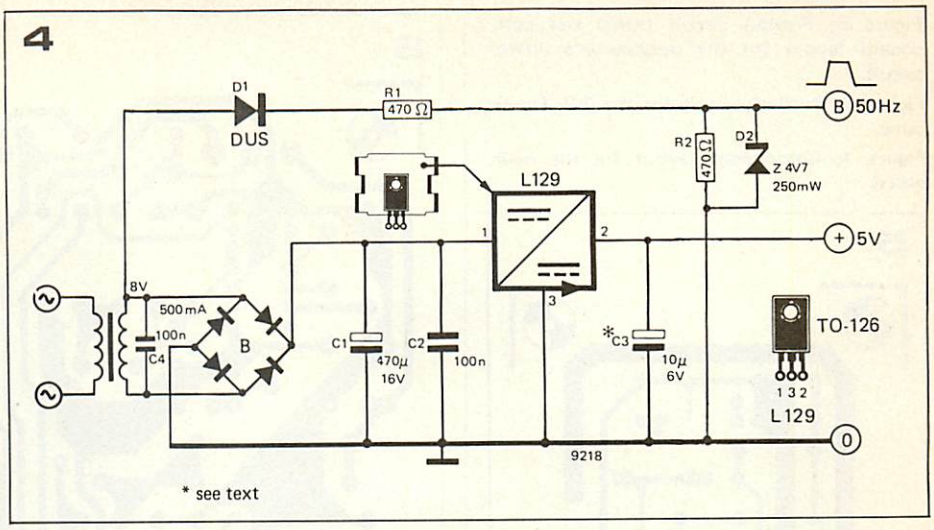
3a


6-9V 50Hz
DUS
470Ω
470Ω
4V7
IC7
9029-3a

igure 3. The complete circuit of the TV nnis game. The modulator/oscillator rcuit is shown inset at the bottom right-and corner.

igure 3a. Suggested modification to derive eld sync pulses from the mains for mains nly versions of the game. This should give a ore stable picture than the free-running eld oscillator.

igure 4. Circuit of the mains power supply or TV Tennis.



Parts list for figures 3, 5 and 7

Resistors:
R1,R2,R39,R43,R55 = 4k7
R3,R4,R47 = 33 k
R5,R9 = 10 k NTC
R6,R10 = 820 Ω
R7,R11 = 5k6
R8,R12 = 18 k
R13,R16,R17,R20,R21,R24,R25, R28,R29,R32,R33,R36,R56,R59 = 10 k
R14,R18,R22,R26,R30,R34,R40,R44, R57 = 100 k
R15,R19,R23,R27,R31,R35,R53 = 2k2
R37,R41,R48,R52 = 2k7
R38,R42 = 10 Ω
R45 = 1k8
R46,R49,R54 = 1 k
R50 = 12 k
R51 = 470 Ω
R58 = 27 k
P1,P2 = 4k7 lin. preset
P3,P6 = 47 k lin.
P4,P5,P7,P8 = 100 k lin. preset

Capacitors:
C1,C2 = 4µ7, 10 V
C3 = 22 n
C4,C8,C11,C14,C17,C20,C23 = 100 n
C5,C6 = 15 n
C7 = 390 p
C9,C15,C21 = 1n5
C10,C16,C22 = 180 p
C12,C18,C24,C26,C27,C28,C29 = 470 n
C13 = 68 n
C19,C25,C30 = 220 n
C31,C32 = 47 µ, 10 V
C33 = 3n3
C34 = 150 n
C35 = 3p3
C36 = 4 ... 20 p trimmer
C37 = 47 p

Semiconductors:
T1,T2,T3,T4,T5,T6,T7,T8,T9,T10,T11, T12 = BC547B
T13 = AF239
D1 ... D14 = 1N4148
IC1,IC2,IC3,IC4,IC5,IC6,IC7,IC8,IC9 = 74121
IC10,IC11 = 7400
IC12 = 7402
IC13 = 7474

Sundries:
L = 4 wdg, 1 mm ϕ Cu, ϕ 8 mm
HF Tr = 60 Ω → 240 Ω impedance converter (see text)

to the junction of R58 and R59. This portion of the circuitry fuctions as the video mixer. Black level occurs when the $\overline{Q}$ outputs of IC7 and IC8 are both high and the bat and ball inputs to D11, D12 and D13 are all low. The voltage at the junction of R58 and R59 is then solely determined by the value of these resistors and is about 1.35 V. When a sync pulse occurs then the junction of these two resistors is held down to about 1 V via D3 or D4. When bat or ball signals occur the inputs to D11, D12 or D13 go high, so the potential at the junction of R58 and R59 becomes about 4 V. If the unit is to be used for mains only operation the astable in box A can be dispensed with and field sync pulses may be derived from the 50 Hz mains by the modification shown in figure 3a. P1, R5, R6, C1 and C2 are omitted; the sync pulses are fed in at the original connection to the positive side of C1 on the board, and the track between this point and the output of N2 (pin 6 of IC10) must be broken.

The sync pulses are buffered by emitter followers T1 and T2 to avoid loading the monostables excessively. The buffered sync pulses are then fed via the trigger delays to the appropriate monostables which generate the horizontal and vertical components of the bat and ball waveforms. The trigger delay circuits are all identical in principle and merely vary in component values. The trigger delay for IC3 operates as follows: normally T5 is turned on by base current through R23. Its collector voltage (and hence the A inputs of IC3) is low. The cathode of D7 is held at a few volts positive by the voltage via R21 from P7 (max. 2.5 V), and since T2 is turned off the anode of D7 is at 0 V. C15 thus has a voltage across it equal to the voltage on the cathode of D7 minus the base-emitter voltage of T5. On the leading edge of the line sync pulse T2 turns on, forward biassing D7. C15 thus charges until the voltage across it is

$5\ V - V_{beT2} - V_{D7} - V_{beT5} = 3\ V$

approximately. On the trailing edge of the sync pulse T2 turns off. The voltage on the cathode of D7 therefore reverts to its initial value (the potential supplied via R21 from P7). However, since the voltage across C15 is still 3 V then the base of T5 must be negative. T5 therefore turns off. C15 now charges via R22 until the voltage on the base of T5 reaches about 0.7 V when T5 turns on and the collector voltage goes low, triggering the monostable.

It is evident that the trigger delay is dependent on the time taken to charge C15 after T5 has been turned off, which is in turn dependent upon the voltage applied to the cathode of D7 from P7. The trigger delay may thus be varied by a d.c. voltage, in the case of the bats derived from the various potentiometers, and in the case of the ball from the emitters of T11 and T12.

In the case of the ball, as explained earlier, the trigger delay in both horizontal and vertical directions is continuously varied to achieve motion of the ball. Horizontal movement of the ball is controlled by FF2 and the integrator constructed around T12. When FF2 is preset the Q output is high and C32 charges via P9 and R50. The potential on the emitter of T12 therefore rises. This is applied to R13, thus continuously increasing the trigger delay and making the ball move to the right. When FF2 is cleared (reset) then C32 discharges via P9 and R50. The voltage on the emitter of T12 falls, thus decreasing the trigger delay and making the ball move to the left. The rate of charge or discharge of C32, hence the speed of the ball, is determined by the setting of P9. Vertical ball movement is controlled in a similar manner by FF1 and T11. Note that in this circuit the AND-gates shown in the block diagram have been replaced by NOR-gates connected to the $\overline{Q}$ outputs of the monostables. This is of course exactly equivalent to AND-gates connected to the Q outputs (De Morgan's theorem).

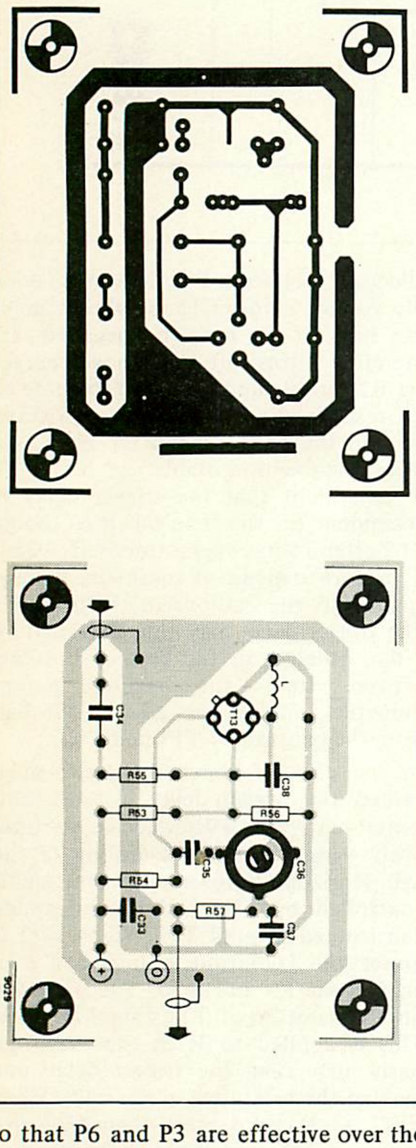
The horizontal bat trigger delays are preset,by P7 for the right-hand player, and by P4 for the left-hand player. This allows the position of the bats to be adjusted to a few cm away from the sides of the screen. The vertical position of the bats is continuously adjustable, by P6 for the right-hand player and P3 for the left-hand player. P5 and P8 are presets used to adjust the bat position

Figure 5. Printed circuit board and component layout for the modulator/oscillator circuit.

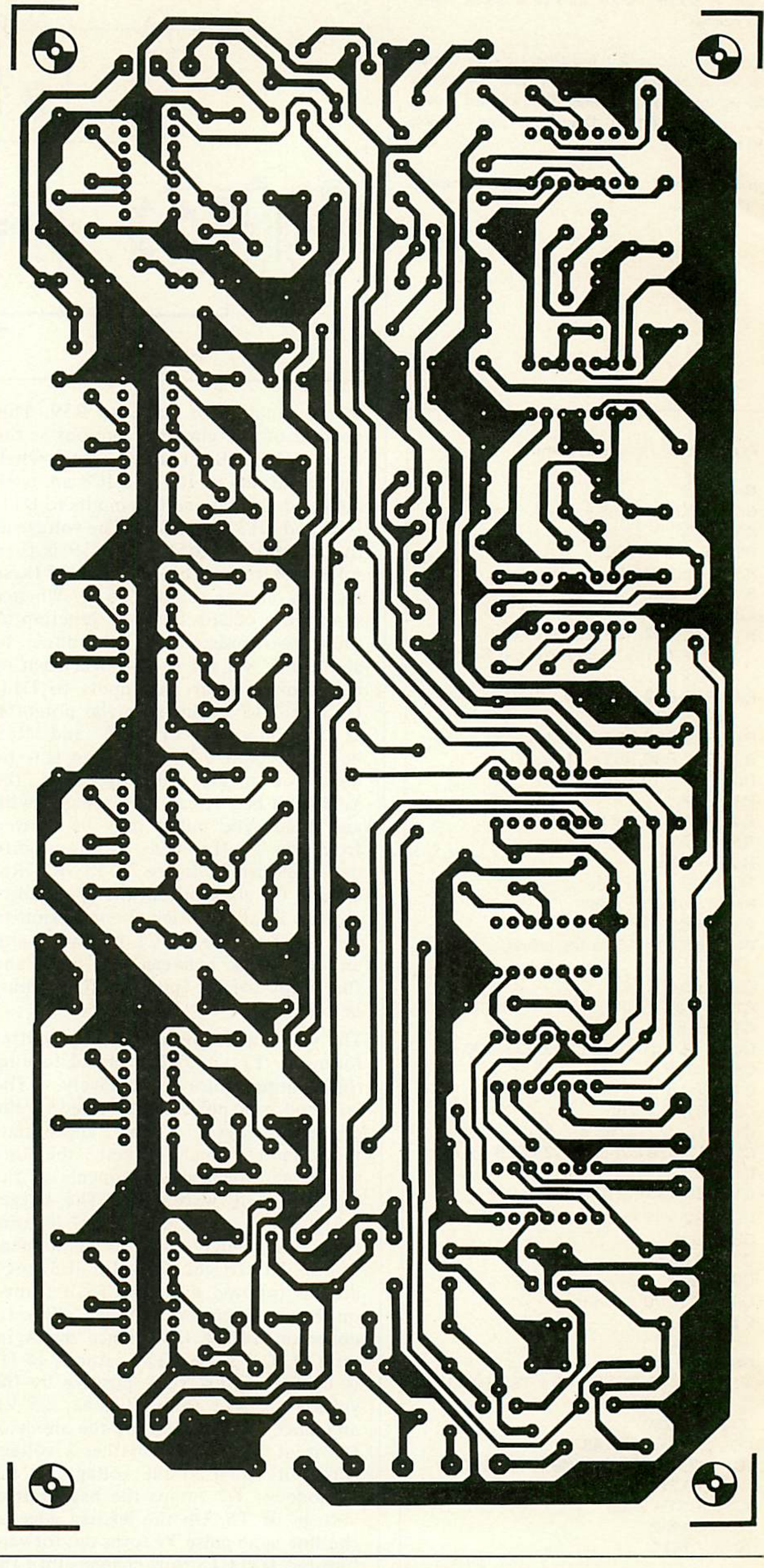
Figure 6. Printed circuit for the TV Tennis game.

Figure 7. Component layout for the main board.

5



6



so that P6 and P3 are effective over the full height of the screen.

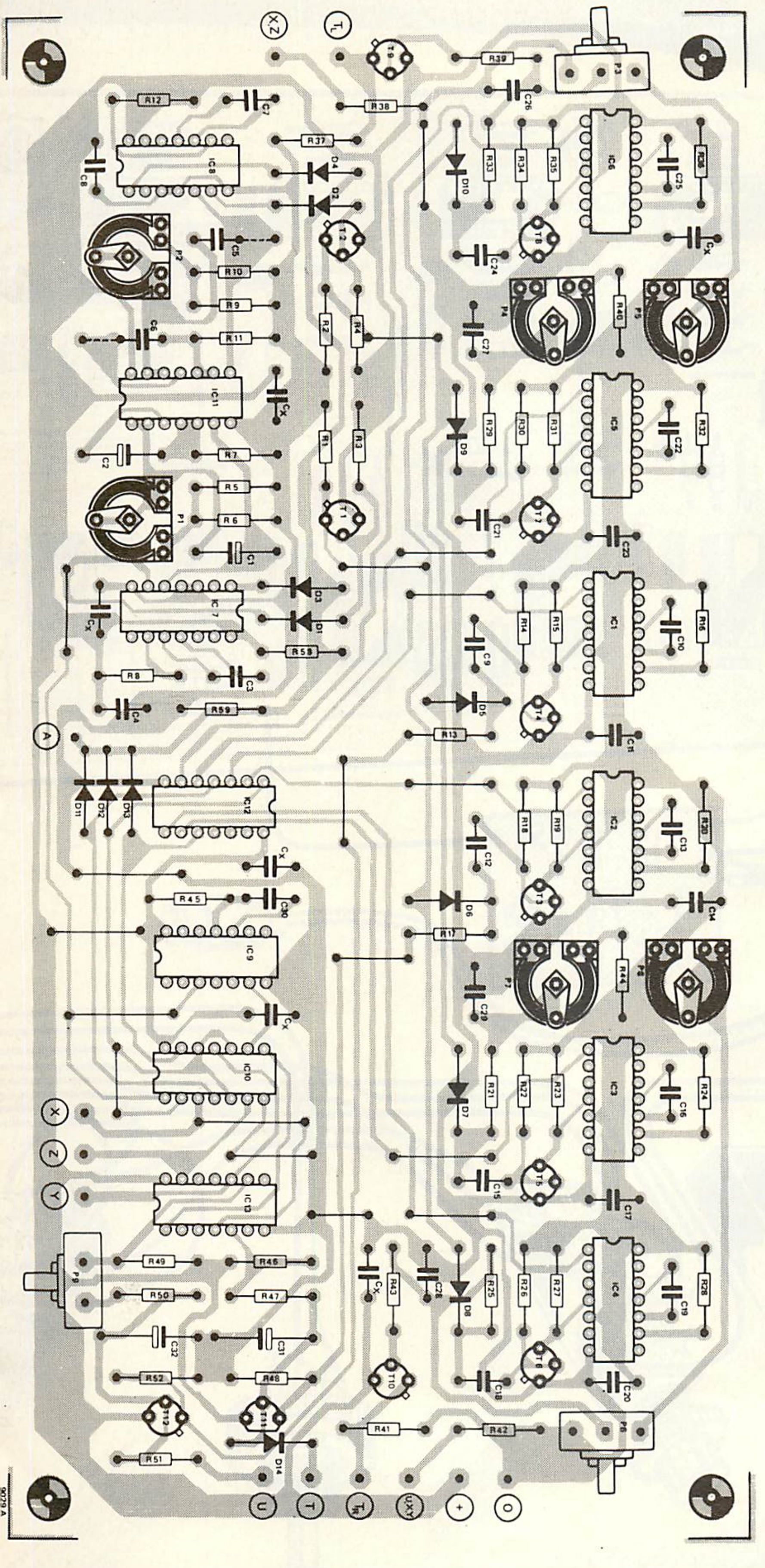
Service of the ball

It is evident that if the state of FF2 is not reversed by a coincidence between the ball and one of the bat signals then the voltage at the emitter of T12 will continue to rise or fall as C32 either charges or discharges, until it reaches either zero volts or supply minus the base-emitter voltage of T12. The ball will then disappear off one side of the screen or the other and will not return. For this reason (as well as for the rules of the game) it is necessary to 'serve' the ball when this has occurred.

Ideally the ball should emanate from the bat of the player who is serving. However, in practice this is difficult to achieve as it means that at the instant of service the vertical ball trigger delay must be matched to the vertical bat trigger delay. Since the delay circuits are independent component tolerances will make this unlikely. It is, however, possible to make the ball service dependent upon the bat position at the time of service, though not coincident with it.

Service is accomplished as follows: for a service by the left-hand player the 4-pole switch S1 is closed. Thi produces several results. Firstly points X and Z are connected to ground via R38. This clears FF1 and presets FF2 so tha when the ball is served it will travel up wards and to the right.

7



Point U (R51) is connected to positive supply, thus charging C32 rapidly and holding the ball off the left-hand side of the screen. Point T (cathode of D14) is connected to the emitter of T9, whose base is fed via R39 from P3 (left-hand bat control). The voltage on C31 is thus constrained to slightly above the emitter voltage of T9, thus determining the vertical position from which the ball will start. When the switch is released the constraints on C31 and C32 are released so the ball travels in a direction determined by the states of FF1 and FF2 (i.e. up and to the right).

Service by the right-hand player operates, so to speak the same way but backwards, i.e. pushing S2 grounds point X so that the ball still travels upwards. However, point Y is grounded so that the ball travels to the left, and point U is grounded to discharge C32 so that it starts from the right. The vertical starting position is determined by the emitter potential of T10.

Modulator and oscillator

The only part of the circuit which remains to be described is the modulator/oscillator which converts the video output at point A into a VHF signal suitable for feeding direct into a television aerial socket. This part of the circuit is shown inset in figure 3. An AF239 forms the basis of the oscillator circuit which is tuned to the required frequency by the coil L and C36/C37. The output may be fed direct into an unbalanced 50 - 75 Ω coaxial cable terminating in a normal TV coax plug, or if the TV has continental type 240 - 300 Ω twin feeder input then the output must be fed through an inverse balun transformer before feeding into the 300 Ω feeder.

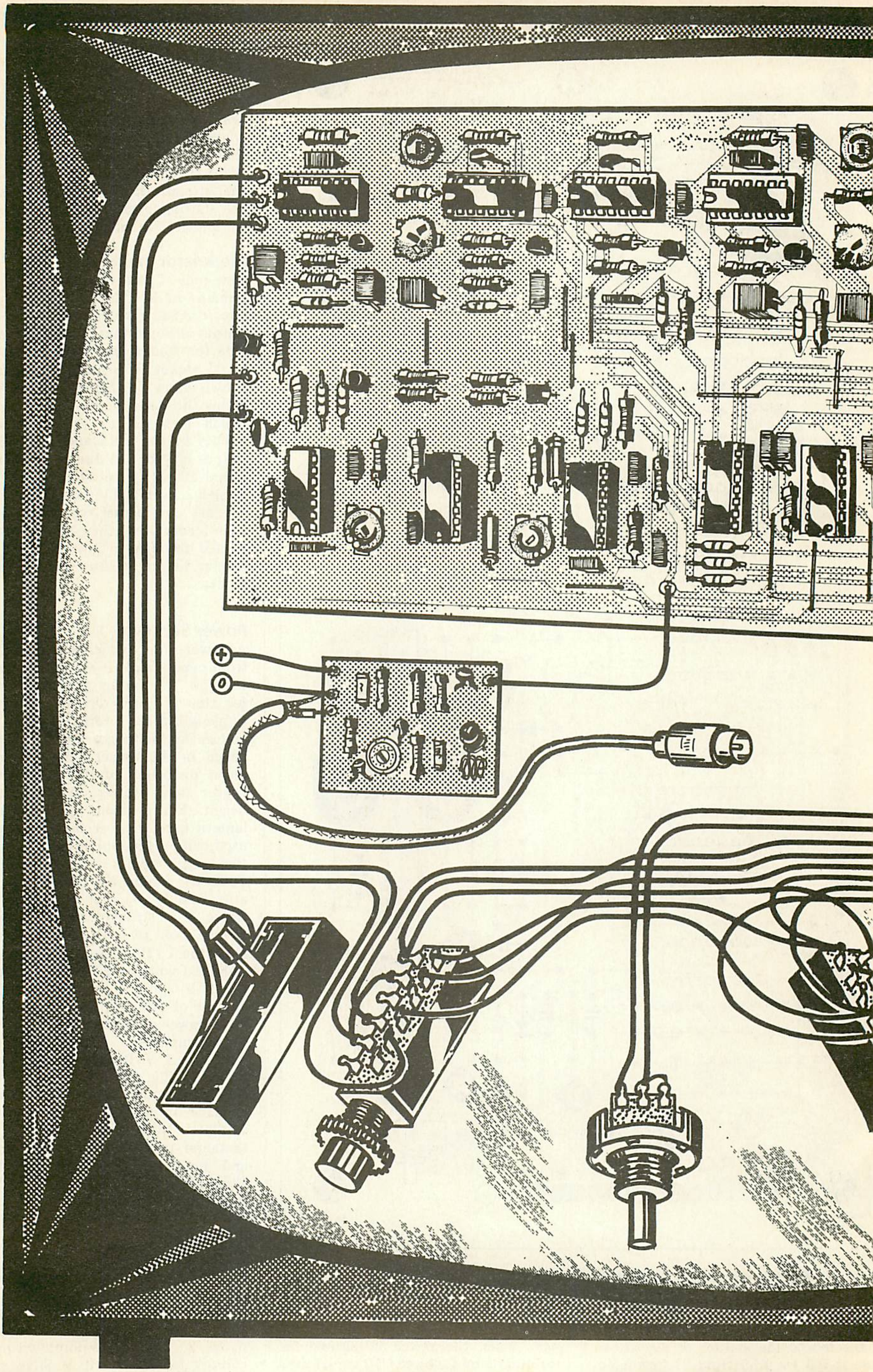
Power Supply

A power supply which is absolutely free from mains ripple is absolutely essential for the TV Tennis game. The reason for this is fairly obvious. Any mains ripple will cause a variation in the input voltages to the trigger delay circuits, and hence in the trigger delays. This produces distortion of the picture as the trigger delay varies down the screen height. For portable operation a 6 V lantern battery or accumulator may be used, with a decoupling capacitor across the supply pins on the board (say 1000 μ), whilst for mains only operation the 5 V power supply shown in figure 4 is strongly recommended. It is based on an integrated circuit regulator the L129. This IC will provide a stabilised voltage of 5 V from inputs up to 20 V and will supply a maximum current of 600 mA. However, to minimise power dissipation within the IC it is recommended that a transformer with a 6.3 V RMS secondary voltage be used. This will give a D.C. input to the IC of about 9 V. The bridge rectifier is made up of 4 1-amp diodes such as 1N4001. Note that C3 should be a tantalum type to reduce output noise and any tendency to R.F. instability. Components D1, D2, R1 and R2 correspond with figure 3a.

Construction and adjustment

The p.c. board and component layout for the VHF oscillator are given in figure 5, for the main board in figures 6 and 7, and for the power supply in figure 8. A point-to-point wiring diagram is given in figure 9. Slider poten-

9



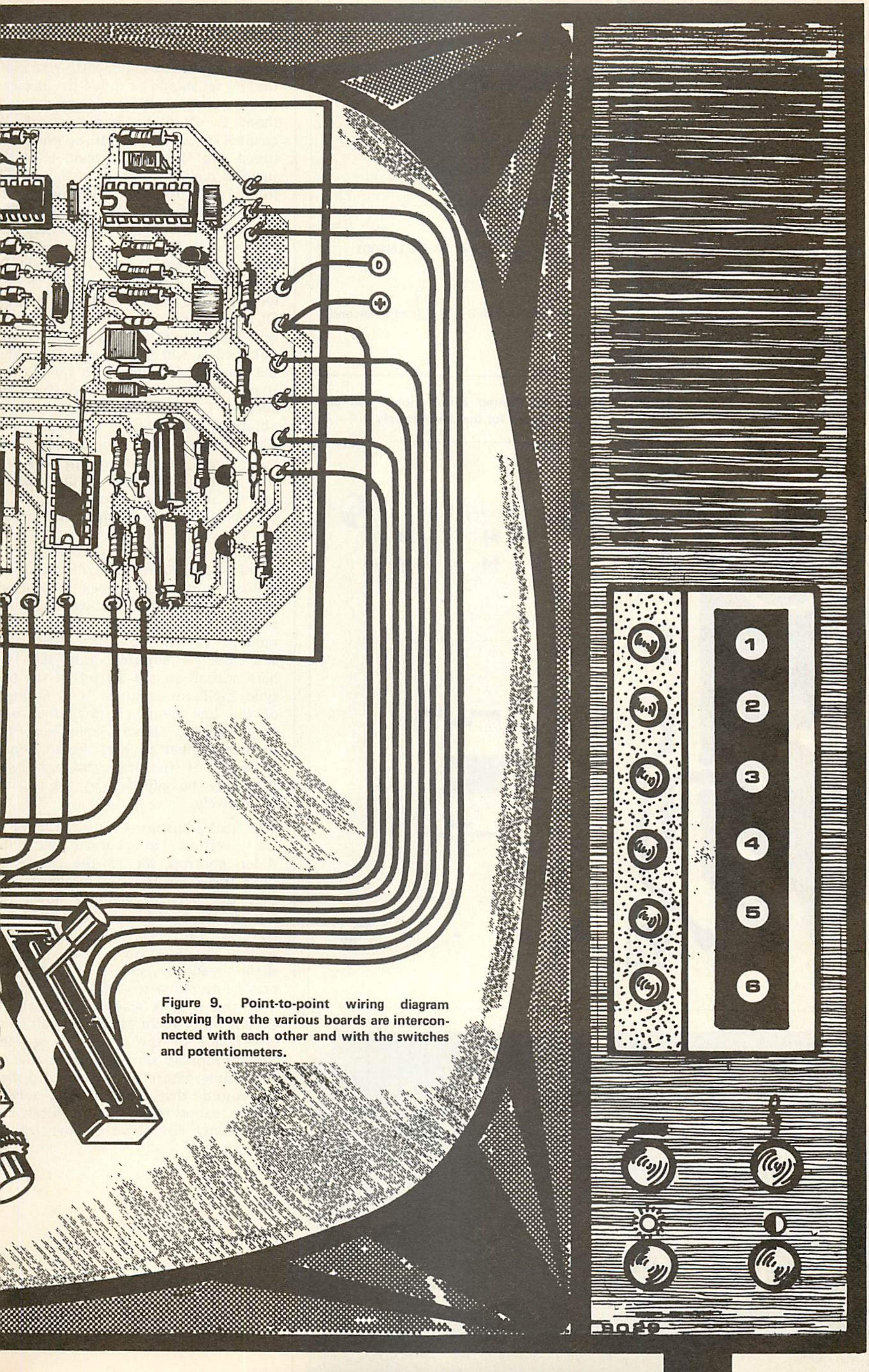


Figure 9. Point-to-point wiring diagram showing how the various boards are interconnected with each other and with the switches and potentiometers.

tiometers are used for the bat controls as these give easier control than rotary types and are sufficiently robust for domestic use. The oscillator is mounted on a separate board as it must be housed in a completely screened box to avoid radiated interference and to minimise pickup of other transmissions. A small diecast or pressed aluminium box with a lid is suitable. The main board housing should also be a metal box. Having checked that the circuit is correct and that the power supply is giving the correct voltage before connecting it to the unit, power can then be applied and the output of the VHF oscillator plugged into a TV set. Due to the harmonics generated extending into the hundreds of MHz the unit will function on both VHF and UHF although the line oscillator frequency is of course different for 405 and 625 line reception. Initially all the potentiometers should

Parts list for figures 4 and 8

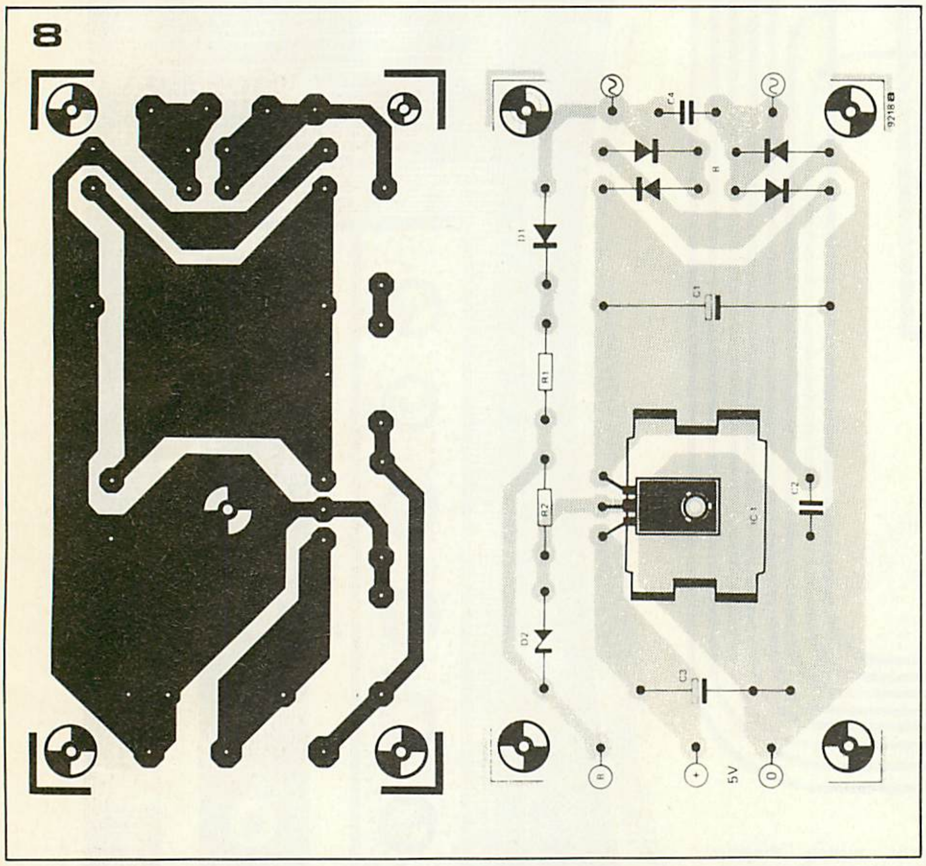
Resistors:
R1,R2 = 470 Ω

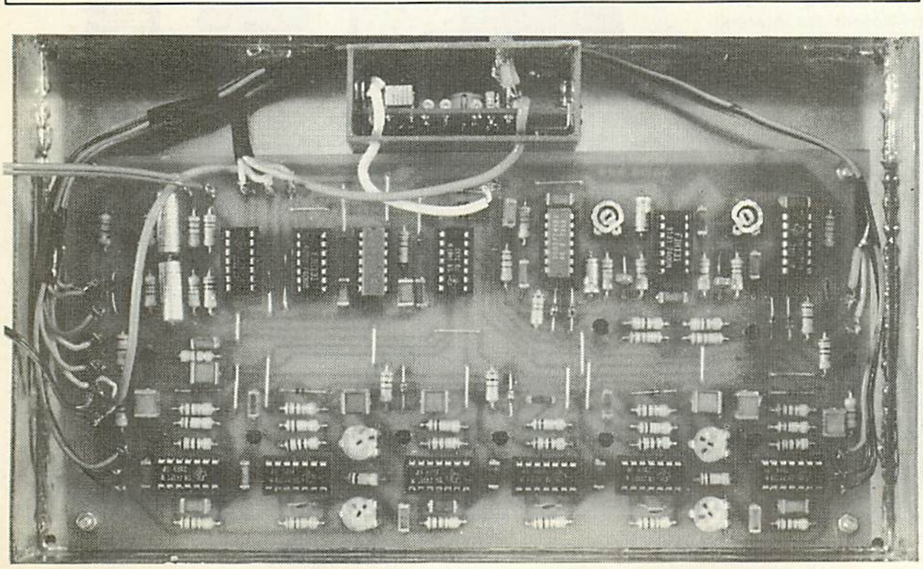
Capacitors:
C1 = 470 µ/16 V
C2,C4 = 100 n
C3 = 10 µ/6 V (tantalum)

Semiconductors:
D1 = DUS
D2 = 4.7 V zener
B = Bridge rectifier, or 4 x 1N4001
IC1 = L129

Sundries:
Transformer, 6.3 ... 8 V (r.m.s.) secondary

Figure 8. Printed circuit board and component layout for the power supply.





be set at the middle of their travel. If oscilloscope is available the waveform point A can be checked, if not, th proceed as follows. For VHF operati the TV set should be tuned to channel or 9, though with pushbutton tune there is often no indication of t channel the set is tuned to, so it must tuned over the entire band until t signal is picked up. By adjusting the T tuning and C36 it should be possible tune in the signal. At first the pictu will be rather chaotic as the field a line sync oscillators are not running the correct frequency. By adjusting it should be possible to obtain vertic lock, i.e. the picture will stop 'rolling Of course with mains field sync there no adjustment and if lock is n obtained it will be necessary to adju the frame hold control on the TV se It may be found that, due to the tole ances of C1 and C2 it is not possible obtain the correct field sync frequenc The oscillator may run at 25 Hz, which case the picture will lock b will jitter considerably. In this case and C2 should be reduced to 2 µ 2. may be found that a black bar appea in the centre of the screen. This because the field sync oscillator running at 100 Hz, and P1 should adjusted until normal lock is obtaine Having obtained vertical lock t picture will probably consist of random pattern of white dashes. can now be adjusted until the tw bats appear on the screen. If the li sync oscillator is tuned to a multip of the line frequency then four ba may appear. Having obtained t correct number of bats the horizont positions of the left- and right-han bats may be adjusted by P4 and respectively.

The final adjustment is to the range the vertical bat controls. With t slider controls set to the centre their travel P5 and P8 are adjusted that the bats are halfway down t screen. It should now be possible traverse the bats over the enti screen height, and some furth slight readjustment of P5 and may be necessary to achieve this.

The unit is now ready for use and should be possible to serve a ball fro either side of the screen by pressi the appropriate service button. Due the simple nature of the circuit it ma be found that pressing the servi button causes slight picture jitter, b this should not prove inconvenient practice.

frequency counter

Logic IC's are nowadays so cheap that it is possible to build a digital frequency counter for a very small outlay. The circuit described here is based on the popular 74 TTL logic family. The first part deals with the basic counter, and in a subsequent article additions to the instrument will be described.

Specification

Input sensitivity (frequency measurement)	1.7 V p-p.
Input sensitivity (period measurement)	2.6 V p-p.
with an input risetime of 0.5 μs/V.	
Maximum input frequency	18 MHz.

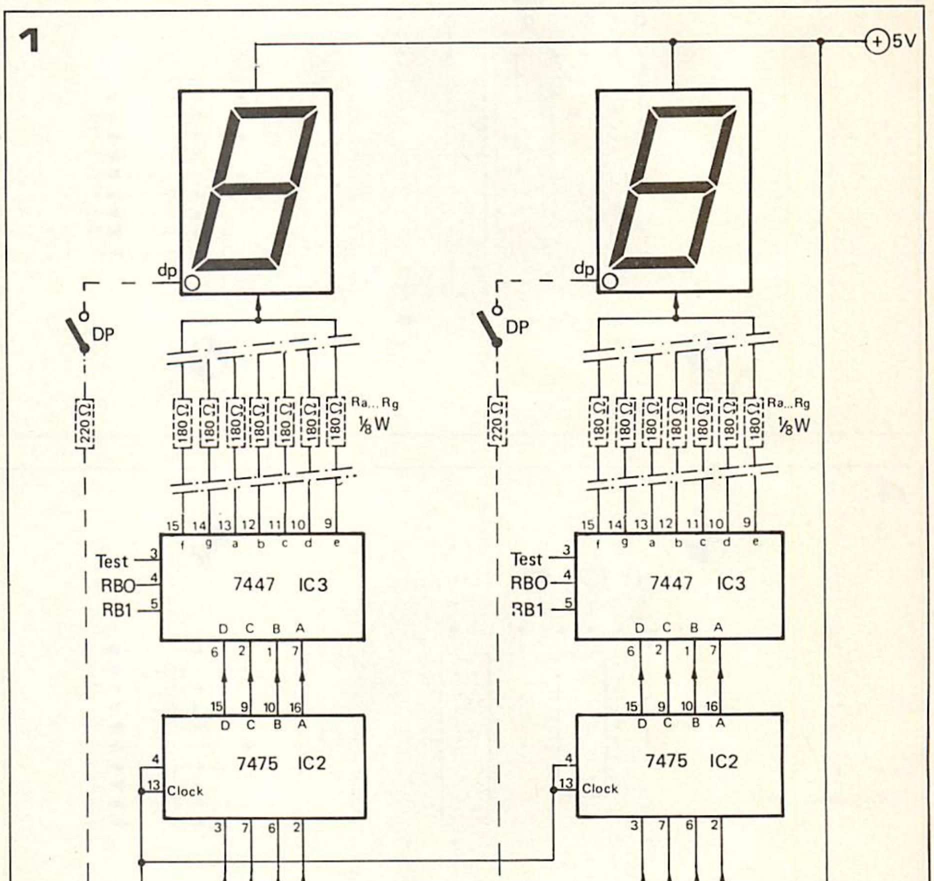
n its basic form the instrument is a six-igit frequency/period meter. The basic ounter/latch/display is shown in figre 1, which is the circuit of two stages f the counter, showing how the 7490's re cascaded, and how the interconections between the latch and reset nputs are made. The segment series reistors are shown dotted, as the circuit hay be used with either Minitron or ED displays, and series resistors are ot required with Minitrons.

 p.c. board for one stage of the ounter/latch/display decoding is given n figure 2. Six of these boards are reuired for the six-digit counter. The isplays are all mounted on a single oard to which the counter boards are vired, either with wire links, as in figre 3, or if LED displays are used, via egment resistors, as in figure 4.

igure 5 shows the pinout and voltage/urrent curve for a Minitron display ype 3015F. Note that for use with a 447 decoder the points shown as round are in fact commoned to +5 V. p.c. board for use with Minitron disays is shown in figure 6, and the comonent layout in figure 7, showing the onnections to a counter board.

igure 1. Two stages of the counter/latch/isplay circuit, showing how the counters are ascaded.

1

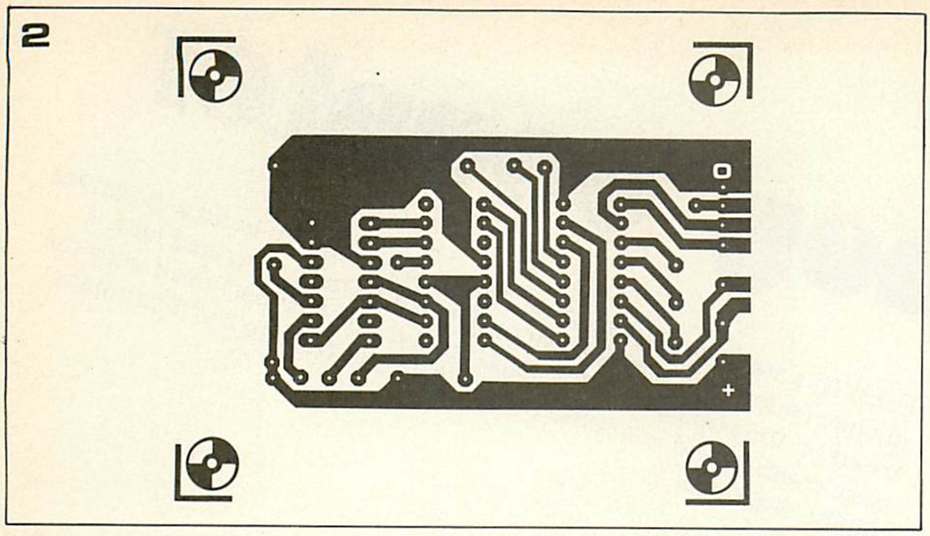


Parts list for figure 1

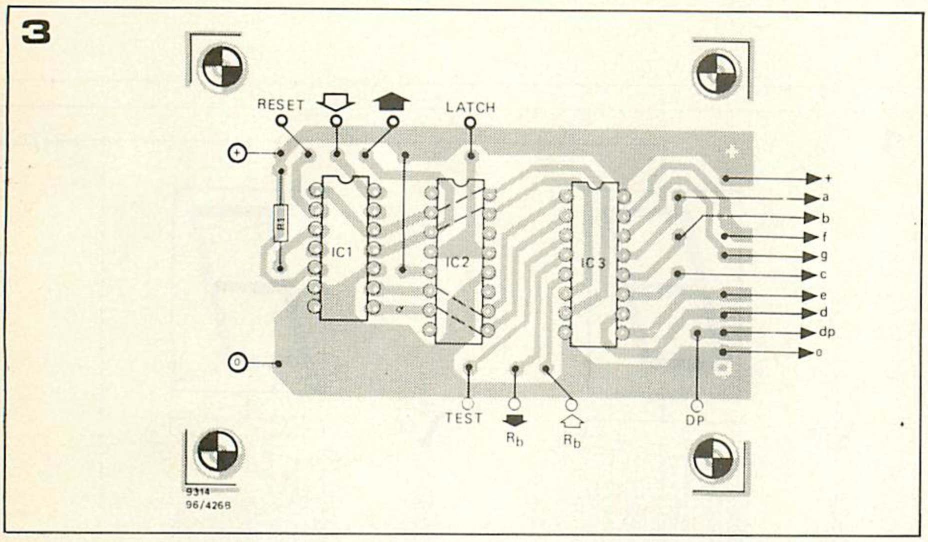
IC's:
IC1 = 7490
IC2 = 7475
IC3 = 7447

Resistors:
R1 = 1 k
$R_a \ldots R_g$ = 180 Ω (LED display only)

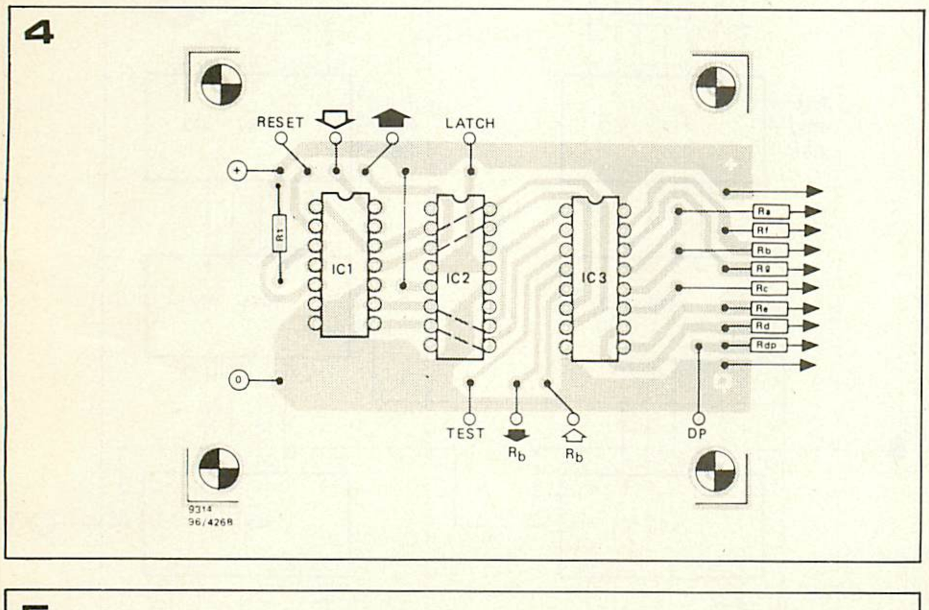
2



3



4



5

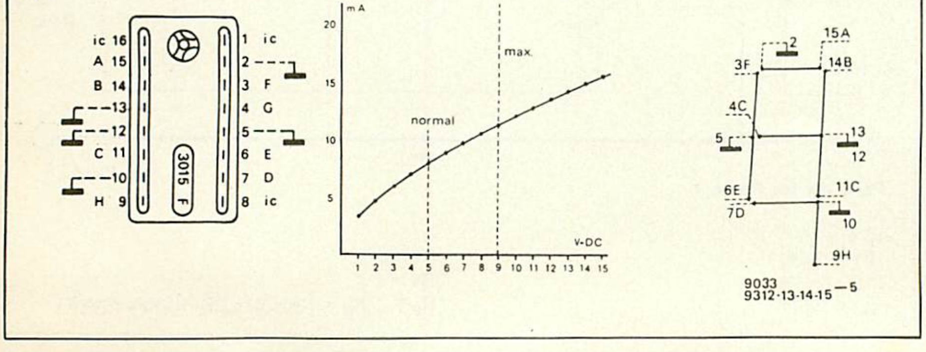


Figure 2. P.c. board for one decade of t counter, latch and display driver.

Figure 3. Component layout for figure 2 usi Minitron displays.

Figure 4. Component layout for figur showing segment resistors for LED displa

Figure 5. Pinout and characteristics of Mi tron.

Figure 6. P.c. board for Minitron displ

Figure 7. Component layout for Minitr display.

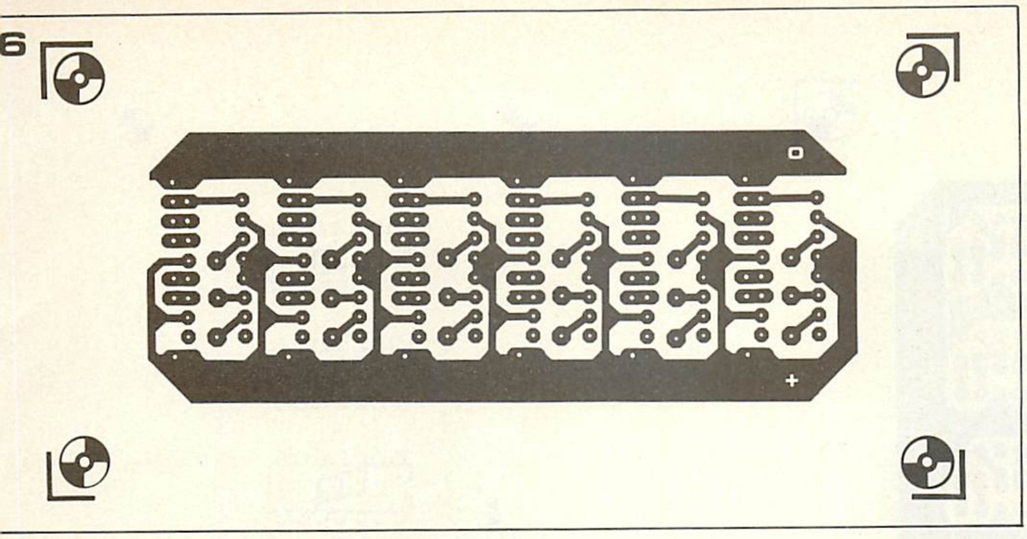
Figure 8. Pinouts of three popular LED d plays.

Figure 9 shows the corresponding boar for use with LED displays. Most com mon anode LED displays are pin com patible with respect to the cathode (se ment) connections, but some types hav multiple anode connections (usuall pins 3 and 9). These are catered for c the board, but if a display is used th does not have anode connections t these pins it may or may not be neces ary to cut them off, depending c whether or not they are N.C. (no con nection).
The pin connections of three popul LED displays are given in figure 8. Fo further data on common-anode LED di plays see Elektor No. 3 page 451.
Photographs 1 and 2 show the gener appearance of the display/counter boar assembly, and also how the segmen resistors are soldered to the back of th display board when using LED display

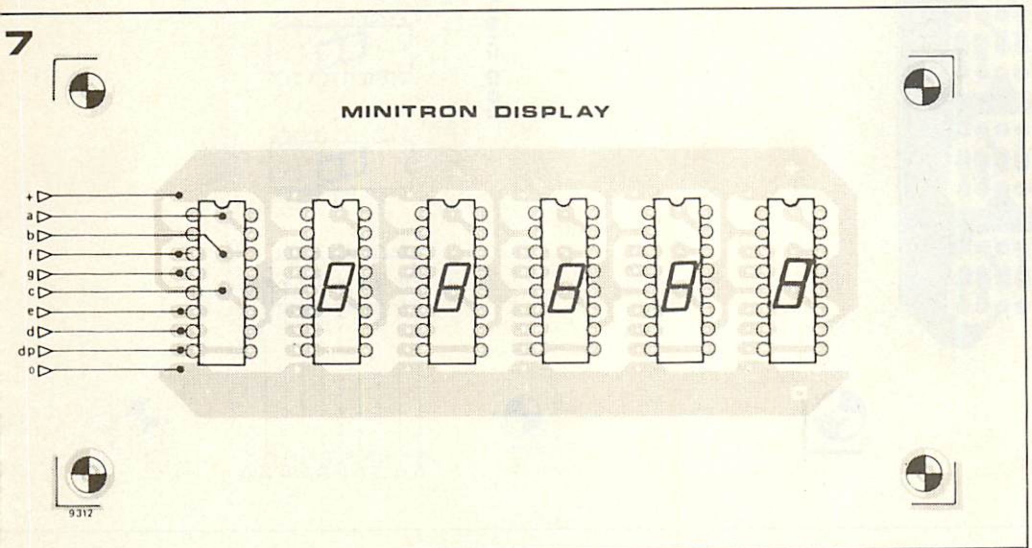
Control logic

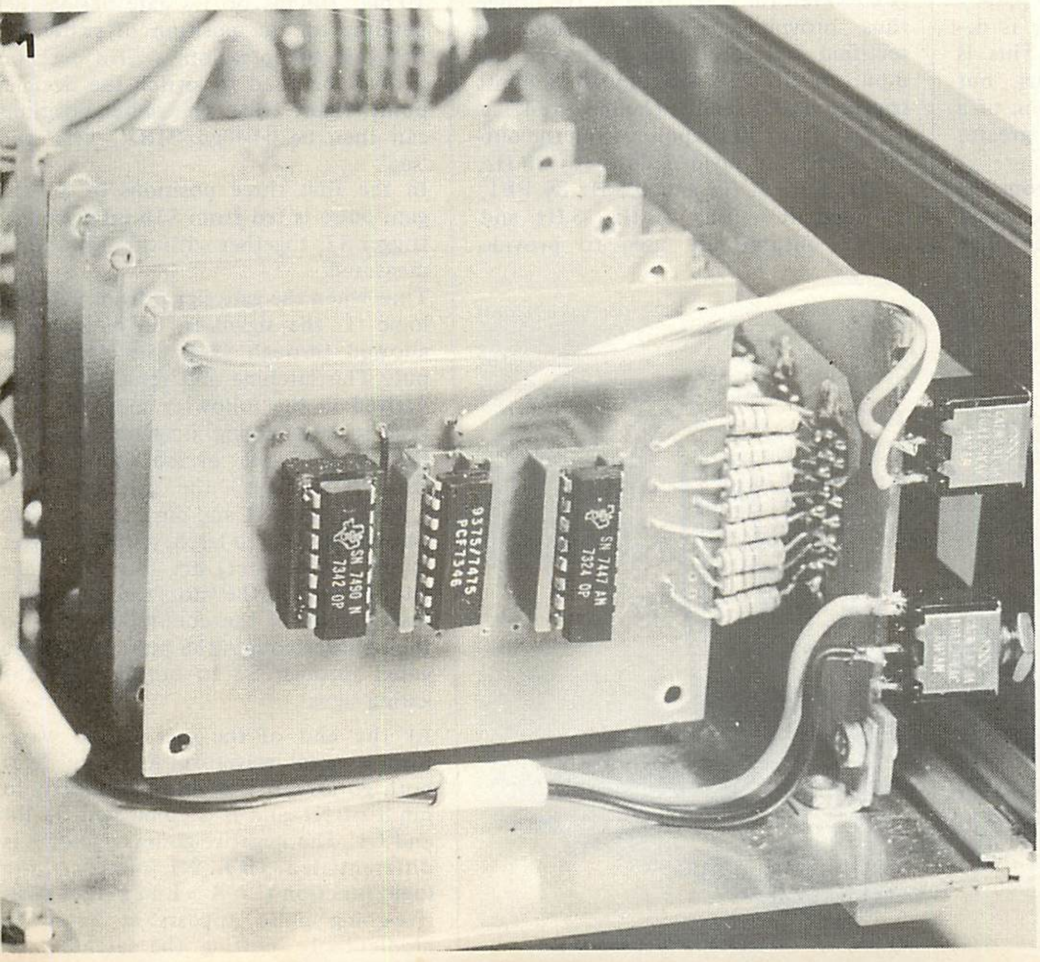
To make the decade counter just de scribed function as a frequency counte various control signals must be applie to it. Firstly, the pulses to be counte must be gated into the first stage of th counter. Secondly, after the coun period has ended the count must b stored in the latch. The counter mus then be reset ready for the next coun All these functions are performed b the control logic, the circuit of which given in figure 10.
The counter will operate in two basi modes, frequency and period. In th frequency mode incoming pulses ar counted for a period of time dependen upon the counter gate period. Thus i the incoming frequency was 100 kH and the gate period 1 s then the coun displayed would be 100000.
In the period mode the internal fre quency reference of the counter is itsel counted and is gated by one cycle of th incoming signal. Thus, if the interna reference frequency was 100 Hz, an the signal to be measured had a perio of 1 s, then the count displayed woul be 000100. Of course the decimal poin on the display board can be shifted s that this could be displayed as 1.00 (se below).
The control logic operates as follows. I

6

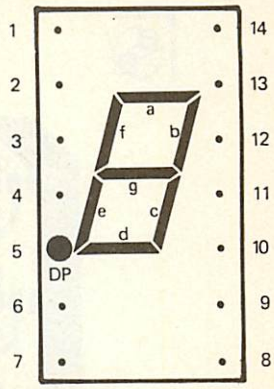


7





8



Opcoa SLA 1

Pin	
1	Cathode a
2	Cathode f
3	NC
4	NC
5	NC
6	Cathode DP
7	Cathode e
8	Cathode d
9	NC
10	Cathode c
11	Cathode g
12	NC
13	Cathode b
14	Common Anode

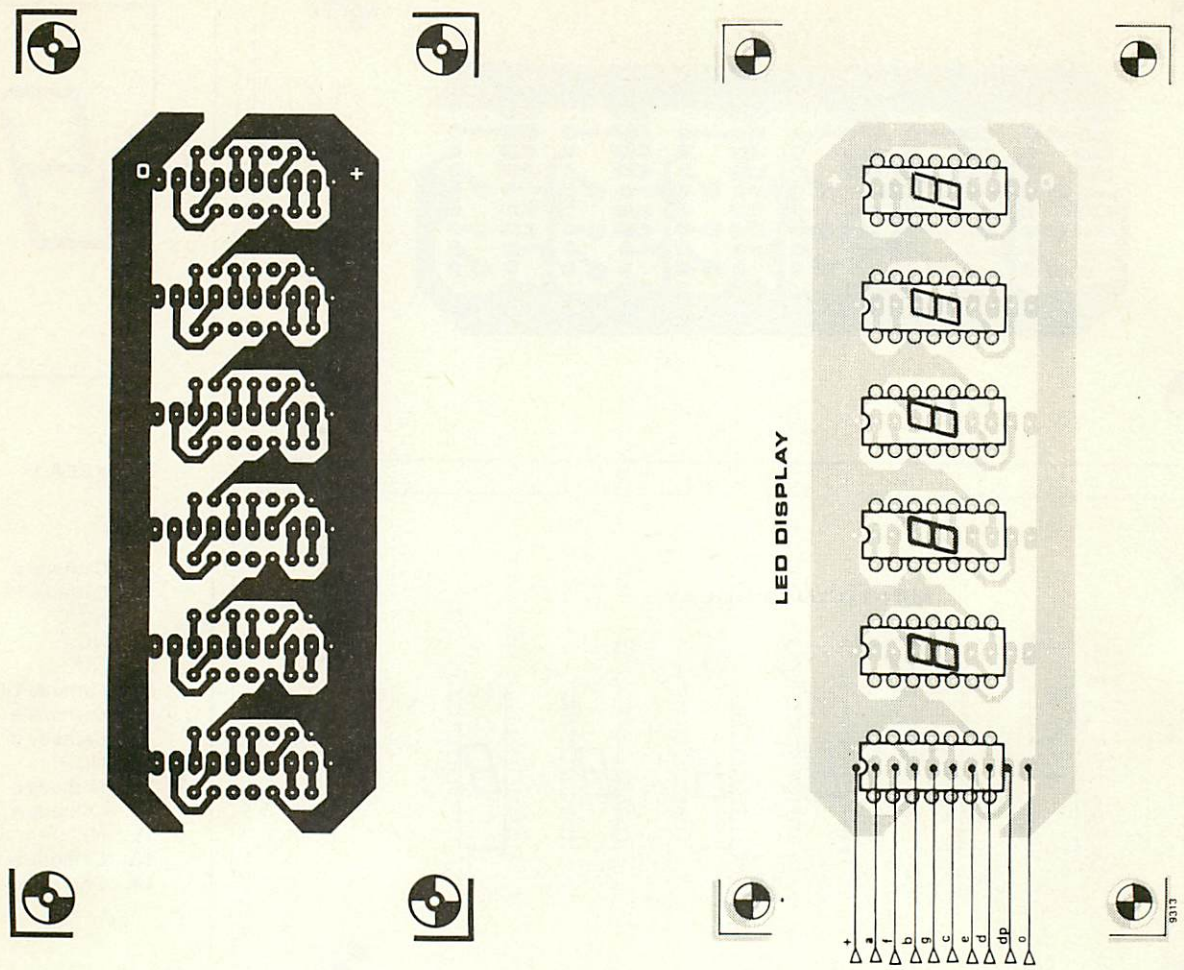
Hewlett-Packard

Pin	5082-7730
1	Cathode a
2	Cathode f
3	Common Anode
4	No pin
5	No pin
6	Cathode DP
7	Cathode e
8	Cathode d
9	NC
10	Cathode c
11	Cathode g
12	No pin
13	Cathode b
14	Common Anode

Data Lit 707

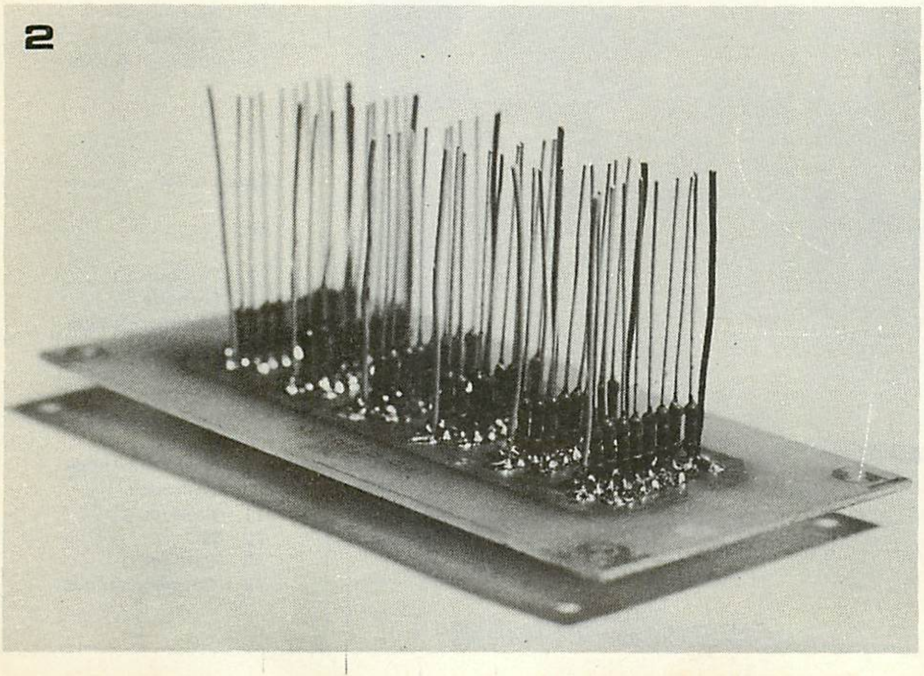
Pin	
1	Cathode a
2	Cathode f
3	Common Anode
4	NC
5	NC
6	Cathode DP
7	Cathode e
8	Cathode d
9	Common Anode
10	Cathode c
11	Cathode g
12	NC
13	Cathode b
14	Common Anode

9



the basic version of the frequency counter the reference frequency is derived from the 50 Hz mains. This is adequate for many applications, but provision is made for the addition of a crystal-controlled reference for greater accuracy and versatility.
The 50 Hz reference is taken from the secondary of the mains transformer that supplies power to the counter. The A.C. waveform is rectified by the bridge thus providing a 100 Hz full-wave rectified waveform. This is fed to the input of S1 (½ 7413 NAND Schmitt trigger) via R1, and is clamped to 4.7 V by D1. The 100 Hz pulses from the output of S1 are divided down to 50 Hz, 10 Hz, 5 Hz, 1 Hz and 0.5 Hz by FF1, IC4 and IC5. The 50 Hz, 5 Hz and 0.5 Hz outputs are used to provide 10 ms, 100 ms or 1 s gate periods depending on the position of switch S1. For ease of operation, a fifth deck on S1 can be used to switch the decimal point (figure 10b). The switch positions can then be labelled 'MHz', 'kHz' and 'sec'.
In the first three positions of S1 the gate pulse is fed from S1b into Schmitt trigger S2, together with the signal to be measured.
Thus when the gate signal from S1b is at logic '1' the signal to be measured is allowed through S2 to the counter input. The latching and reset signals are derived in the following manner, referring to the timing diagram figure 11. During the gate period (waveform B from S1b 'high') the gating signal B holds pin 9 of N1 and pin 11 of N2 high. The outputs C (to latch) and D (to reset inputs of counter) are thus low. The latch is thus in the 'store' mode and the reset inputs of the counter are low, so the counter counts the pulses which are gated through S2 to output E by the gating signal.
At the end of the gate period waveform B and waveform A (from S1a) both go low. A is connected directly to pin 8 of N1 and B is connected via R4 and C1. The negative-going edge of B is differentiated (B'). N1 performs the logic function $C = \overline{A + B}$ so a short positive-going pulse appears at output C, momentarily putting the latches into

2



10a

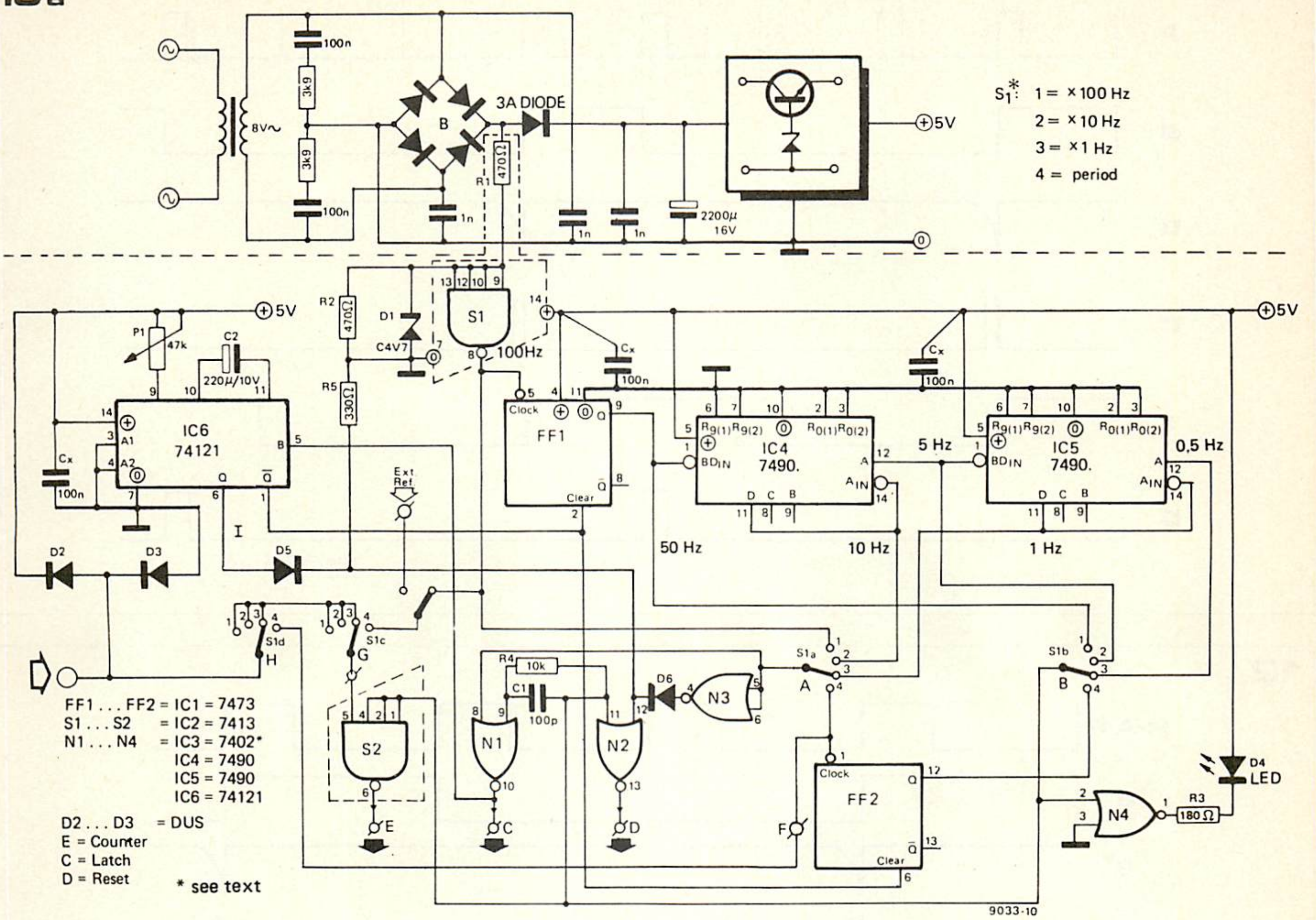
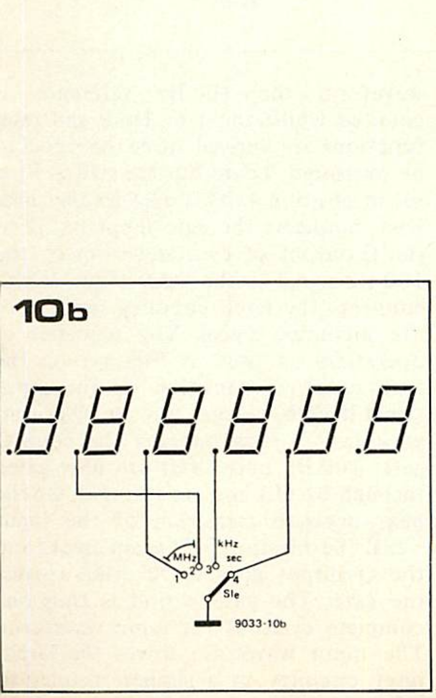


Figure 9. P.c. board and component layout for LED display.

Figure 10. Circuit diagram of control logic.

10b



the 'enable data entry' mode and thus storing the count. This pulse also triggers the monostable IC6, which performs several functions. Firstly, its Q output holds the input to S1 high, thus blocking the 100 Hz pulses to FF1. It also holds pin 12 of N2 high, so the output remains low. The $\overline{Q}$ output clears FF1. When the monostable resets the timebase will restart. The next positive transition of the A signal will be inverted by N3, and the input (pin 12) of N2 will be pulled low by R5. Since the other input is connected to the B signal, which is already low, the output of N2 goes high for the duration of the positive A pulse, thus resetting the counter. When the B signal goes high again the counter commences another count and the sequence repeats. D4 lights when the gate is open.

The pulse length of the monostable IC6 can be varied by P1. It is apparent that this pulse length determines the time for which the timebase is disabled, and hence the interval between counts. This facility is useful, as with a short count interval the continual variation in the last digit can be annoying. A longer count interval will alleviate this. On the other hand, when a rapid succession of measurements is to be taken then a short count interval is useful.

Period Measurement

To measure the period of the incoming

Parts list for figure 10

Resistors:
R1,R2 = 470 Ω
R3 = 180 Ω
R4 = 10 k
R5 = 330 Ω
P1 = 47 k, lin.

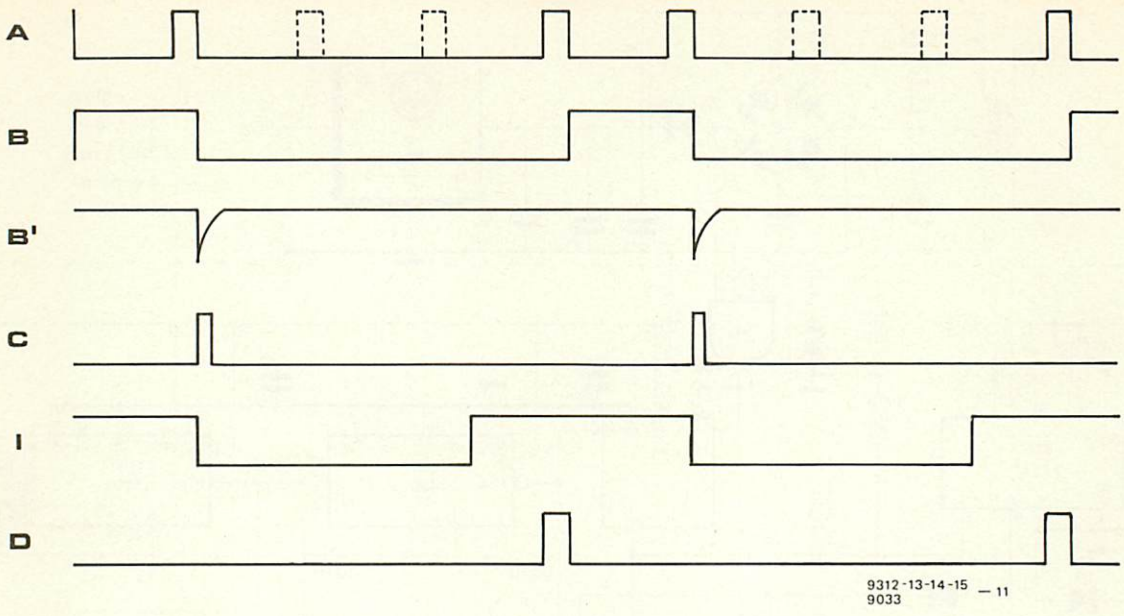
Capacitors:
C1 = 100 p
C2 = 220 μ, 10 V
C_x = 100 n

Semiconductors:
D1 = zener 4.7 V, 250 mW
D2,D3,D5,D6 = DUS
D4 = LED

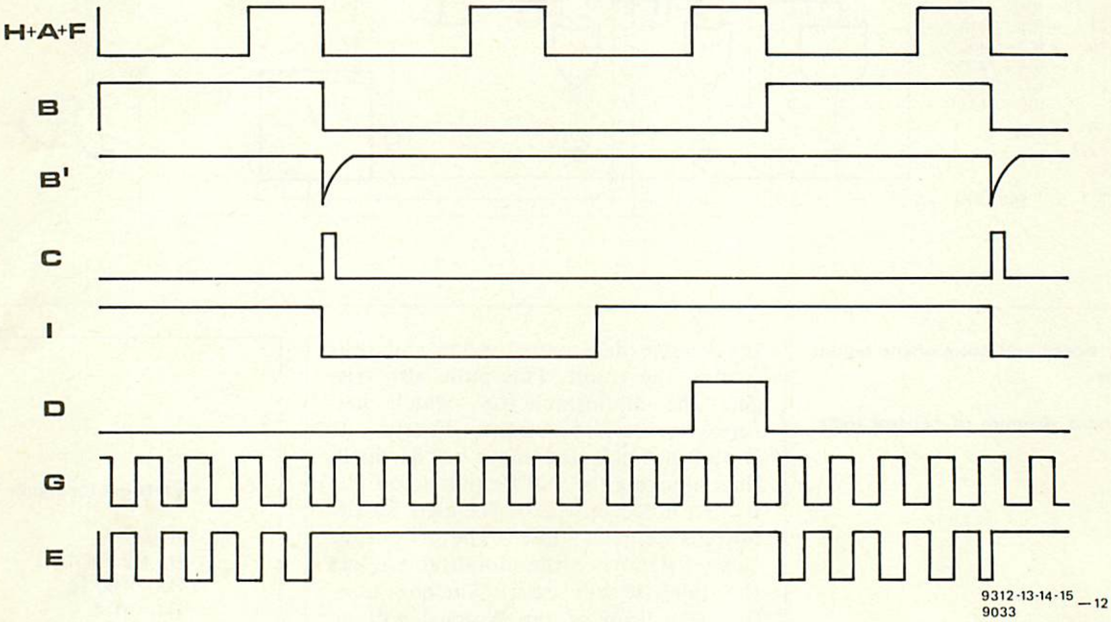
IC's:
IC1 = 7473
IC2 = 7413
IC3 = 7428 (7402)
IC4,IC5 = 7490
IC6 = 74121

Sundries:
S1 = 4-pole 4-way switch (or 5-pole 4-way, see text)

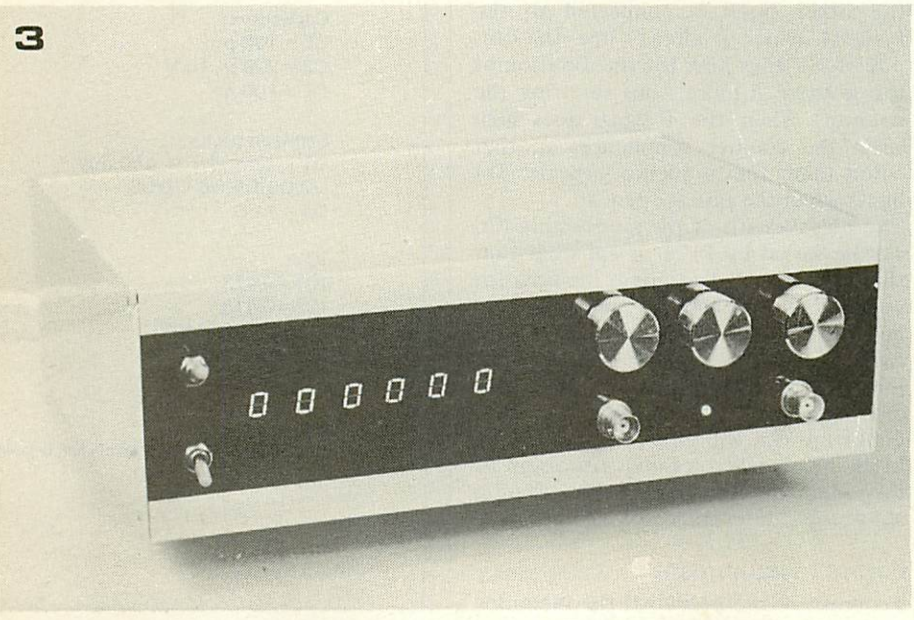
11



12

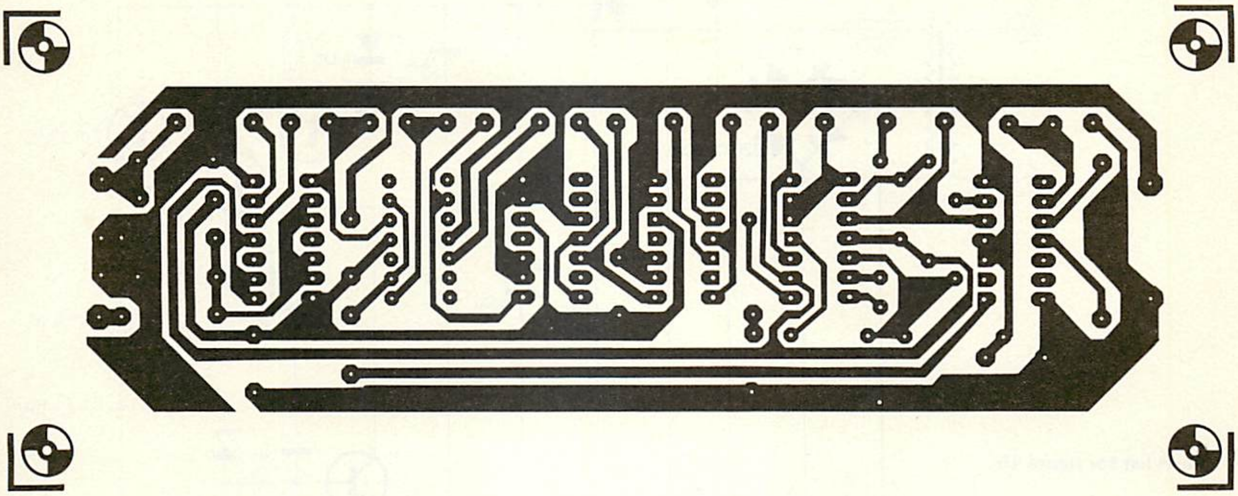


3



waveform the 100 Hz reference i counted whilst the gate, latch and rese functions are derived from the signal t be measured. To do this the switch S1 i set in position 4. This disables the time base, connects the gate input of S2 t the Q output of FF2 and connects th 100 Hz signal to the other input. It als connects the latch circuitry input A t the incoming signal. The sequence o operations is thus as follows: on th first negative transition of the inpu signal H FF2 clocks and its Q outpu goes to '1' thus opening the counte gate. 100 Hz pulses (G) are now gate through S1 (E) and are counted. On th next negative transition of the inpu signal the flip-flop FF2 again clocks an the Q output goes to '0', thus closin the gate. The gate period is thus on complete cycle of the input waveform The input waveform drives the latch reset circuitry in a similar manner t

13



14

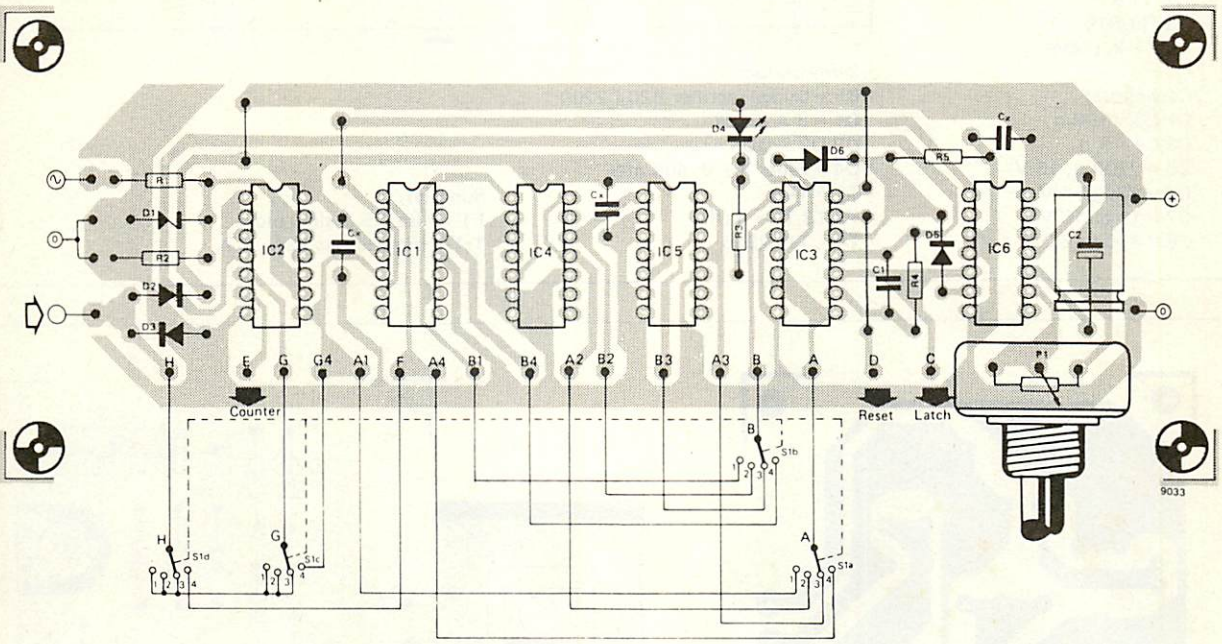


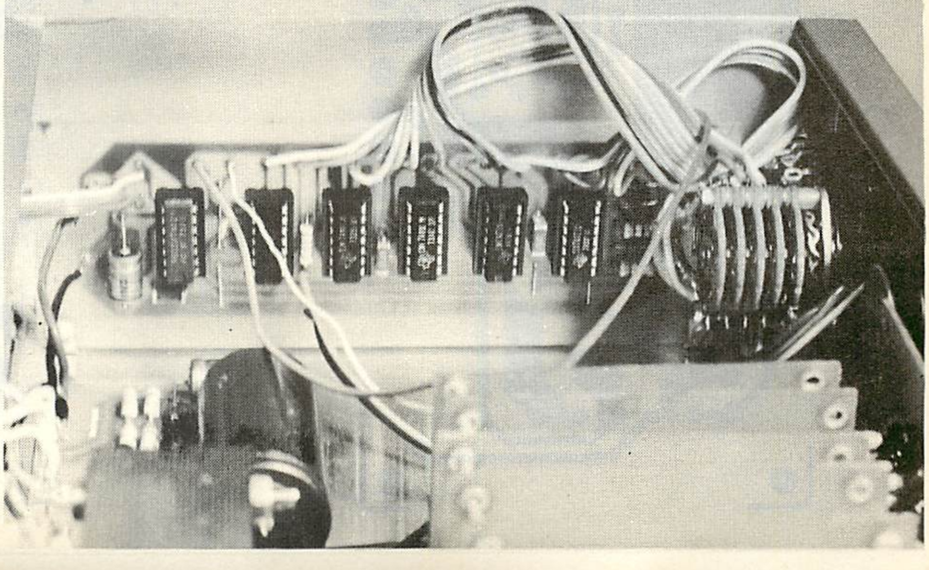
Figure 11. Timing diagram of counter in frequency measuring mode.

Figure 12. Timing diagram of counter in period measuring mode.

Figure 13. P.c. board for control logic.

Figure 14. Component layout for control logic.

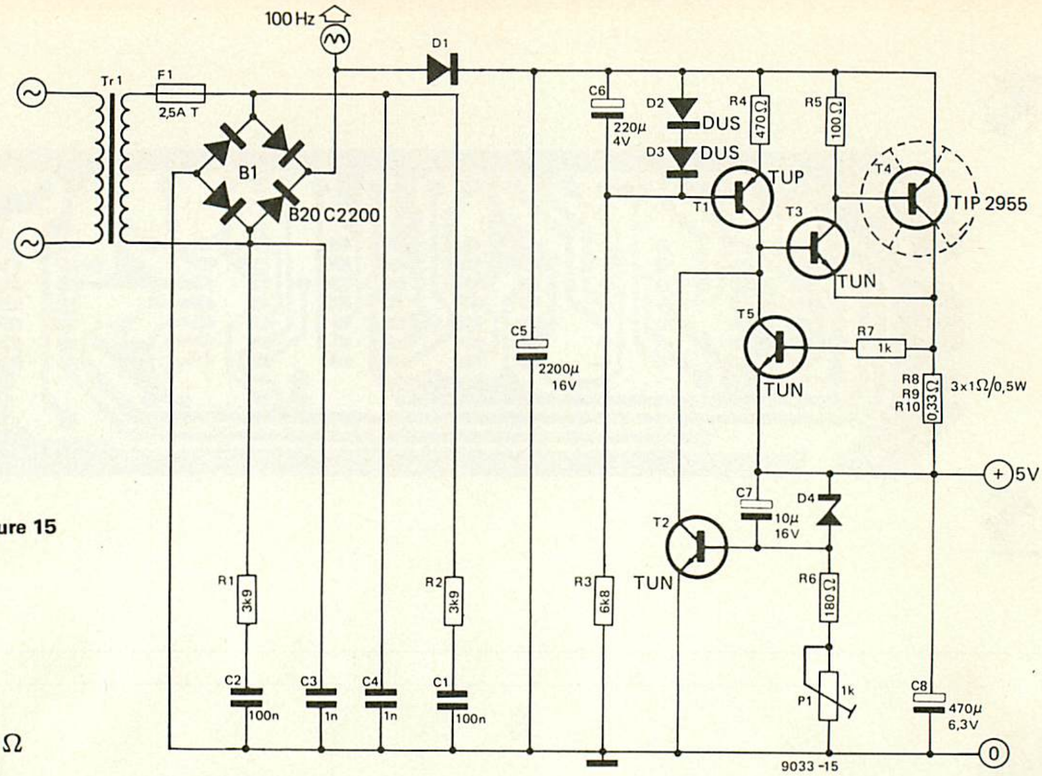
4



that for a frequency measurement, and the timing diagram is shown in figure 12. Of course, the A signal is now the input signal, and the B signal is the Q output of FF2.

With a 100 Hz reference frequency and

15



Parts list for figure 15

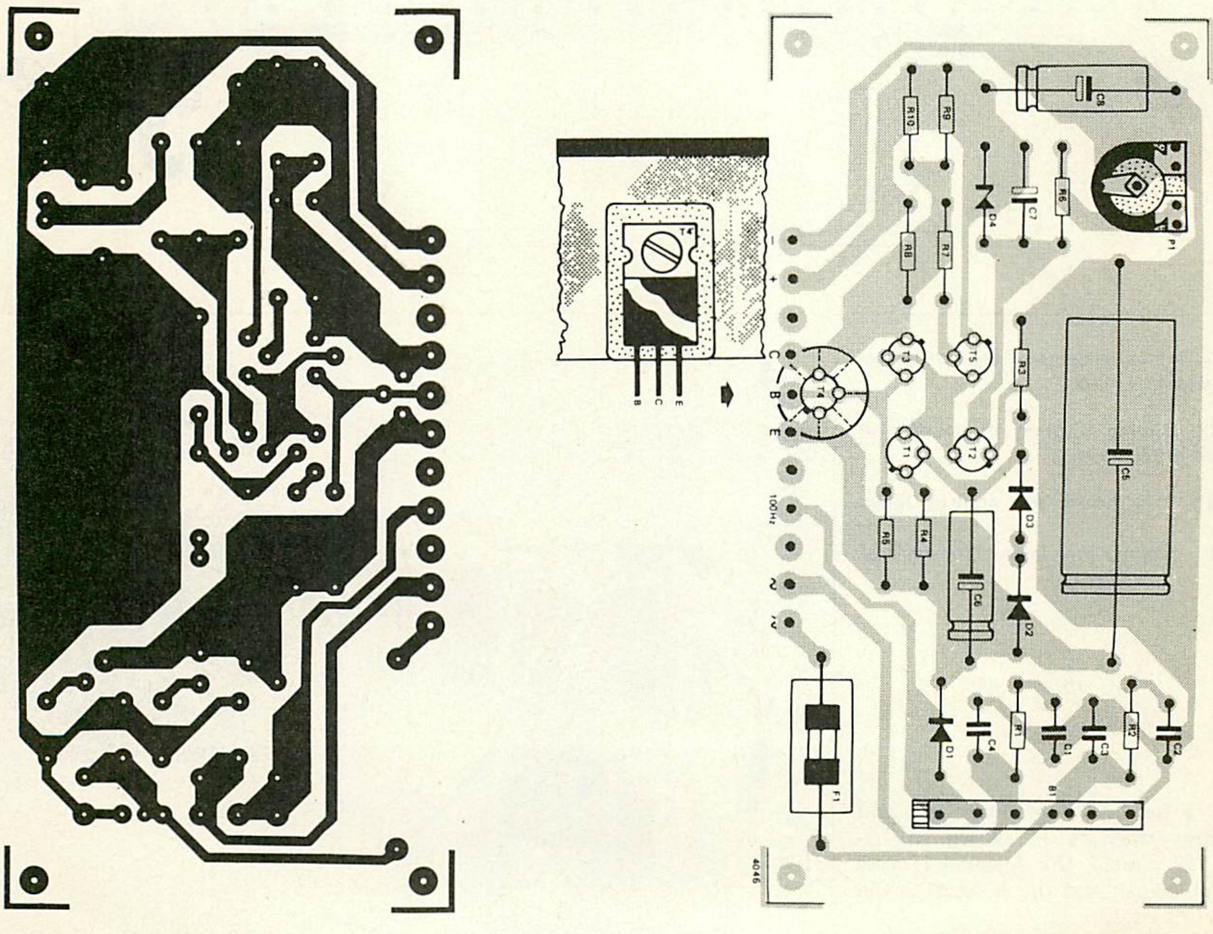
Resistors:
R1,R2 = 3k9
R3 = 6k8
R4 = 470 Ω
R5 = 100 Ω
R6 = 180 Ω
R7 = 1 k
R8,R9,R10 = 1 Ω
P1 = 1 k, preset

Capacitors:
C1,C2 = 100 n
C3,C4 = 1 n
C5 = 2200 µ, 16 V
C6 = 220 µ, 4 V
C7 = 10 µ, 16 V
C8 = 470 µ, 6,3 V

Semiconductors:
B1 = bridge rectifier B20 C2200
D1 = 3 A diode
D2,D3 = DUS
D4 = zener 4.7 V, 400 mW
T1 = TUP
T2,T3,T5 = TUN
T4 = TIP 2955

Sundries:
F1 = fuse 2.5 A slow blow
Tr1 = transformer 12 V, 2 A

16



igure 15. Power supply for frequency ounter.

igure 16. P.c. board and component layout f power supply.

he gate periods of 10 ms, 100 ms and s the range of the instrument is mited. It is only possible to obtain a ull-scale reading in the period mode vhen the period is 9,999.99 seconds. 'or a period of 1 s the display will be nly 000100, a resolution of one art in a hundred. Clearly, for short eriod measurements a higher reference requency is necessary to obtain a larger ount and hence a better resolution. rovision is made for feeding in an ex-ernal reference frequency by breaking he circuit at the point marked 'EXT EF'. In the frequency mode the maxi-num and minimum frequencies which an be measured are limited by the gate eriods. For instance with a 1 s gate eriod a frequency of 100 Hz will only e measured with a resolution of one art in a hundred, whilst with a 10 ms ate period an input frequency of reater than 99.9999 MHz would cause he counter to overrange. However, ince the upper frequency limit of the 'TL counters used in the circuit is only 8 MHz anyway, this problem does not rise.

printed circuit board and component ayout for the control logic board are iven in figures 13 and 14, showing the onnections to the switch.

'ower supply

suitable power supply for the fre-uency counter is shown in figure 15. 'his is well decoupled against mains-orne interference and has a 100 Hz utput for the reference frequency. A oard and component layout for the ower supply are given in figure 16. s the complete frequency counter raws about 2 amps, the series regulator ransistor T4 should be mounted on an dequate heatsink. If the unit is housed n an aluminium case then the back of he case should prove suitable.

n a future issue we shall be describing dditions to the frequency counter, otably an input preamplifier to in-rease the input sensitivity. ◼

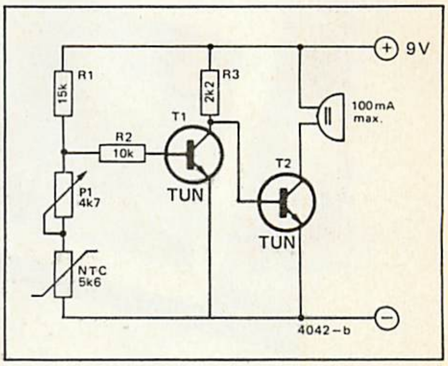
J.P. Kuhler jr.

humming kettle

Those who have in the course of time lost the whistle of their domestic kettle and the unfortunate ones who do not possess a whistling kettle at all, who must boil water without the aid of an acoustic signal, are encouraged by the author not to resign themselves to this unsatisfactory situation. A very modest amount spent on components together with a little work puts a 'humming kettle' within everyone's grasp!

The circuit is so simple that further explanation is hardly necessary. As the temperature increases, the resistance of the NTC drops until at a certain moment (adjustable with P_1) transistor T_1 cuts off, so that T_2 conducts and the buzzer is activated.

Of course the circuit must be mounted in, on, or in the immediate vicinity of the kettle.

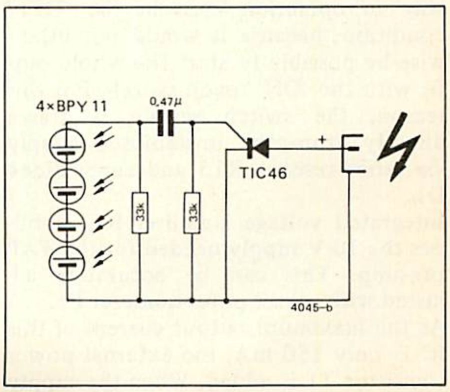


R. Buggle

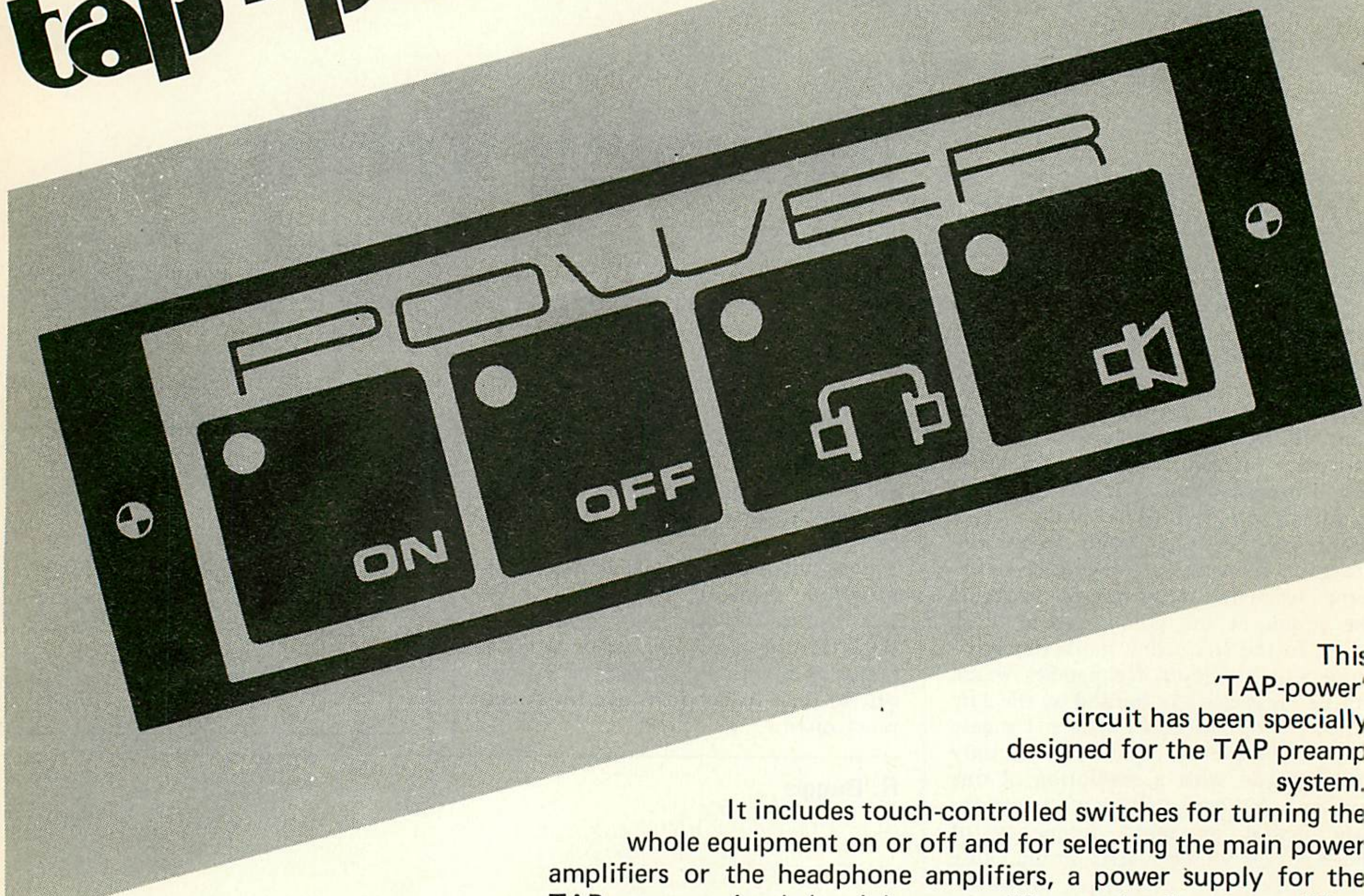
active flash slave

For those who have often been annoyed by badly illuminated flash photographs and also dislike the tangle of cables involved in using two flashguns, the flash slave is the only solution.

The author spent quite some time building several slave units before arriving at the design presented here, which has the advantages that it requires no separate supply voltage and that both electronic and ordinary flashguns can be operated. Four silicon photovoltaic cells (BPY 11) form a light sensor. Undoubtedly other types will do, too. The thyristor must be of a type with a very low firing voltage; the TIC 46 used here performs quite well. The circuit itself needs little comment: only that the polarity of the flash connection should be correct; the 'plus' should be connected to the centre pin of the connecting cable. The circuit can best be housed in a small, transparent plastic box.



tap - power



This 'TAP-power' circuit has been specially designed for the TAP preamp system.
It includes touch-controlled switches for turning the whole equipment on or off and for selecting the main power amplifiers or the headphone amplifiers, a power supply for the TAP pre-amp, simple headphone amplifiers and a disc preamplifier.

NAND gates N1, N2 and N3, N4 (IC_4 = CD4001) make up two touch switches. Four LEDs are used to indicate the condition in which the system has been set; D2 = ON, D3 = OFF, D6 = headphones and D5 = power amplifier.

Because of the difference between this circuitry and the rest of the TAP system, construction is much simpler: instead of a diode matrix only two flip-flops are used here.

The power supply is split up into three sections: one for the touch switches, one for the rest of the TAP preamp and one for the disc preamplifier.

The supply for the touch switches must stay in operation even in the 'OFF' condition, because it would not otherwise be possible to start the whole outfit with the 'ON' touch switch. For this reason, the switch supply is drawn directly from the unstabilised supply via series resistor R15 and zener diode D1.

Integrated voltage stabiliser IC_3 stabilises the 10-V supply needed for the TAP pre-amp. This can be accurately adjusted with preset potentiometer P1.

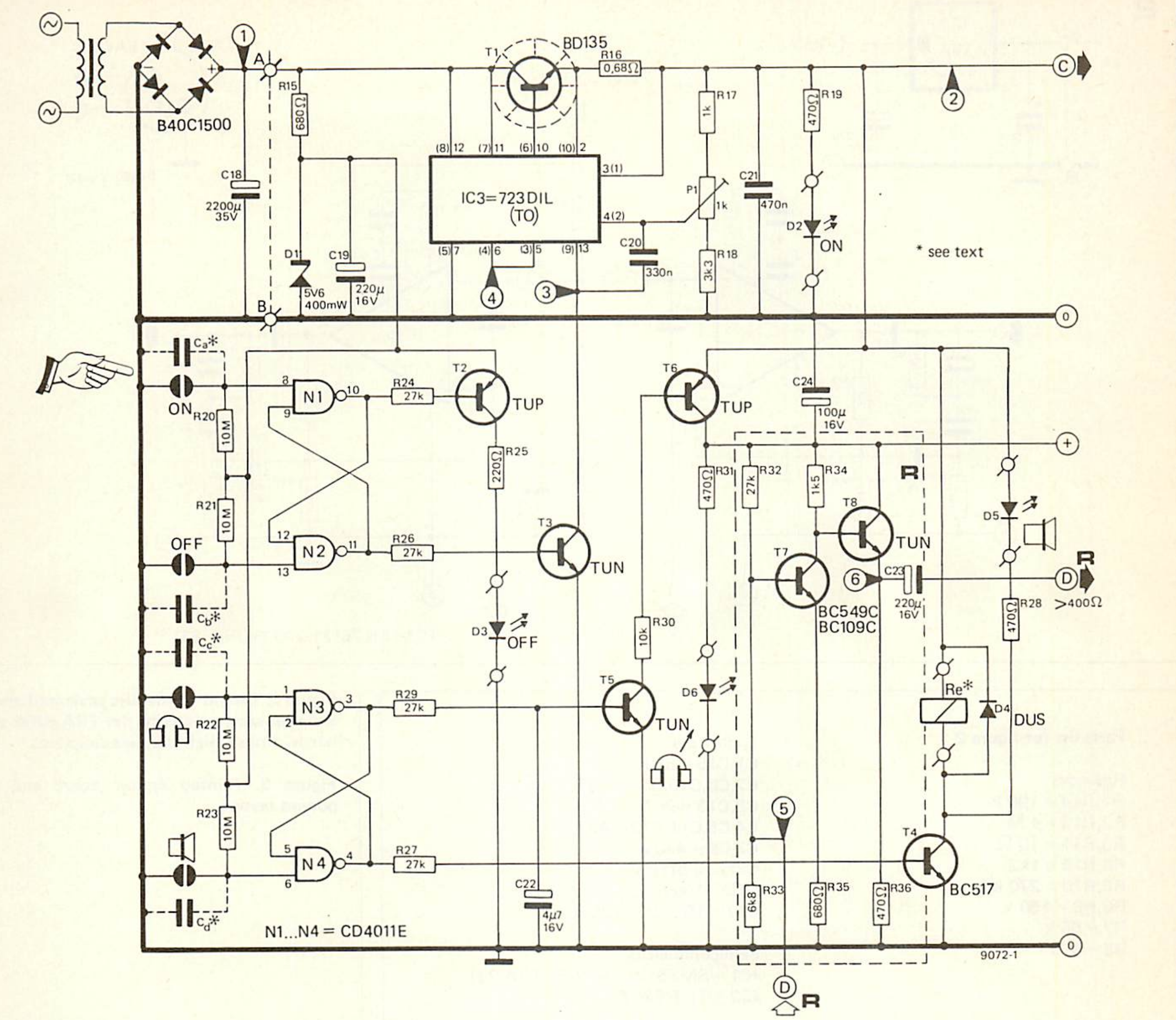
As the maximum output current of this IC is only 150 mA, the external power transistor T1 is added. When the supply voltage is switched on with the 'ON' touch switch, the logic state prevailing at the output of gate N1 is '1', while it is '0' at the output of N2. Transistors T2 and T3 are therefore cut off, and the supply voltage becomes available at output C.

When the 'OFF' panel is touched, logic levels at the outputs of N1 and N2 are reversed, with the result that T2 and T3 turn on. The potential at pin 13 of IC3 is therefore pulled down almost to zero, so that the internal output transistors in the IC are cut off. The voltage at output C drops to 0 and the TAP preamp is turned off.

The flip-flop formed by N3 and N4 provides a changeover between headphones and the main power amplifier. When the output of N3 is at logic '1', transistors T5 and T6 turn on, switching on the headphone amplifier built around T7 and T8. This amplifier, including the associated components within the dashed rectangle in figure 1, is duplicated on the board for the left-hand headphone channel. Both amplifiers derive their supply from the collector of T6.The output of N4 is at logic'0'. Transistor T4 is cut off and relay Re is not energised. The relay contacts,

Figure 1. Circuit of the main power supply the TAP switches for on/off switching an loudspeaker/headphone selection, and one o the headphone amplifiers.

1



Parts list for figure 1

Resistors:
R15,R35 = 680 Ω
R16 = 0.68 Ω
R17 = 1 k
R18 = 3k3
R19,R28,R31,R36 = 470 Ω
R20,R21,R22,R23 = 10 M
R24,R26,R27,R29,R32 = 27 k
R25 = 220 Ω
R30 = 10 k
R33 = 6k8
R34 = 1k5
P1 = 1 k

Capacitors:
C18 = 2200 μ/35 V
C19,C23 = 220 μ/16 V
C20 = 330 n
C21 = 470 n
C22 = 4μ7/16 V
C24 = 100 μ/26 V

Sundries:
Transformer = 240 V/16 V, 1 A (see text)
Bridge rectifier = B40C 1500
Relay Re = 10 V, 300 Ω (see text)

Semiconductors:
D1 = 5V6/400 mW
D2,D3,D5,D6 = LED
D4 = DUS
T1 = BD 135 (cooled)
T2,T6 = BC 177 (possib. TUP)
T3,T5,T8 = BC 107 (possib. TUN)
T4 = BC 517
T7 = BC 549 C, BC 109 C
IC3 = μA 723
IC4 = CD 4011

which switch the supply for the main power amplifiers on and off at the primary of the mains transformer for these amplifiers, stay open.

When the loudspeaker touch panel is touched the relay contacts close and the power amplifier is turned on: the headphone amplifier no longer gets a power supply because the logic '0' at the output of gate N3 cuts off transistors T5 and T6.

The disc preamplifier (figure 2) is the same as was described in the April 1975 issue of Elektor. Power supply for the preamplifier is provided by the integrated stabiliser IC_2. Points A and B are connected to the corresponding points in figure 1.

Construction

Current consumption of the touch-switching circuit is about 30 mA in the 'OFF' position. In the switched-on state, the maximum consumption with headphone listening is about 100 mA (not counting the TAP preamplifier, of course!). Including the TAP preamplifier, the maximum current consumption is 320 mA when the headphone amplifiers are on and the volume control is at maximum.

Figure 1 shows six points at which the D.C. voltage can be checked. With the transformer secondary delivering 16 volts RMS and the TAP preamp not connected, the voltages at these points should be 20 V, 10 V, 12 V, 6.8 V, 1.8 V and 6 V respectively.

The headphone amplifier delivers 2 V R.M.S. with the maximum input signal of 850 mV. Headphones with an impedance of 400 ohms or higher can be

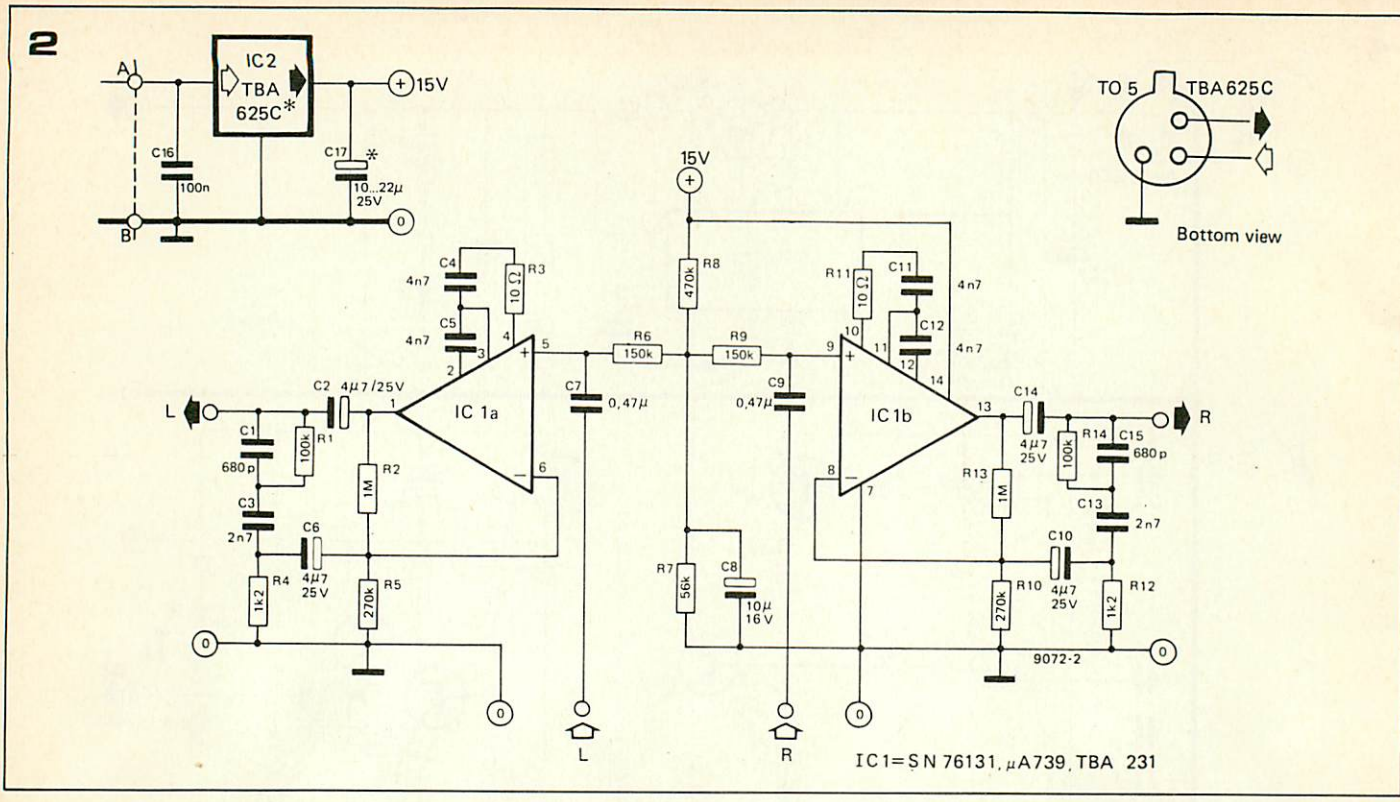


Figure 2. Circuit of the disc preamplifiers, and external connections to the TBA 625C stabiliser IC from which they are supplied.

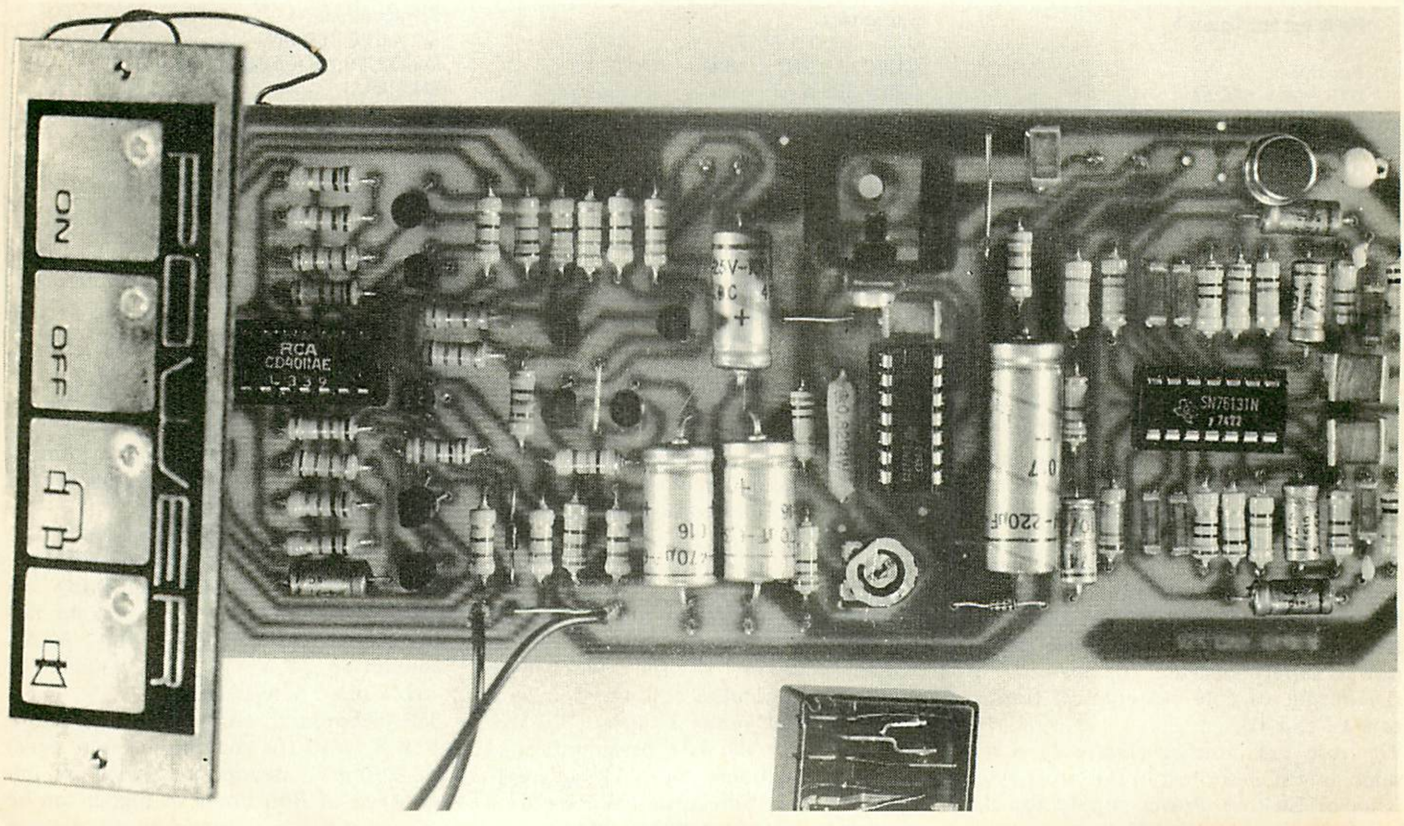
Figure 3. Printed circuit board and component layout.

Parts list for figure 2

Resistors:
R1,R14 = 100 k
R2,R13 = 1 M
R3,R11 = 10 Ω
R4,R12 = 1k2
R5,R10 = 270 k
R6,R9 = 150 k
R7 = 56 k
R8 = 470 k

Capacitors:
C1,C15 = 680 p
C2,C6,C10,C14 = 4μ7/25 V
C3,C13 = 2n7
C4,C5,C11,C12 = 4n7
C7,C9 = 470 n
C8 = 10 μ/16 V
C16 = 100 n
C17 = 10 ... 22 μ/25 V

Semiconductors:
IC1 = SN 76131, μA 739, TBA 231
IC2 = TBA 625 C



onnected to the output D. The value of capacitor C23 is calculated for headphones with an impedance of 2 k.

ransistor T1 must be adequately ooled; the power dissipation – and ence the dimensions of the heatsink eeded – depends on the transformer econdary voltage:

Transformer secondary voltage (V RMS)	Heatsink area (cm^2)
16	50
18	80

It is often a good solution to use the case as a heat sink, with the transistor mounted on the outside.

The pull-in voltage for relay Re is about 10 V. The contacts must be rated to make and break at least 250 V, and a current depending on the maximum drawn by the power amplifiers. For two 100 W amplifiers driving 4-ohm loads a relay with 8 A contacts is suitable.

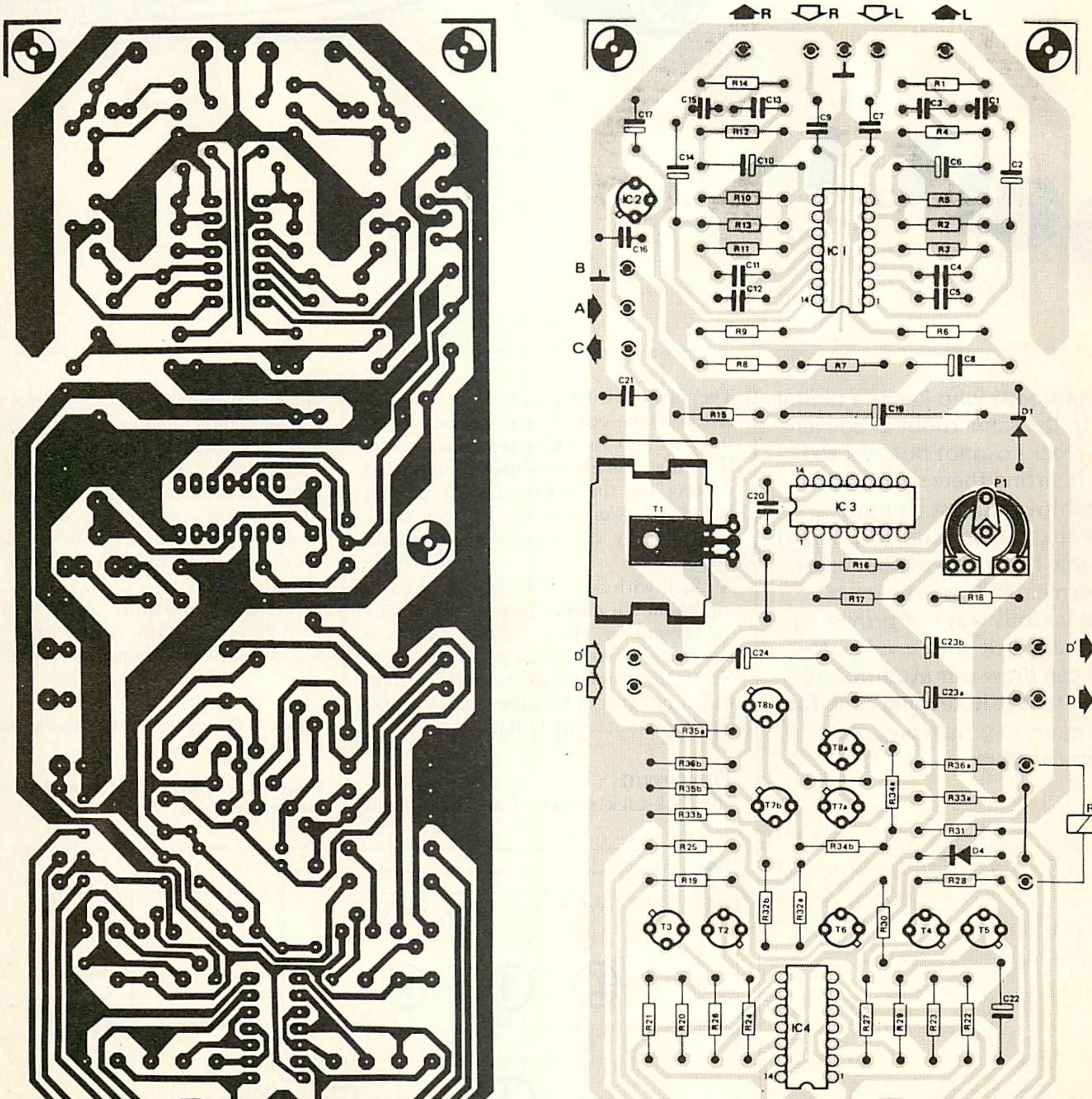
To avoid relay chatter when a number of touch panels are operated at the same time, it is advisable to connect 1 n capacitors C_a to C_d across each pair of touch contacts.

A 100 n/400 V capacitor can be connected across the relay to prevent contact burning.

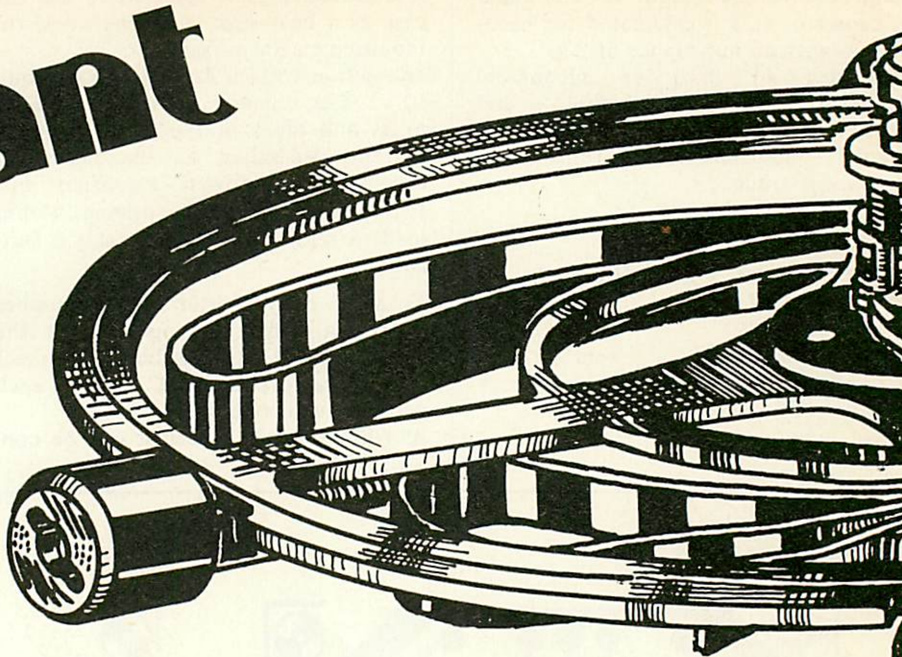
The TBA 625C stabiliser IC delivers an output of 15 V. As this is the minimum acceptable voltage for the disc preamplifier, it is essential that a Type C stabiliser be used. A heat sink is not absolutely necessary. A tantalum electrolytic capacitor should be used for C17 to forestall any possible tendency to oscillation.

Figure 3 shows the printed circuit board and the component layout for the TAP-power circuit. Except for the mains transformer, bridge rectifier, smoothing capacitor C18 and relay, all the components are accomodated on one board.

3



clamant clock part 1



Any horologist who keeps a digital clock in the same room as conventional clocks cannot but feel sad to see it sitting there, mute and reproachful amongst its more vociferous brothers, its only sound the feeble humming of the mains transformer. In this article we look at various ways of providing the digital clock with a voice, so that it can draw our attention to the fact that it is keeping time far more accurately than any mere mechanical clock.

The main attribute lacking in a digital clock is the comforting tick which assures us that the thing is actually going. How many man-hours have been wasted waiting for the elusive change of that last digit? 'Well I'm sure its been stuck at that time for more than a minute now.'

A clock with a seconds display or flashing colon alleviates these problems, but the hypnotic effect of such devices has been known to send people to sleep. No such problem exists with a tick, which informs us that the clock is working without actually looking at it.

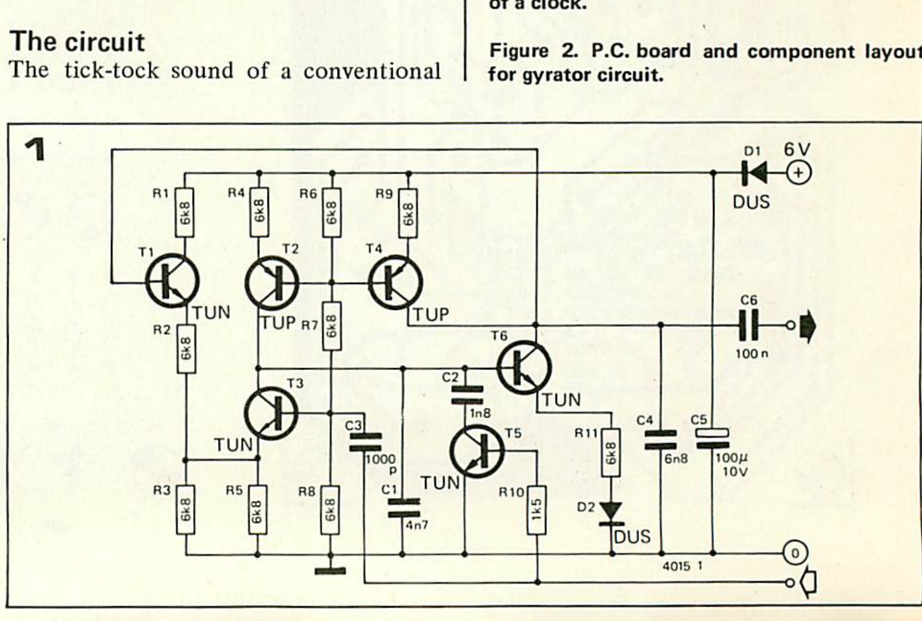
The circuit

The tick-tock sound of a conventional clock is produced by the balance wheel (or pendulum) and escapement, the tick and tock sounds having different pitch. The pitch of the sounds and the repetition frequency obviously depend on the physical construction of the clock. A grandfather clock will have a deeper, more leisurely tick than a travelling alarm.

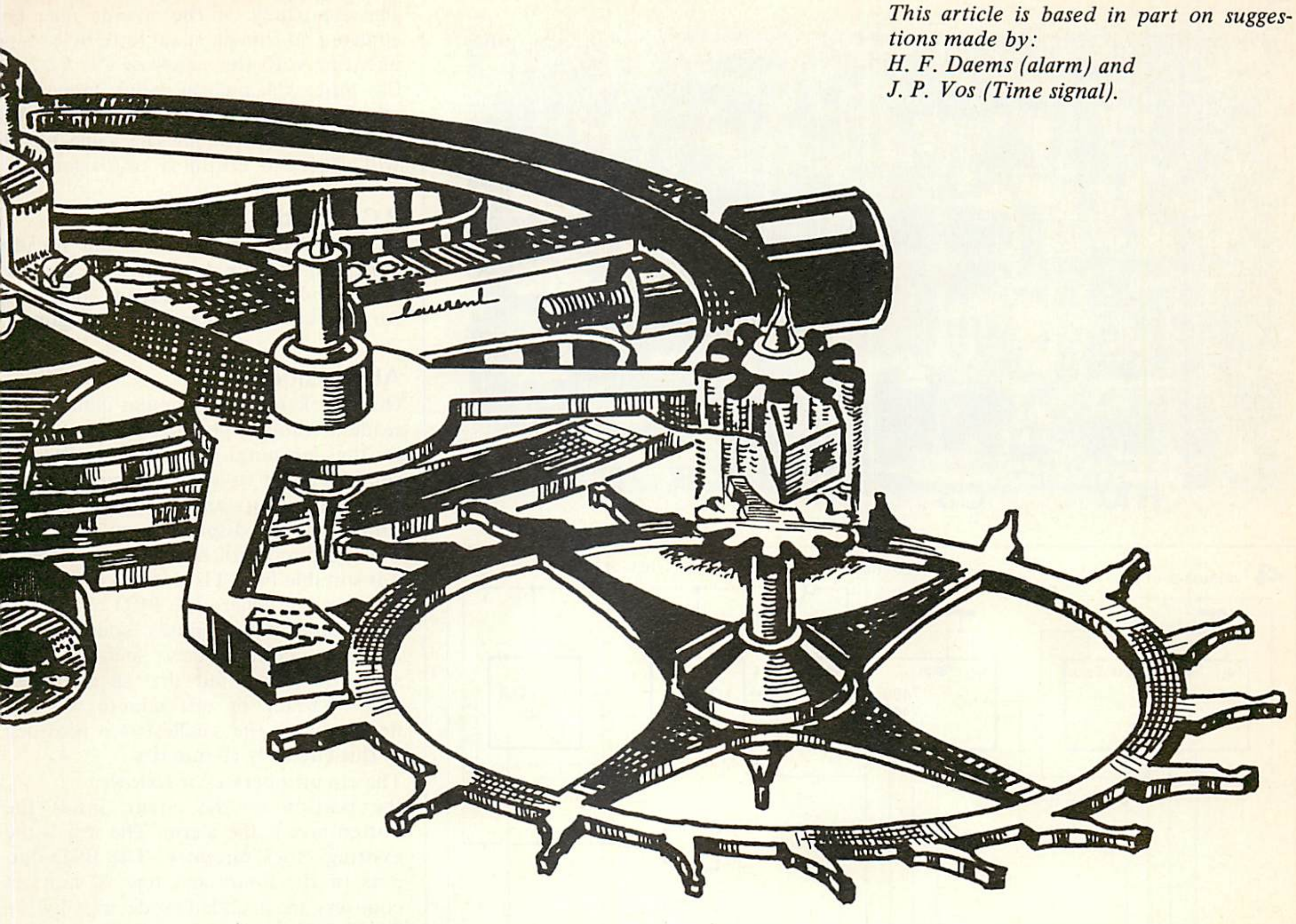
Electronic simulation of the sound is fortunately relatively simple. The waveform of the ticking is a damped res-

Figure 1. Gyrator circuit to simulate tick-tock of a clock.

Figure 2. P.C. board and component layout for gyrator circuit.



This article is based in part on suggestions made by:
H. F. Daems (alarm) and
J. P. Vos (Time signal).



onance similar to a percussion instrument. A suitable circuit is therefore the gyrator used in the Elektor Minidrum (february 1975). This circuit (with the component values modified for this application) is given in figure 1. Suitable 1 Hz trigger pulses may be obtained from the clock circuit by taking an output from the counter preceding the seconds counter. The pulses must be TTL compatible (5 V amlitude) and have a 1 : 1 mark-space ratio, otherwise the ticking will sound unbalanced. The pulses are fed into the base of T3 through C3 to trigger the gyrator. whilst T5 switches C2 in and out of circuit to alter the relative frequency of the tick and tock.

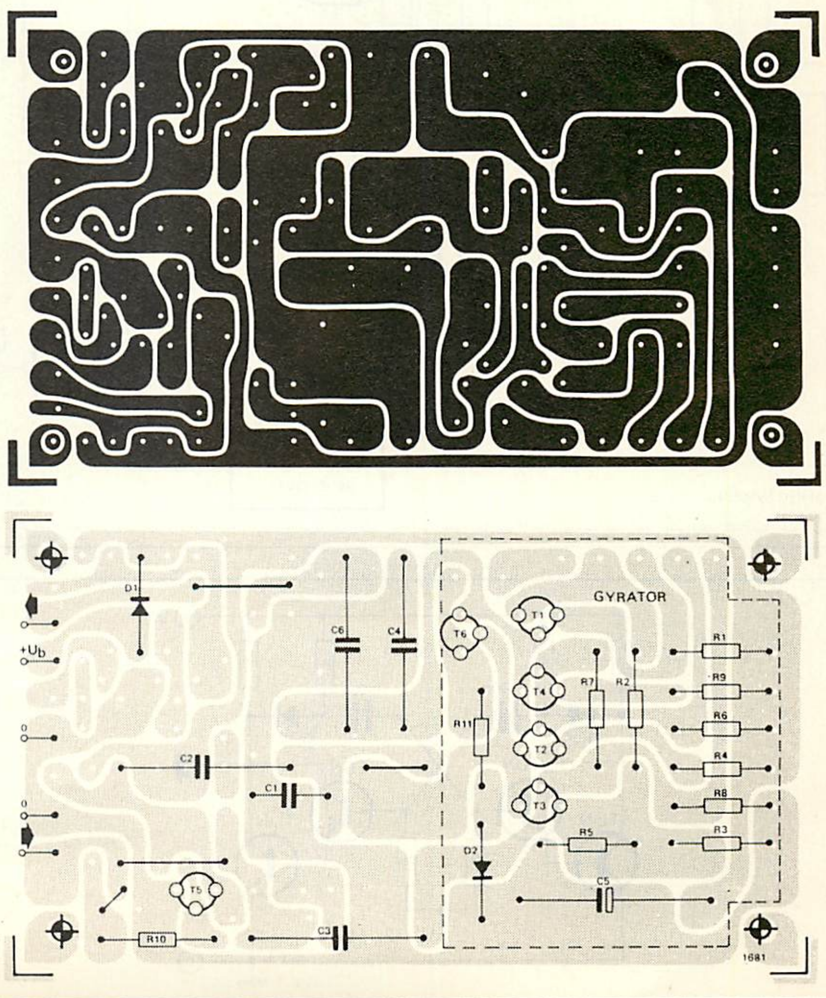
Components list for figure 1

Resistors:
R1 ... R9,R11 = 6k8
R10 = 1k5

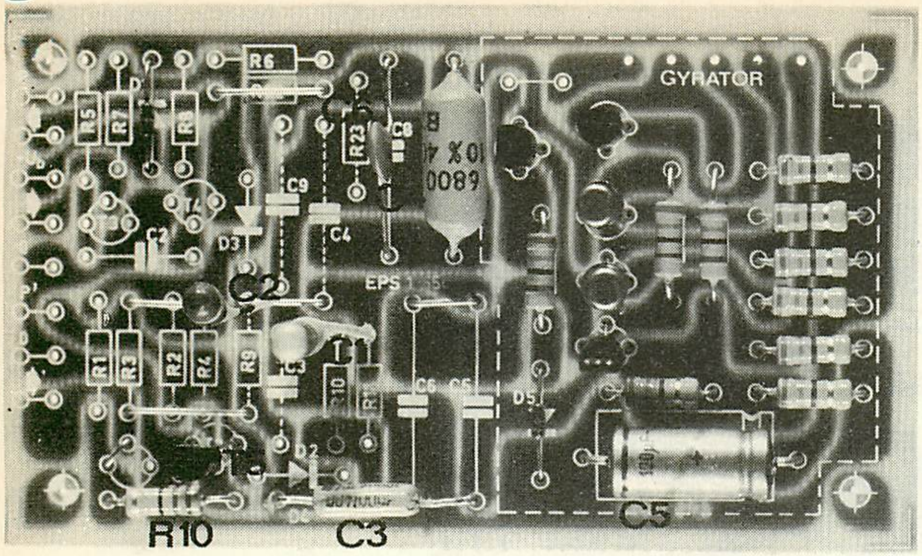
Capacitors:
C1 = 4n7
C2 = 1n8
C3 = 1 n
C4 = 6n8
C5 = 100 µ/10 V
C6 = 100 n

Semiconductors:
T1,T3,T5,T6 = TUN
T2,T4 = TUP
D1,D2 = DUS

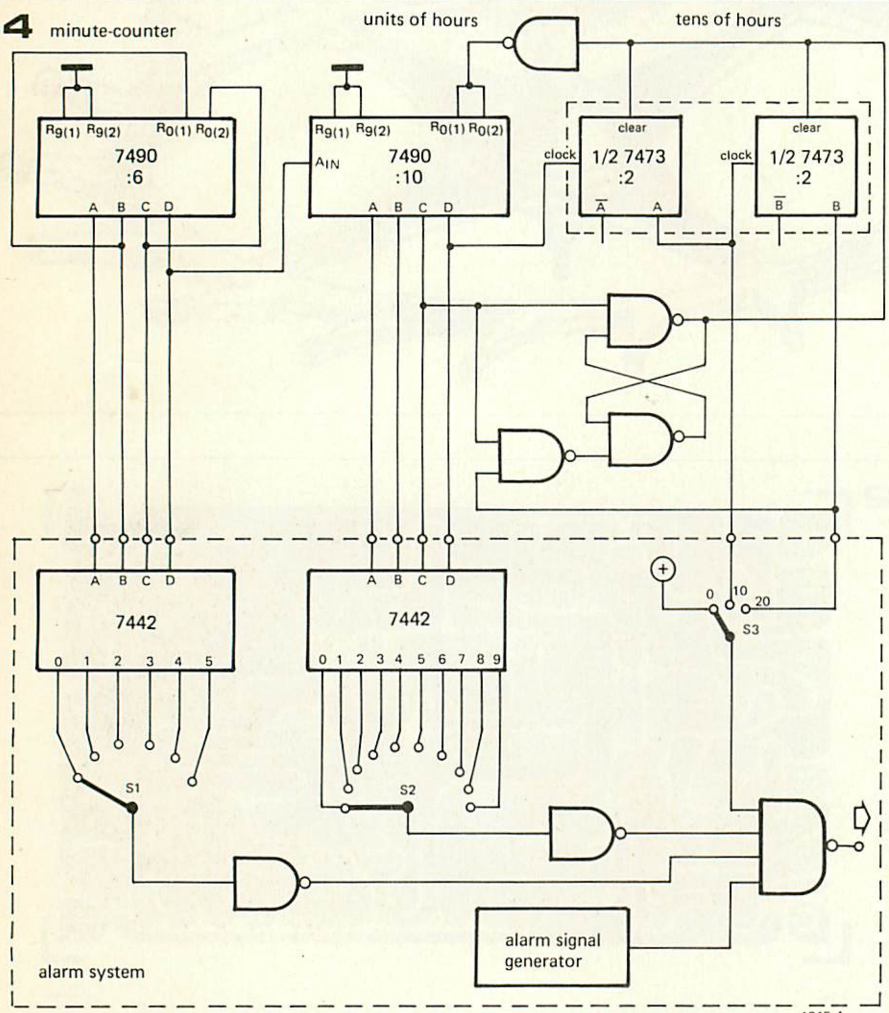
2



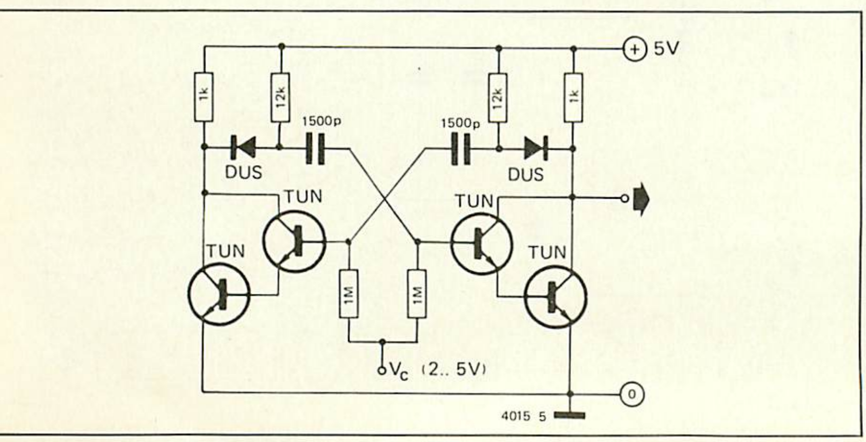
3



4



5



The frequency of the sounds may be adjusted to suit personal taste by experimenting with the values of C1, C2 and C4. Since C3 and the input impedance of the trigger input differentiate the trigger pulse, changing the value of C3 will affect the 'crispness' of the sound.

P.C. Board

A suitable printed circuit board already exists for the Minidrum gyrator, and the board and component layout (modified for use with clock) are given in figure 2.

Alarm Clock

One clock noise in popular demand by readers (though perhaps not first thing in the morning) is an alarm. It is a simple matter to add an alarm to a digital clock (but unfortunately not so simple if the display is multiplexed). The alarm control circuit given in figure 4 is suitable for TTL clocks with parallel outputs (i.e. where the BCD outputs of the hours and minutes counters are available continuously and are not strobed). It was felt that an alarm setting accuracy of one minute was not necessary, so the smallest step provided in this circuit is 10 minutes.

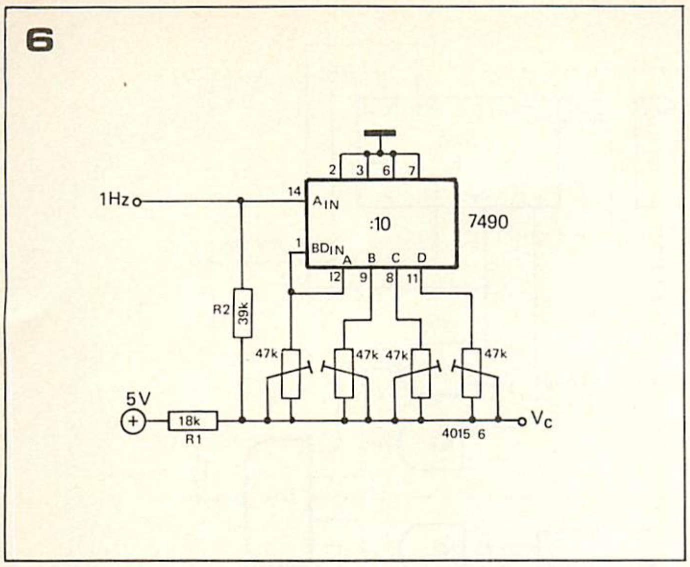
The circuit operates as follows:
the portion of the circuit inside the dotted box is the alarm. The rest is the existing clock circuitry. The BCD outputs of the hours and tens of minutes counters are decoded to decimal by the 7442's. No decoding of the tens of hours is required as the truth table for this counter (table 1) shows. Outputs A and B are never both '1' at the same time. The desired alarm time is selected by single-pole switches S1 - S3. When the required time is reached three of the inputs of the four-input NAND gate go high. This allows the alarm signal connected to the fourth input to pass through the gate.

The possibilities for the actual alarm signal generator are endless. The simplest solution would be a fixed frequency oscillator such as an astable multivibrator. There are however more interesting possibilities. The voltage-controlled multivibrator of figure 5 can be made to play a tune by connecting differing voltages sequentially to the control input. For a control voltage range of 2-5 V the frequency range covered is about 3 octaves. There are various methods of driving the oscillator. A simple circuit is shown in figure 6. This consists of a 7490 connected as a BCD decade counter, with its outputs connected to the VCO via presets. As the

Table I

HOURS	A	$\overline{A}$	B	$\overline{B}$
0	0	1	0	1
10	1	0	0	1
20	0	1	1	0

6



7

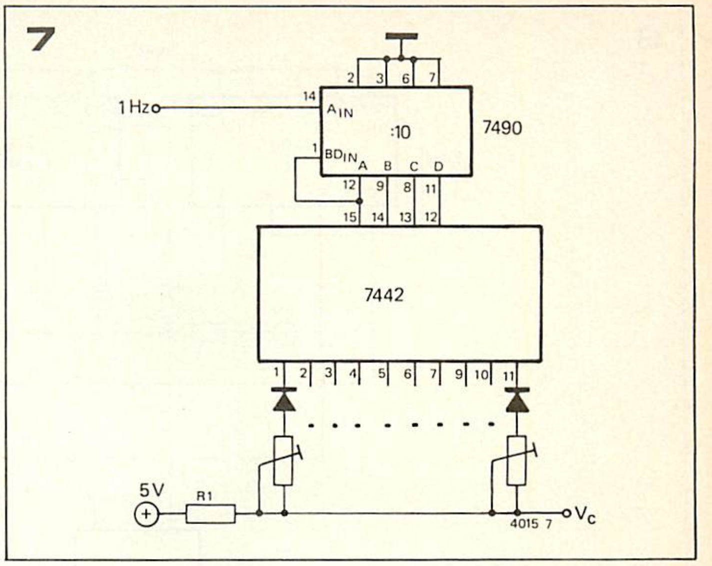


Figure 3. Photograph of the completed board.

Figure 4. Circuit of an alarm control system.

Figure 5. A voltage-controlled oscillator VCO that may be used to generate a tuneful alarm signal.

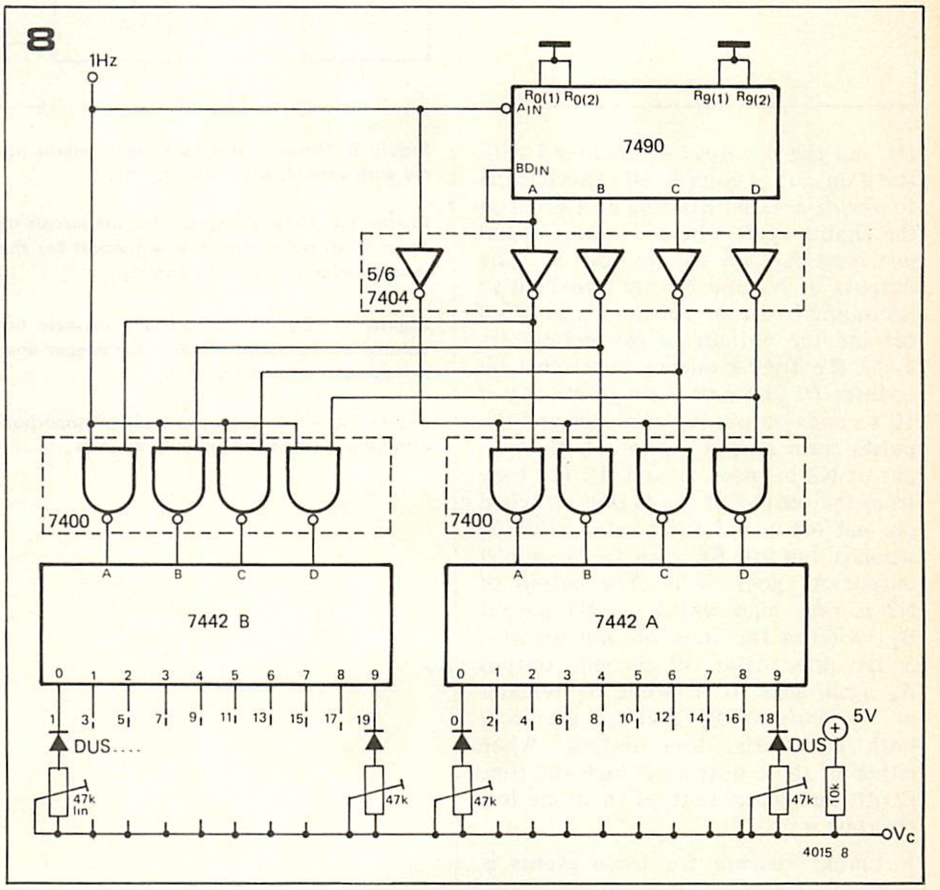
Figure 6. Using the existing seconds counter in the clock to produce a varying voltage for the VCO. Since the outputs interact it is difficult to tune this circuit to play a particular melody.

Figure 7. This circuit may be used to make the VCO play a tune. Ten independent sequential outputs are produced, so each preset can be used to tune one note in the sequence.

Figure 8. Extension of the circuit of figure 7 to a 20-note sequence.

Table I. Output of an arbitrary tens of hours counter as in figure 4.

8



output states of the counter change so will the output voltage to the VCO. Of course the outputs change in a binary sequence so more than one output can be high at one time.

Since the outputs interact it is difficult to set this circuit to play a particular tune. In addition the 1 Hz clock pulses are also fed in via R2 increasing the permutations still further.

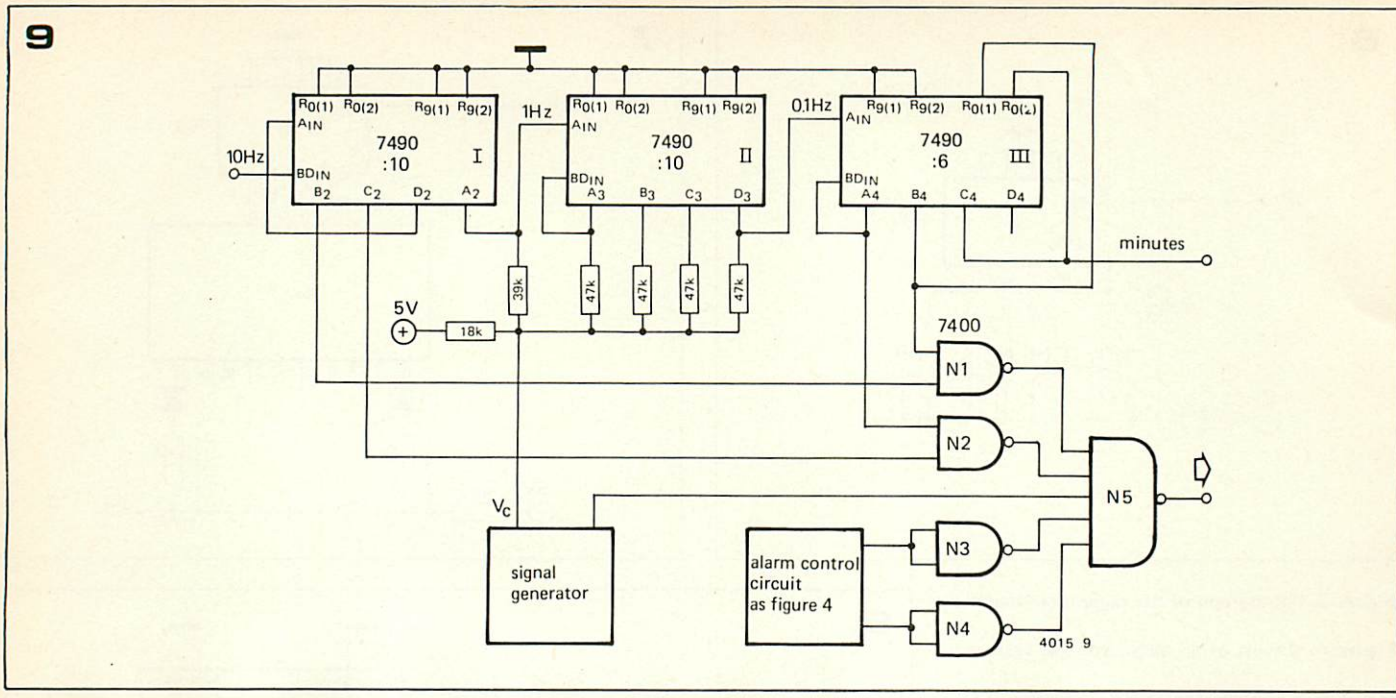
If one requires a circuit which can be set to play a particular tune then figure 7 is more suitable. Here the outputs of the 7490 are decoded with a 7442 to give ten independent outputs. These outputs go low in sequence as the counter goes through its cycle. All other outputs are high, reverse-biassing their respective diodes, so no current flows through their respective presets. Only the preset connected to the output which is low forms a potential divider with R1. This means that each note in the sequence can be tuned independently.

This ten-note sequence can easily be extended to twenty notes by the circuit of figure 8. In this circuit two decoders are driven by the 7490 and are switched in and out by the 1 Hz clock pulses to the counter. Thus, during the half-period when the clock pulse is '0' the outputs of the 7490 are switched through the transfer gates (7400) to decoder A. The other transfer gates are disabled by the '0' on their commoned inputs, so their outputs are all '1'. This is an invalid input code for the 7442 so all its outputs are high. During the '1' half period of the clock pulse the reverse situation occurs. Decoder B is enabled, whilst A is disabled. Decoder A thus controls the even notes 0, 2, 4, . . . in the sequence, whilst decoder B controls the odd notes 1, 3, 5, ... Of course in this case, if an equal time span is required for each note then the clock pulse waveform must have a 1 : 1 mark-space ratio. The 7490 in all these cases can be the existing seconds counter in the clock.

Another variation on the alarm theme can be obtained by a circuit which changes the rhythm of the tone sequence, making it less monotonous. Such a circuit is given in figure 9. The dividers I to III are again part of the existing clock circuit. The operation of the circuit is as follows:

counter II controls the pitch of the voltage controlled multivibrator as in the circuit of figure 6, except that no adjustment is provided for. The time at which the alarm sounds is again determined by the alarm control circuit, as in figure 4. The rhythm variation is provided by gating the C output of counter I with the A output of counter

9



III, and the B output of counter I with the B output of counter III. This has the following effects. Starting at a point in the timing cycle where counter III has just reset A_4 and B_4 are both '0'. The outputs of N1 and N2 are thus high so (assuming it is time for the alarm to go off and the outputs of N3 and N4 are high) the tone sequence controlled by counter III can pass through N5. After 10 seconds output A_4 goes high and the pulses from output C_2 switch the output of N2 between '0' and '1'. The tone from the output of N5 is thus switched on and off at a 2.5 Hz rate. After 20 seconds output B_4 goes to '1' whilst output A_4 goes to '0'. The output of N2 is thus high whilst via N1 output B_2 switches the tone on and off at a 5 Hz rate. After 30 seconds output A_4 again goes to '1' while B_4 remains at '1'. Outputs B_2 and C_2 therefore both affect the tone output. When either of these outputs is high the tone is off, and when both of them are low the tone is on.

A timing diagram for these events is shown in figure 10. The top two waveforms are the outputs B_2 and C_2 during a 1 second interval of the sequence (this repeats every second). The other 4 waveforms are the tone outputs that occur for the four possible states of A_4 and B_4.

The audible effect is thus as follows:
an uninterrupted tone sequence for 10 seconds, then a further 10 second interval of tone bursts and silence as in figure 10d, then 10 seconds as figure 10e and finally 10 seconds as in figure 10f, after which the sequence repeats. Of course, during each ten second period the frequency of the tone is being varied by the outputs of counter II.

It should be noted that for all these alarm circuits a symmetrical 1 Hz squarewave is required from the output of counter II. This means that the 7490 (which consists of a divide-by-2 and a divide-by-five counter in the same package) must be connected with the divide-by-2 after the divide-by-5, as shown in figure 9. If an existing clock circuit is used this counter may be connected as a BCD decade counter (i.e. with the divide-by-5 after the divide-by-2). Some slight modification may therefore be necessary.

Figure 9. Circuit for generating an alarm signal with variable pitch and rhythm.

Figure 10. Timing diagram for the circuit of figure 9, showing the tone sequences for the four possible states of A_4 and B_4.

Figure 11. Circuit to gradually increase the volume of the alarm signal if the sleeper does not awaken immediately.

Figure 12. A complete alarm circuit incorporating the ideas of the previous circuits.

Volume Control

In order not to awaken the sleeper too harshly it is a simple matter to arrange a volume control so that the alarm tone starts at a low level and gradually becomes louder and louder until it is switched off. This is achieved by the circuit of figure 11. The counter shown is the minutes counter (i.e. the one that drives the minutes display). Since the alarm can only be set in units of ten minutes, the alarm will sound when the tens of minutes have just changed to the required number and the minutes counter is reset. Outputs A to C of the minutes counter are thus at '0', so T2 to T4 are turned off. The alarm tone is applied to the base of T1 via R1 and switches this transistor on and off causing a signal from the loudspeaker. Since there is a 390 Ω resistor (R2) in series with it the tone is not very loud. After 1 minute the A output of the counter goes to '1', switching on T2 and thus connecting R3 in parallel with R2. The tone thus becomes louder. After 2 minutes output B becomes '1' while A becomes '0'. R4, which is smaller than R3, is paralleled with R2, so the tone becomes louder still. After 3 minutes outputs A and B are '1', and after 4 minutes output C becomes '1', by which time the tone is quite loud.

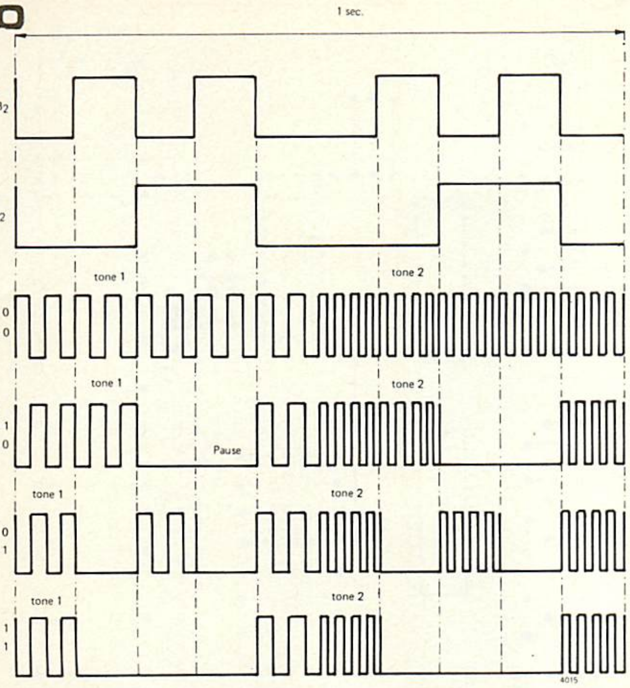
Output D is not connected to this system. If the sleeper has not awoken after 8 minutes output D will become '1' and can be connected to set off a small explosive charge underneath the bed. A less drastic cure for the deep sleeper is to connect an additional transistor to output D with a 56 Ω resistor in series with its emitter.

The complete circuit of an alarm system is given in figure 12. Everything within the dotted box is the alarm circuit, whilst everything outside is the existing clock circuitry. This differs slightly from the circuits discussed in that a HEX-inverter replaces the five-input NAND-gate in the alarm control circuit. This has open-collector outputs, so the outputs may be joined to perform a wired-OR function. In this circuit the additional transistor T9 is shown connected to output D5 for the extra loud alarm signal. A suitable printed circuit board and component layout for this alarm are given in figure 13.

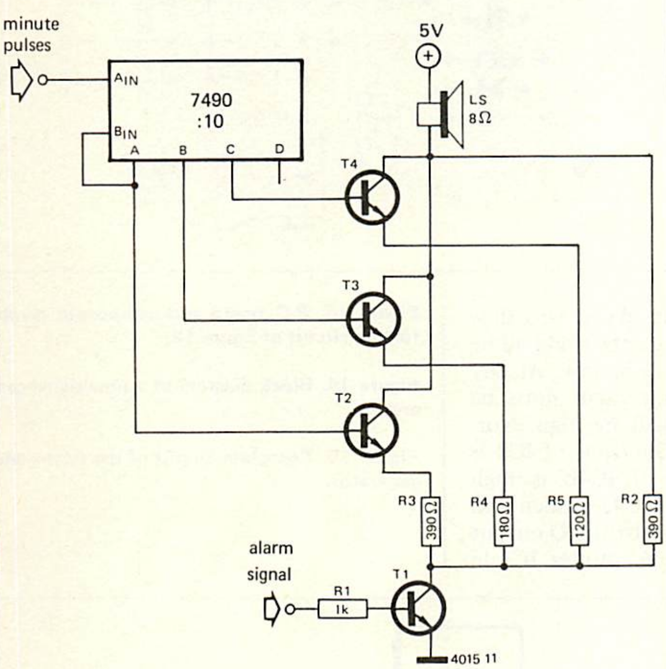
Time Signal Generator

Provision of a 'six pips' time signal every hour is a relatively simple matter

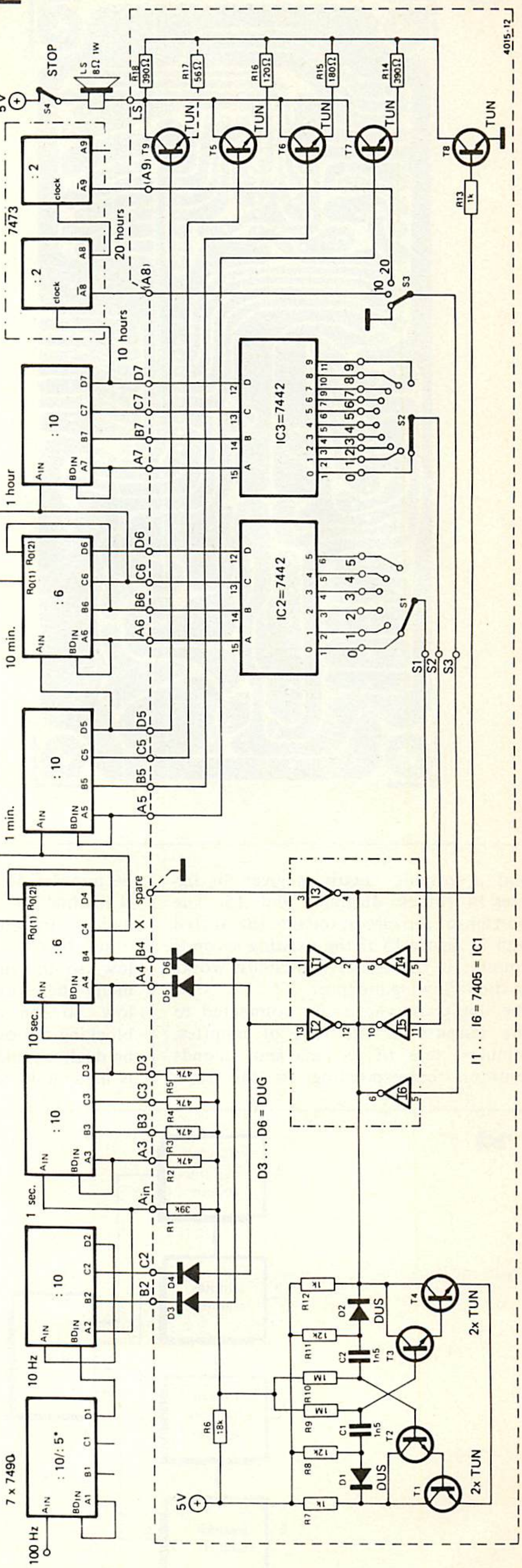
10



11



12



Components list for figure 12

Resistors:
R1 = 39 k
R2 ... R5 = 47 k
R6 = 18 k
R7,R12,R13 = 1 k
R8,R11 = 12 k
R9,R10 = 1 M
R14,R18 = 390 Ω
R15 = 180 Ω
R16 = 120 Ω
R17 = 56 Ω

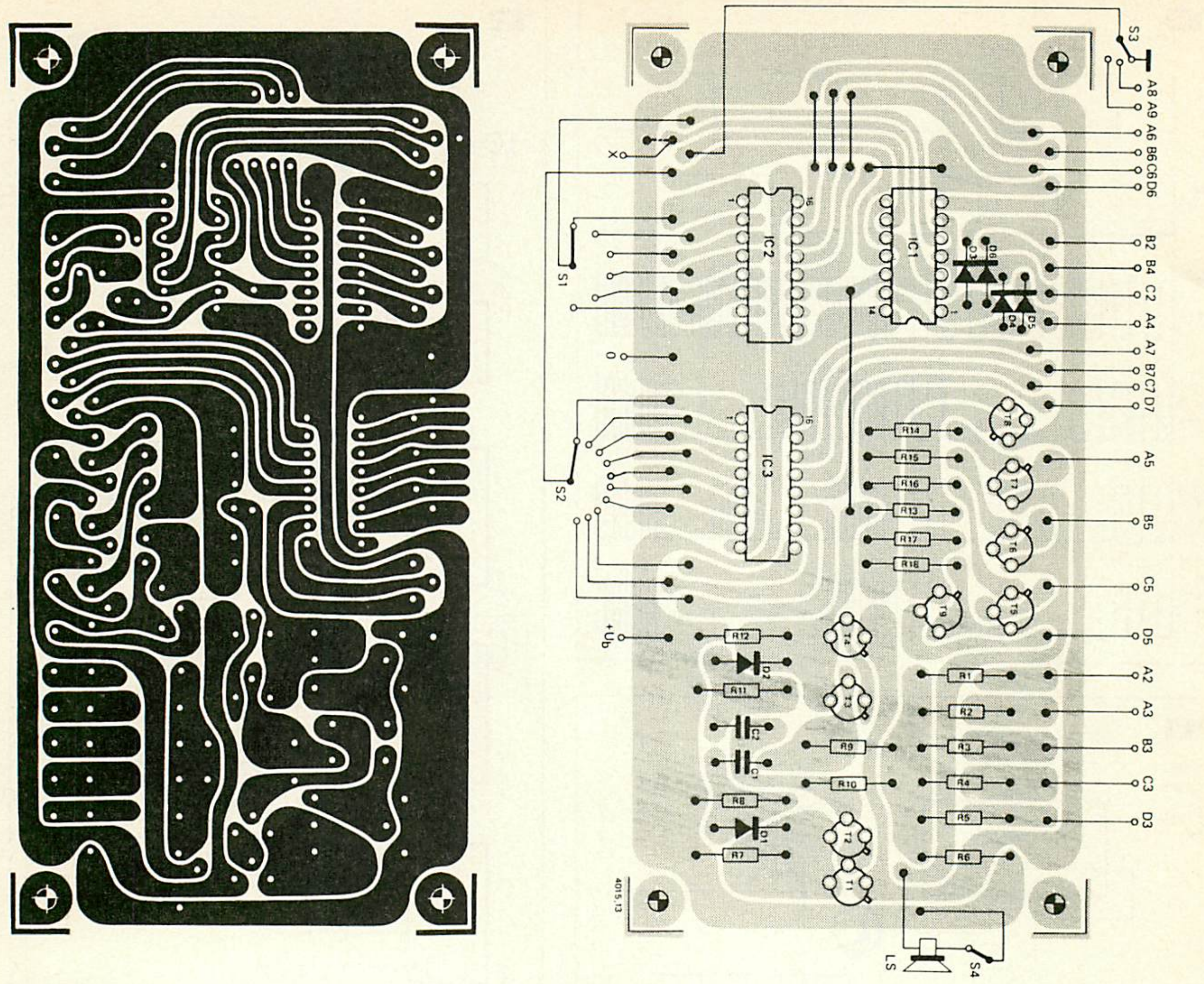
Capacitors:
C1,C2 = 1n5

Semiconductors:
T1 ... T9 = TUN
D1,D2 = DUS

IC's:
IC1 = 7401
IC2,IC3 = 7442

Switches:
S1 = single pole 6-way
S2 = single pole 10-way
S3 = single pole 3-way (decimal coded thumbwheel switches suggested)

13



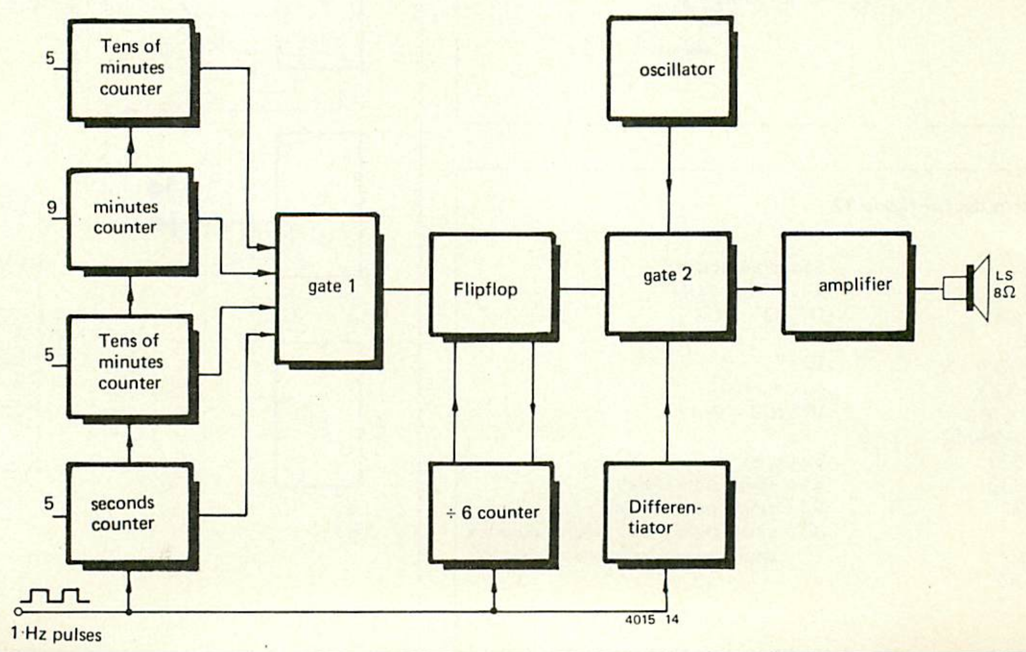
and a suitable circuit is given in figures 14 (block diagram) and 15. The portion of the circuit outside the dotted box in figure 15 is the existing seconds counter in the clock. The circuit works in the following manner:
the inputs of gate 1 are connected to the outputs of the tens of minutes, minutes, tens of seconds and seconds counters corresponding to the time 59 minutes 55 seconds. When this time is reached the inputs of gate 1 will all be high, so the output will be low. At any other time at least one input must be low, so the output will be high. Normally therefore, the $\overline{Q}$ output of IC2 is low, so the output of IC4b is high blocking the oscillator IC4a (which will be dealt with later), whilst the Q output is high, holding the ÷ 6 counter IC3 in

Figure 13. P.C. board and component layout for the circuit of figure 12.

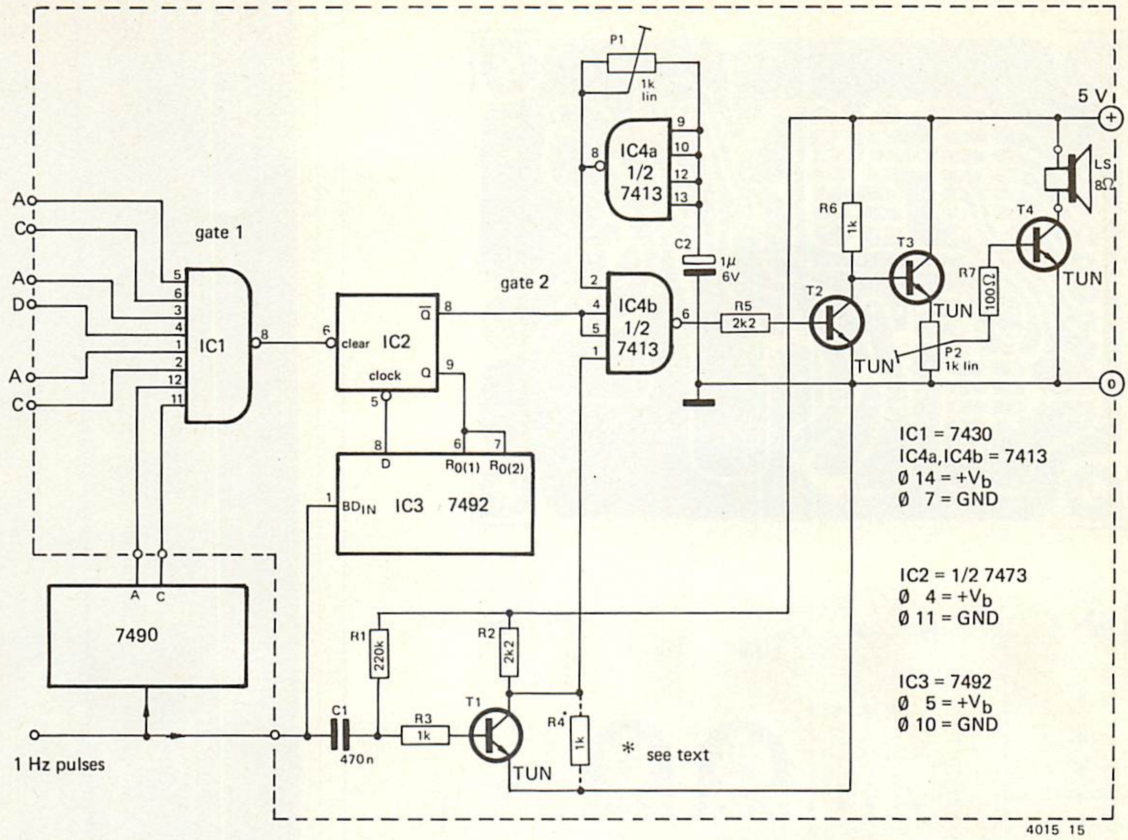
Figure 14. Block diagram of a time-signal generator.

Figure 15. Complete circuit of the time-signal generator.

14



15



Components list for figure 15

Resistors:
R1 = 220 k
R2,R5 = 2k2
R3,R4,R6 = 1 k
R7 = 100 Ω
P1,P2 = 1 k

Capacitors:
C1 = 470 n
C2 = 1 µ, 6 V

Transistors:
T1 ... T4 = TUN

IC's:
IC1 = 7430
IC2 = 7473
IC3 = 7492
IC4 = 7413

the reset condition. On the negative-going edge of the incoming seconds pulse at 59 minutes 55 seconds the output of the seconds counter will assume the condition '5', i.e. outputs A and C high. The output of gate 1 will go low, clearing IC2 so that the Q output goes low and the $\overline{Q}$ output goes high.

IC3 may now count the incoming seconds pulses. However, due to the propagation delays through the seconds counter, IC1 and IC2, it will not count on the abovementioned negative-going edge, as this has already disappeared before the counter is enabled. However, the negative-going pulse is differentiated by C1 and R3 (neglecting R1 and the base resistance of T1), and turns off T1 for about 100 ms. This takes pin 1 of IC4 high, and since pins 4 and 5 are already held high by the $\overline{Q}$ output of IC2 the oscillator will be gated through it providing a 1 kHz tone burst of 100 ms duration.

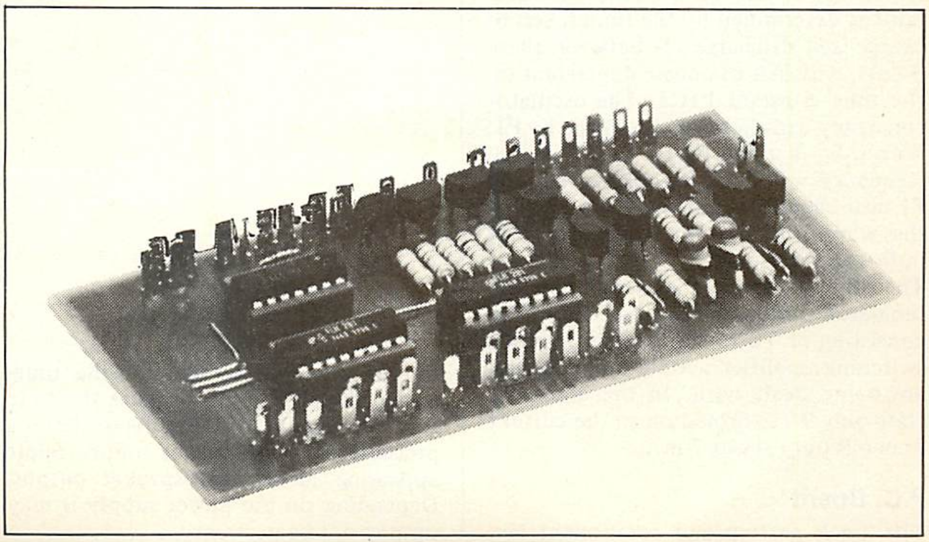
On each negative-going edge of the five subsequent second pulses IC3 will count and the oscillator will provide a 100 ms tone burst. On the fifth pulse the D output of IC3 will go high, and on the sixth pulse the D output goes low, clocking IC2, so that its Q output goes high and its $\overline{Q}$ output goes low. This disables the oscillator and holds the counter (IC3) in a reset condition so that it can count no further seconds pulses. This condition obtains for a further 59 minutes 55 seconds until it is time for the next signal. The circuit thus produces six pips every hour, starting with the first pip at 59 minutes 55 seconds and terminating with a pip exactly on the hour. Of course, this circuit produces pips of equal length, whereas the last pip of a radio time signal is longer than the preceding five. An alternative circuit, which produces this type of signal, was described in Elektor July/August 1975.

Oscillator and Amplifier

The oscillator is a simple single time

COUNT	OUTPUTS D	C	B
0	0	0	0
1	0	0	1
2	0	1	0
3	1	0	0
4	1	0	1
5	1	1	0
0	0	0	0

Table II. Truth table for the 7492 connected as a divide-by-6 counter.



16

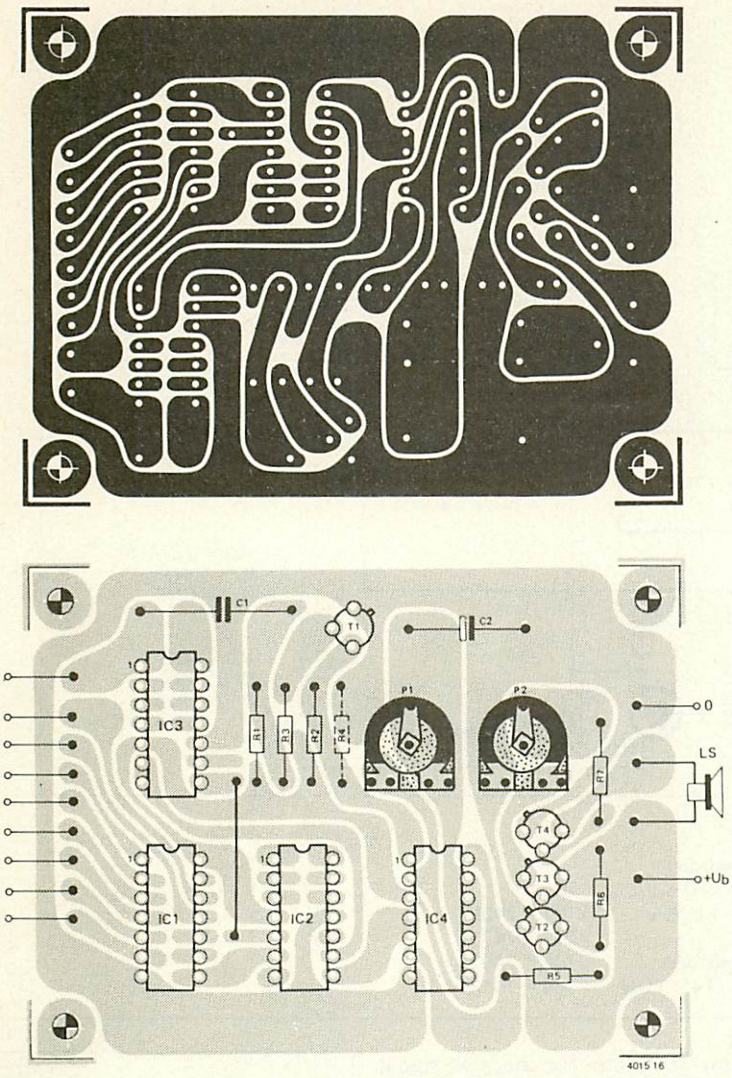
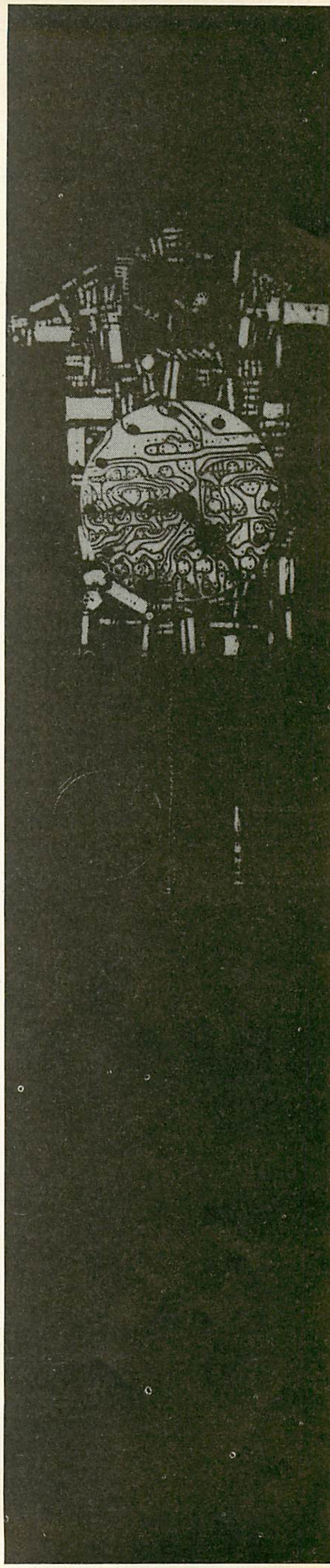


Figure 16. Board and component layout for the time-signal generator.



constant multivibrator based on the 7413 which is a dual 4-input NAND Schmitt Trigger. Assuming the output of IC4a is initially high then C2 will charge through P1 until the voltage across it reaches the threshold of the Schmitt trigger. The output will then go low and C2 will discharge through P1 until it falls below the threshold, when the output will go high again. Because of hysteresis the negative-going threshold is below the positive-going threshold, so the frequency of the oscillator is determined by the time taken to charge and discharge C2 between these points, which is of course dependent on the time constant P1C2. The oscillator frequency can therefore be varied by P1. With C2 = 1 μ and P1 set to 330 Ω the frequency will be about 1 kHz. Altering P1 also changes the mark-space ratio of the waveform, but this is unimportant in this application.
The other gate in IC4 is used to gate the oscillator output into the amplifier, consisting of T2 to T3. This is a simple switching amplifier, as only square waves are being dealt with. In the quiescent state only T2 is turned on so the current drawn is only about 7 mA.

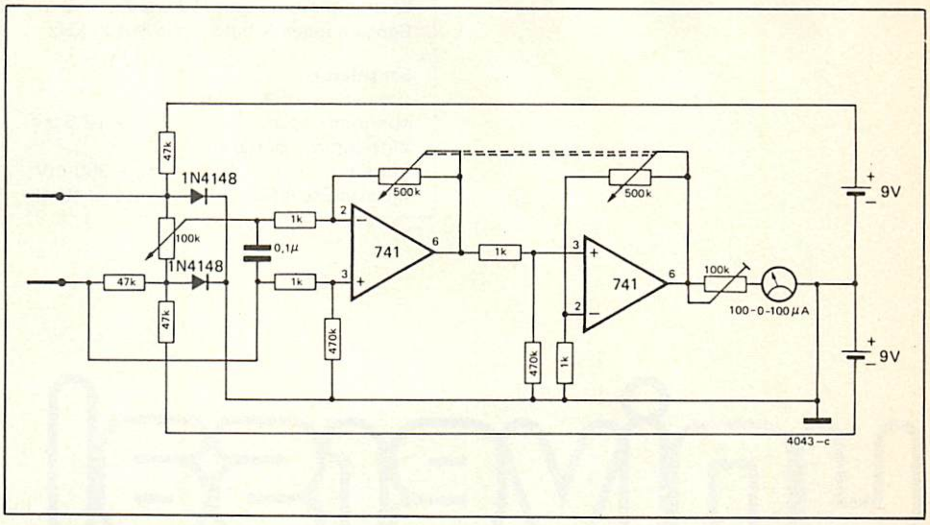
P.C. Board

The track pattern and component layout of a board suitable for the time-signal circuit is given in figure 16. Note that R4 (shown dotted in figure 15) is a precaution against power supply ripple appearing at the loudspeaker output. Depending on the power supply it may or may not be necessary.

J. Jacobs

lie detector

This lie detector works in the usual manner by measuring skin resistance and therefore is no innovation, but in comparison with the designs popular some years ago it offers a number of useful improvements. In the circuit the advantages of opamps have been turned to full use. The detector operates fully symmetrically, and therefore two batteries are required. The voltage across the electrodes according to local regulations in some countries, may not be higher than 2 V so a reference voltage of no more than 1.2 V is applied to the input of the measuring bridge. Since the resistance of the human skin is generally 50 k or less, the voltage across the electrodes will be at maximum 0.6 V. The set-up of the measuring bridge has the additional advantage that the reference voltage is independent of the battery voltage. To obtain a sufficiently high sensitivity the total amplification in the detector should preferably be greater than 100,000 times. Therefore a second opamp was added, which brings the overall amplification to about 250,000 times. With the double potentiometer of 500 k the amplification can be adjusted from 0 to the above-mentioned maximum. The 100 k potentiometer serves to adjust the sensitivity of the moving coil meter; therefore the input bridge is first brought completely out of balance to the one side and then to the other by means of the 100 k potentiometer, whilst the positive and negative deflection of the meter is adjusted to maximum. Afterwards the adjustment potentiometer can, if required, be replaced by a fixed resistor.

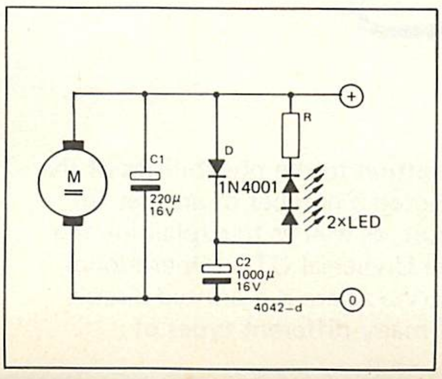


R. Zimmer

brake lights for model cars

This circuit performs two functions: when the supply voltage to the motor of the model car cuts out, the car will not stop abruptly but will continue over some distance and during that time two LED's will light up and function as brake lights. Thus a very realistic effect is obtained. The circuit is extremely simple. As long as the car is under power, there is a voltage across the motor (M), the polarity of which is indicated in the diagram. Capacitor C_1 and (via diode D) also C_2 are now charged.

When the voltage cuts out, C_1 discharges across M and C_2 discharges via the two LED's, resistor R, and motor M. If braking is the result of a short-circuit of the supply voltage, both capacitors discharge via the short-circuit connection; in that case the LED's burn somewhat brighter. The value of resistor R can be calculated with the following simple formula:



$$R = \frac{12 - 2.V_{LED}}{I_{LED}}$$

Usually a value of about 560 Ω will be suitable.

universal OTA PLL

Elektor has taken a lead in drawing attention to the possibilities of the PLL (Phase Locked Loop), and has devoted a number of articles to designs incorporating this versatile circuit, as well as to explaining the principles of different applications. The Universal OTA (Operational Transconductance Amplifier) PLL described here is a printed-circuit module which can form the nucleus of many different types of receiver.

Performance Data

Narrow-band FM reception
(VCO free-running frequency approximately 10.7 MHz)

Capture and hold ranges

	Capture	Hold
Input 160 μV	190 kHz	540 kHz
Input 1.6 mV	250 kHz	4 MHz
Input 10 mV	400 kHz	10 MHz

AM Suppression

Input 160 μV	⩾60 dB
Input 100 μV	>40 dB

Sensitivity
Deviation = ±3 kHz
Minimum input = 3.2 μV
With input = 4 μV:
output = 700 mV,
signal/noise ratio = 40 dB

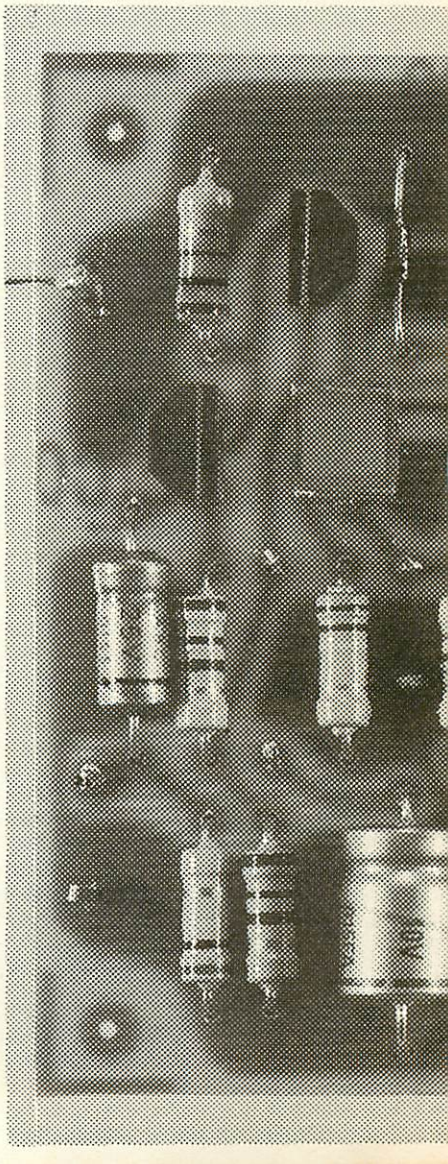
Wide-band Stereo FM reception
(VCO free-running frequency approximately 455 kHz)

Capture and hold ranges
With minimum input (12.6 μV):
Capture range ≈ hold range ≈ 400 kHz

Sensitivity
(Deviation = ±30 kHz)
Minimum input = 12.6 μV
With input = 500 μV:
output = 360 mV,
signal/noise ratio ⩾40 dB

Most of the integrated PLLs now available for FM receivers are expensive and require a 24-volt power supply, which makes them inconvenient for either portable or car-borne use. This universal PLL works quite happily on a 5-volt supply, but the working voltage may be determined in practice by the needs of a MOSFET RF amplifier, which can require 9 volts. This, however, is easy to provide in battery-powered portable equipment, and it also leaves a margin for stabilisation when running from a 12 V car supply.

Sensitivity on a 10.7 MHz FM input with 3 kHz deviation is 3.2 μV for a 700 mV audio output.
For a receiver for the 144 to 146 MHz band, the aerial signal is pre-amplified and converted to a band from 10 MHz to 12 MHz by a stable 134 MHz mixer-oscillator. Any signal in the 2 MHz-wide band can then be tuned in by adjusting (with a potmeter) the frequency of the voltage-controlled oscillator incorporated in the PLL.
Figure 1 shows a block diagram of the arrangement. The 134 MHz local oscillator will normally be a crystal oscillator of lower frequency in conjunction with a multiplier. Assuming the combined gain of the pre-amplifier and the mixing stage to have the easily-achievable value



of 20 dB, the overall receiver sensitivity for the quoted audio output of 700 mV will be some 0.3 μV, which is better than that of most commercial receivers for this band.
For reception of wide-band broadcast FM signals, the unusual arrangement of a double superheterodyne, with a second IF as low as 455 kHz, is used (see figure 2). The low modulation index of a stereo FM signal makes demodulation with a good signal-to-noise ratio difficult to achieve, and even in the best (and most expensive) receivers this is seldom above 50 dB on strong signals. With this very low second IF, 60 dB is achieved.

Yet again; what is a PLL?

For those who have not yet had an opportunity to familiarise themselves with the basic concept of the phase-locked loop, the essential features of this circuit can be repeated. The key element is a voltage-controlled oscillator. When the loop is used in a receiver, this oscillator is automatically synchronised with the carrier of the incoming signal. The other elements in the loop are subservient to the main purpose of keeping the oscillator synchronised. In practice, this is done by maintaining a constant phase difference between the incoming signal and the oscillator output: hence the term 'phase-locked loop'.
By definition, the oscillator is voltage-controlled. So if the incoming signal is frequency-modulated, the control voltage applied to the oscillator to keep it synchronised becomes, of itself, the demodulation of the incoming signal. As

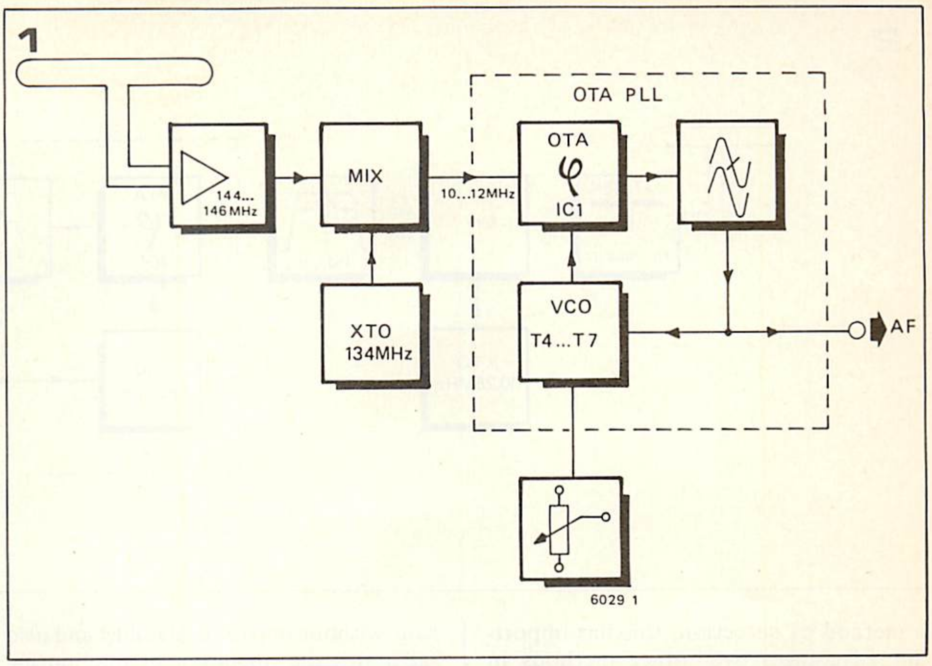
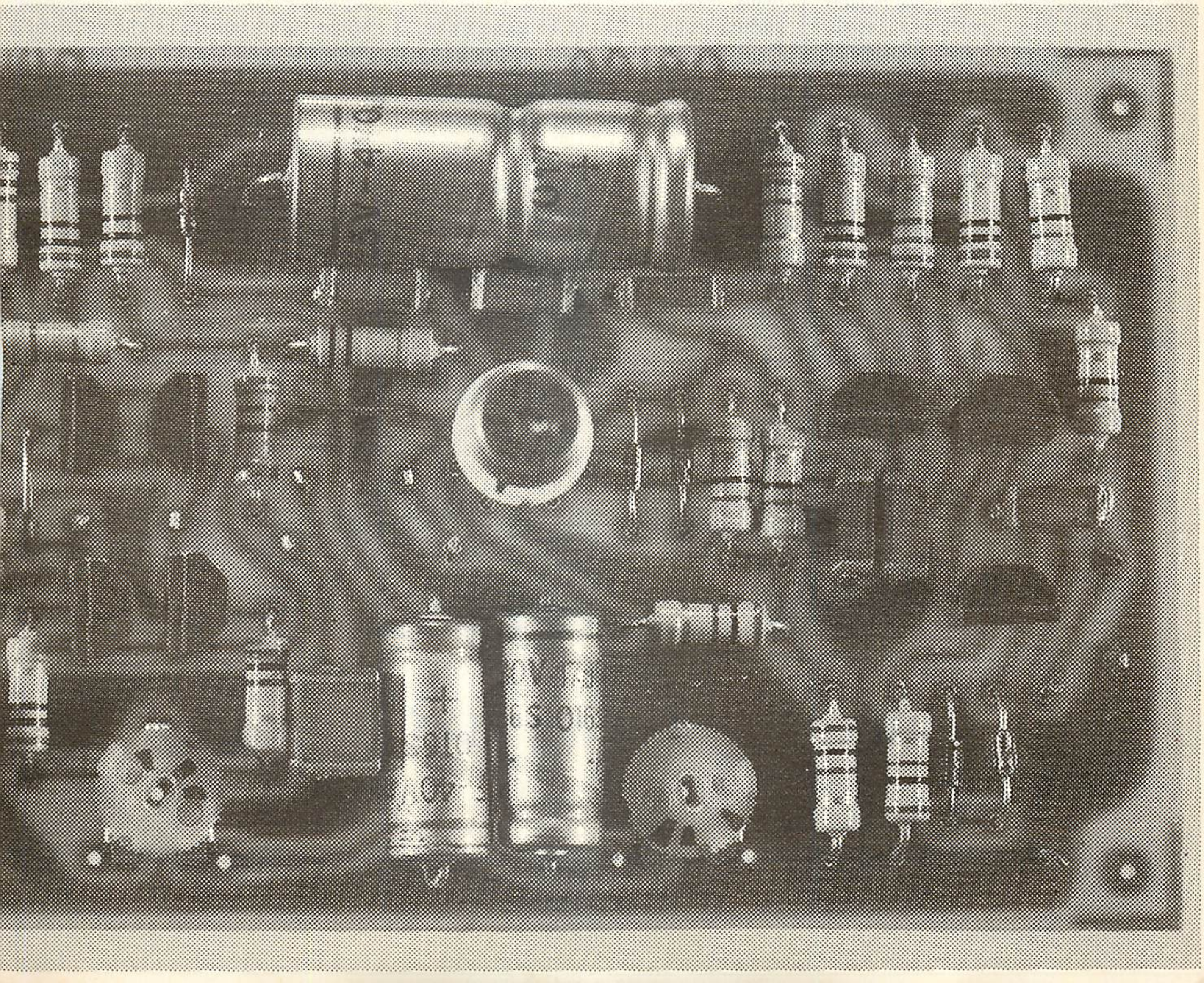
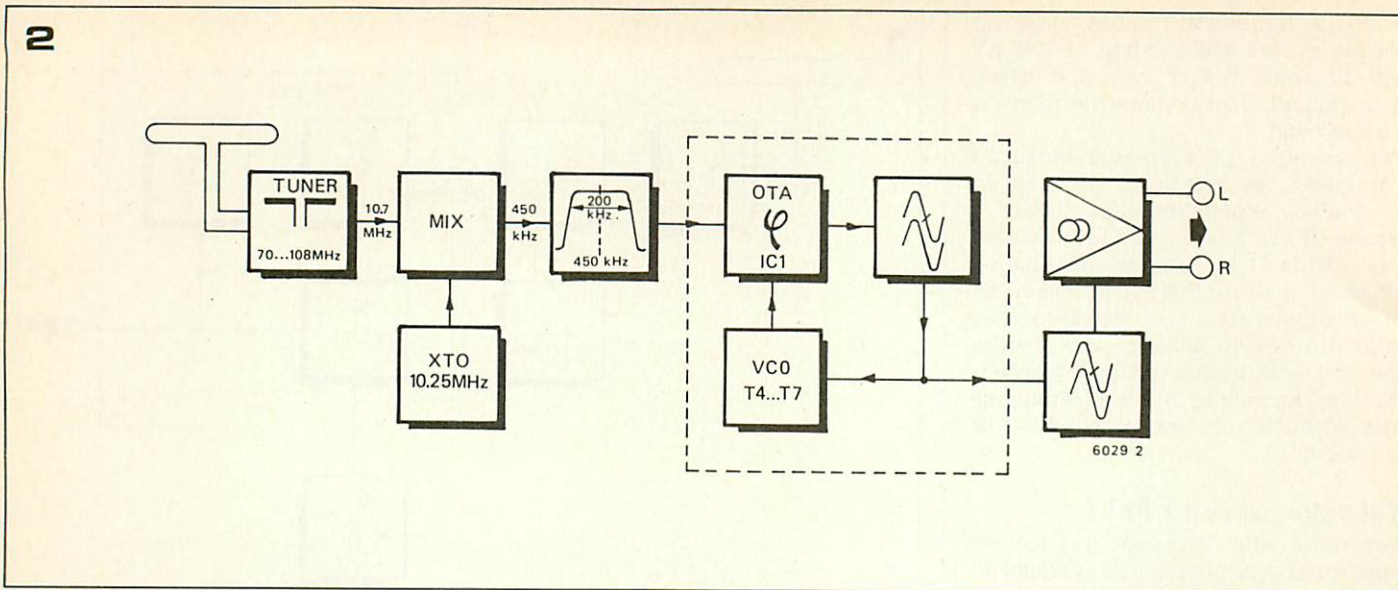


Figure 1. Block diagram of a receiver for narrow-band FM transmissions in the 144 MHz-146 MHz amateur band, with a fixed-frequency mixing oscillator and band-spread tuning by varying the intermediate frequency.



2



a method of detection, this has important advantages over other methods in terms of better rejection of interfering signals, lower distortion, and better signal-to-noise ratio.

Circuit description

The input is fed in across resistor R1 (figure 3). The value of this resistor must be selected to give correct matching to the preceding mixer stage, and suitable values will be given in later articles describing particular applications. Transistors T1 and T2 form a differential amplifier with an asymmetrical input, while T3 and diodes D1 and D2 stabilise the current flowing through T1 and T2. The two collectors of the differential amplifier are connected through capacitors C4 and C5 to the two differential inputs (2 and 3) of the CA3080 operational transconductance amplifier IC1. The use of both inputs in this fashion gives an extra 6 dB gain without impairing stability and also facilitates the operation of the limiting diodes D3 and D4.

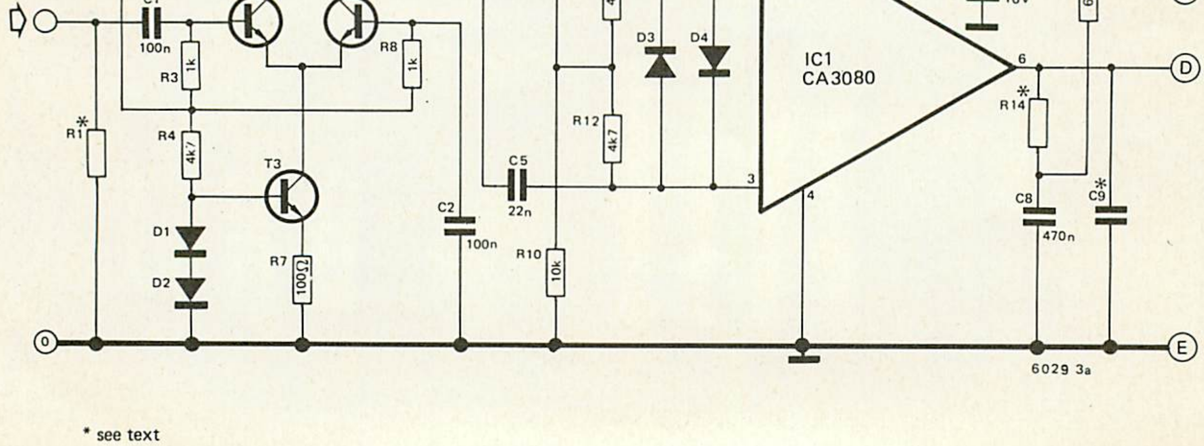
In addition to receiving the RF (or IF) signal at the differential inputs (pins 2 and 3), IC1 is fed via pin 5 with the output of the voltage-controlled oscillator formed by T4 and T5. Although this oscillator is described as voltage-controlled, it should more properly be called current-controlled, the current being regulated by T6 and T7 in the emitter leads of T4 and T5 respectively. It can, however, be said without too much straining of the truth that the commoned bases of T6 and T7 are voltage-controlled from the output (pin 6) of IC1.

In the foregoing description the path of the loop has, in effect, been followed in the reverse direction. Recapping and going the correct way round: the DC component of the signal at pin 6 of the phase-comparator IC1 is amplified by T6 and T7 and controls the frequency of oscillator T4 + T5.

As in all FM detectors, AM rejection is important. The CA 3080 has good AM rejection at low input-signal levels, but is less good at higher levels. These higher levels, however, are taken care of by the clipping diodes D3 and D4, which begin contributing to AM rejection when the peak-to-peak signal between pins 2 and 3 of IC1 exceeds 1 volt.

Capacitor C11 is one of the components whose value influences the VCO free-running frequency (455 kHz in the broadcast FM receiver, or about 10 MHz in the narrow-band FM receiver) so its value is quoted for particular applications (see Table). When the receiver is tuned by varying the VCO frequency, as in the narrow-band FM receiver, potmeters P1 and P2 come into play. When the working IF frequency is fixed, these potmeters can be used for preset adjustment.

3a



* see text

Figure 2. Block diagram of a double superheterodyne for stereo FM reception, with intermediate frequencies of 10.7 MHz and 455 kHz.

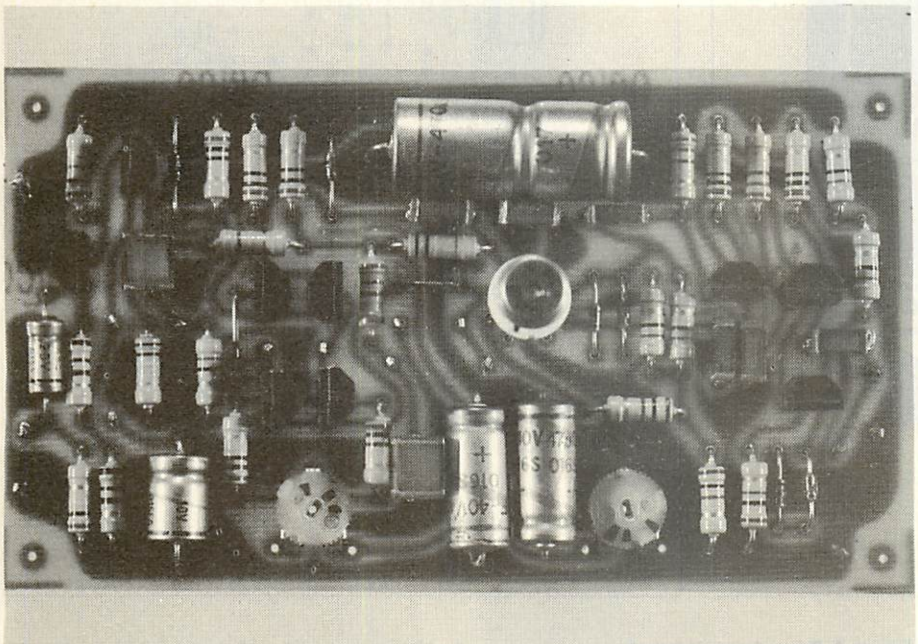
Figure 3. Circuit of the Universal OTA PLL.

Table: Values of R1, R14, R24, C9, C11 and C14 for specific applications.

Values of R1, R14, R24, C9, C11 and C14 for specific applications

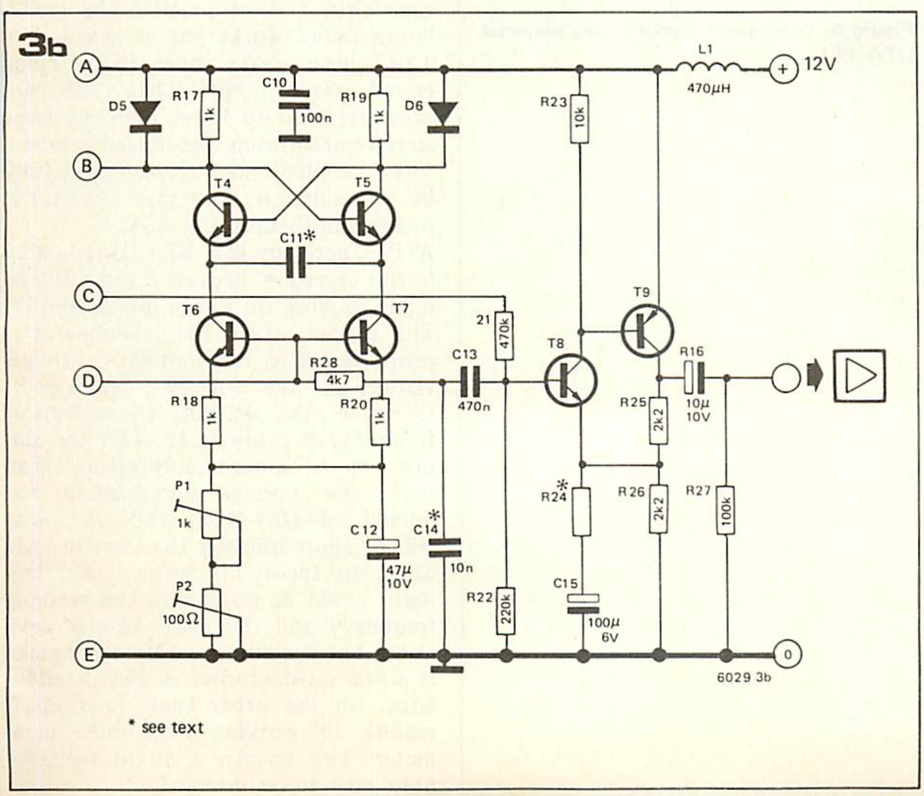
Mode of operation (all FM)			Supply voltage	R1	R14	R24	C9	C11	C14
Type of transmission	Intermediate frequency	Minimum input*							
Wide band mono	10.7 MHz	160 µV	9	330 Ω	1 k	150 Ω	–	100 p	10 n
Narrow band	10.7 MHz	3.2 µV	9	330 Ω-2k2	47 k	0 Ω	–	220 p	10 n
Wide band mono	455 kHz	400 µV	9	–	47 k	2k2	560 p	2n2	10 n
Narrow band	455 kHz	20 µV	9	3k3	47 k	82 Ω	560 p	2n2	10 n
Wide band stereo	455 kHz	500 µV	9	–	47 k	2k2	220 p	2n2	–
Wide band stereo	455 kHz	200 µV	12	–	47 k	2k2	220 p	2n2	–

* At the PLL! (– = omitted)



The low-pass filter which removes the unwanted 'sum' frequency (oscillator plus input signal) is formed by C8, C9, R14 and R16. As the values of these resistors also effect the VCO free-running frequency, they have to be selected carefully for each application. In practice, R16 is given a fixed value of 68 kΩ while R14 is specified for each application. This also applies to the feedback resistor R24 which controls the gain of the output audio amplifier T8 and T9. Resistor R28 and capacitor C14 provide de-emphasis. It will be seen that the whole of the DC component at the output (pin 6) of the phase comparator is passed to the VCO: this helps to ensure a large 'hold range' for the loop.

Detailed descriptions of applications of the Universal PLL will be given in later articles, but the two which have already been mentioned can be briefly discussed here.



* see text

Parts list

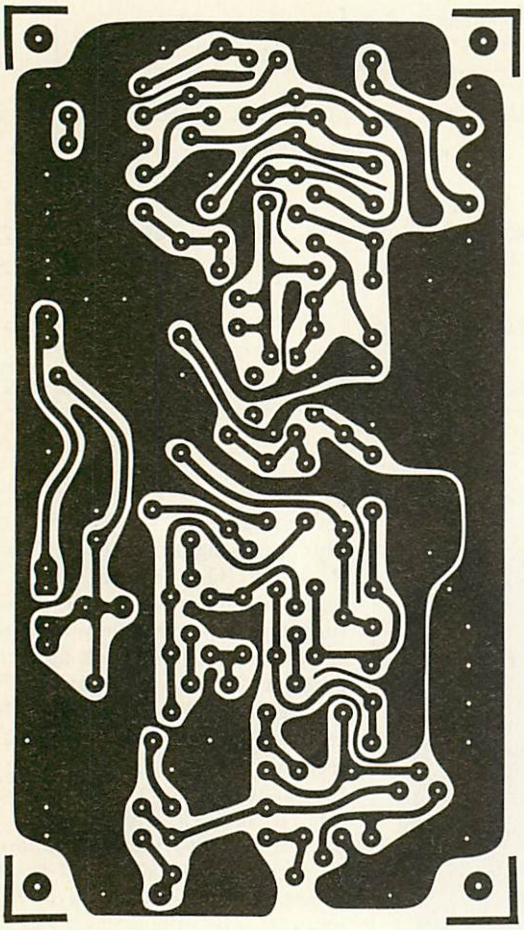
Resistors:
R1,R14,R24 = see table
R2,R4,R11,R12,R28 = 4k7
R3,R8,R15,R17,R18,R19,R20 = 1 k
R9,R10,R23 = 10 k
R5,R6 = 560 Ω
R7 = 100 Ω
R27 = 100 k
R13,R22 = 220 k
R16 = 68 k
R21 = 470 k
R25,R26 = 2k2
P1 = 1 k
P2 = 100 Ω

Capacitors:
C1,C2,C6,C10 = 100 n
C3 = 470 µ/16 V
C4,C5 = 22 n
C7 = 47 µ/16 V
C8,C13 = 470 n
C9,C11,C14 = see table
C12 = 47 µ/10 V
C15 = 100 µ/6 V
C16 = 10 µ/10 V

Inductor:
L1 = 470 µH

Semiconductors:
T1 ... T7 = BF 494
T8 = BC 547
T9 = BC 557
IC1 = CA 3080
D1 ... D6 = 1 N 4148

4



5

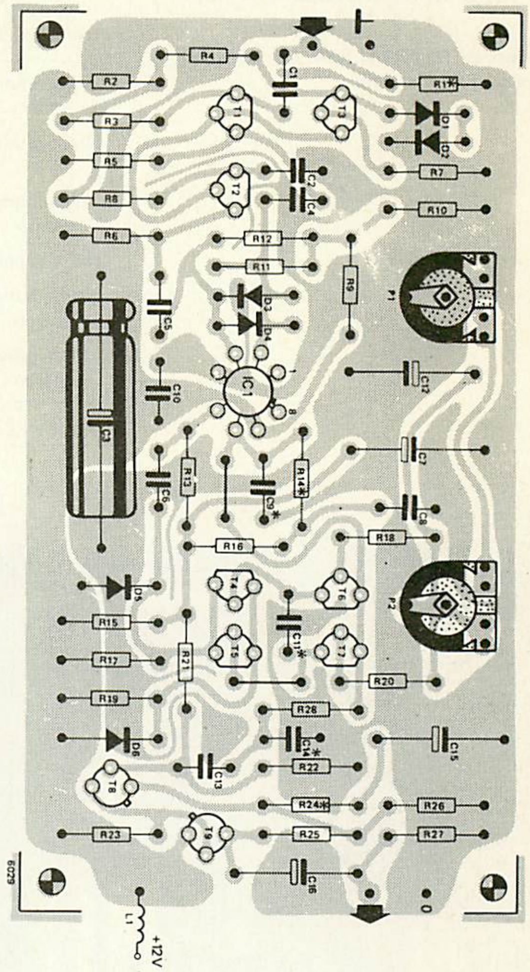


Figure 4. Printed circuit board.

Figure 5. Component layout of the universal OTA PLL.

Narrow-band FM receiver

In narrow-band FM systems, noise always tends to be a problem because the modulation index (the ratio of the maximum deviation to the highest modulation frequency) is by definition low, but the good noise performance of a PLL demodulator goes a long way towards overcoming this handicap. The limiting sensitivity of the Universal PLL, when used in a narrow-band FM receiver, has already been stated to be 3.2 μV, not counting the gain of the RF and mixer stages preceding it. With an input of 4 μV – slightly above the limiting value – the signal-to-noise ratio is 40 dB.

The principle of using a crystal-controlled fixed-frequency local oscillator, and tuning the IF with the VCO, offers a very simple and effective form of band-spreading.

Stereo FM receiver

FM sound broadcasting has a maximum deviation of 75 kHz, which gives a modulation index of 5 on mono transmissions having a 15-kHz audio bandwidth. With a stereo transmission, the maximum modulation frequency is 53 kHz, but the effective bandwidth of the composite stereo signal is greater than this, and in practice the modulation index works out as low as 0.6. This means that, 'other things being equal', stereo reception has a signal-to-noise ratio 20 dB lower than the same stereo transmission reproduced in mono. These problems are discussed more fully in 'Modulation Systems' (Elektor 2, p. 246 and Elektor 3, p. 454).

A PLL detector can help considerably in this situation, because it can easily be made to work on a very low second IF. The output of an FM demodulator is proportional to the quotient of the deviation and the working frequency. If, therefore, the working (intermediate) frequency is as low as 455 kHz, the output will be considerably greater than with the normal intermediate frequency of 10.7 MHz, while the noise will be approximately the same in both cases. In theory, a 'normal' discriminator could be made with this working frequency and the usual 75-kHz deviation, but it would be difficult to make it work satisfactorily. A PLL demodulator, on the other hand, lends itself readily to working with these parameters and enables a 60-dB signal-to-noise ratio to be obtained.

tv test pattern generator

A television pattern generator is one of the most useful TV service aids. It simplifies checking of the video stages, adjustment of picture geometry, and perhaps most important, setting up of convergence in colour receivers. Using logic IC's for the generation of the test pattern allows the construction of a simple and reliable circuit, and the design given here is based on the 74 series TTL logic family.

The test pattern generator produces the well-known dot and crosshatch patterns. In the crosshatch mode a number of horizontal and vertical bars are displayed on the screen, whilst in the dot mode only the crossing points of these bars are displayed, thus producing an array of dots.

Building up the video signal

The number of bars in the display has certain constraints placed upon it by the nature of the television picture. This is composed of a raster of 625 lines. Since the horizontal bars are produced by dividing down the 15625 Hz line frequency digitally, it follows that the ratio (625 : number of bars) must be a whole number, as it is not possible to obtain a non-integral division ratio digitally, and if it were the pattern would move anyway.

Since $625 = 25^2$ then 25 is a convenient number of bars. One of these is lost during the field blanking interval, so only 24 are in fact displayed. Since the 'boxes' formed by the bars should ideally be squares rather than rectangles this determines the number of vertical bars. The aspect ratio of a television picture is 4 : 3, so the number of vertical bars is $\frac{24 \times 4}{3}$ or 32. The oscillator which produces the vertical bars runs at a higher frequency than line frequency (since there are several picture elements along each line).

Parts list for figures 1 and 6

Resistors:
R1 = 1 k
R2,R3 = 470 Ω
P1 = 470 Ω lin.
P2 = 1 k lin.

Capacitors:
C1 = 1n5
C2 = 220 p
C3 = 220 n/250 V

IC's:
IC1 = 7400
IC2 = 7413
IC3,IC4 = 7490
IC5 = 7402

The circuit can conveniently be divided into two sections. The video generator, which produces the actual pattern, and a synchronising unit which produces the field and line sync pulses and also provides the timing for the video generator. The circuit of the video generator is given in figure 1. The vertical bar generator S1 is a NAND Schmitt trigger connected as an astable multivibrator. Since the TV line frequency is 15625 Hz and there are 32 vertical bars it follows that the frequency of this astable must be 500 kHz. P1 provides some adjustment so that the number of lines can be varied slightly. This oscillator is synchronised by line sync pulses. Each line sync pulse turns on T1, grounding pin 5 of S1 and momentarily blocking the oscillator. When the line sync pulse finishes T1 turns off and the oscillator restarts. This ensures that the pulses which make up the vertical bars occur at the same point along every line of the TV picture, as otherwise a random pattern would result.

1

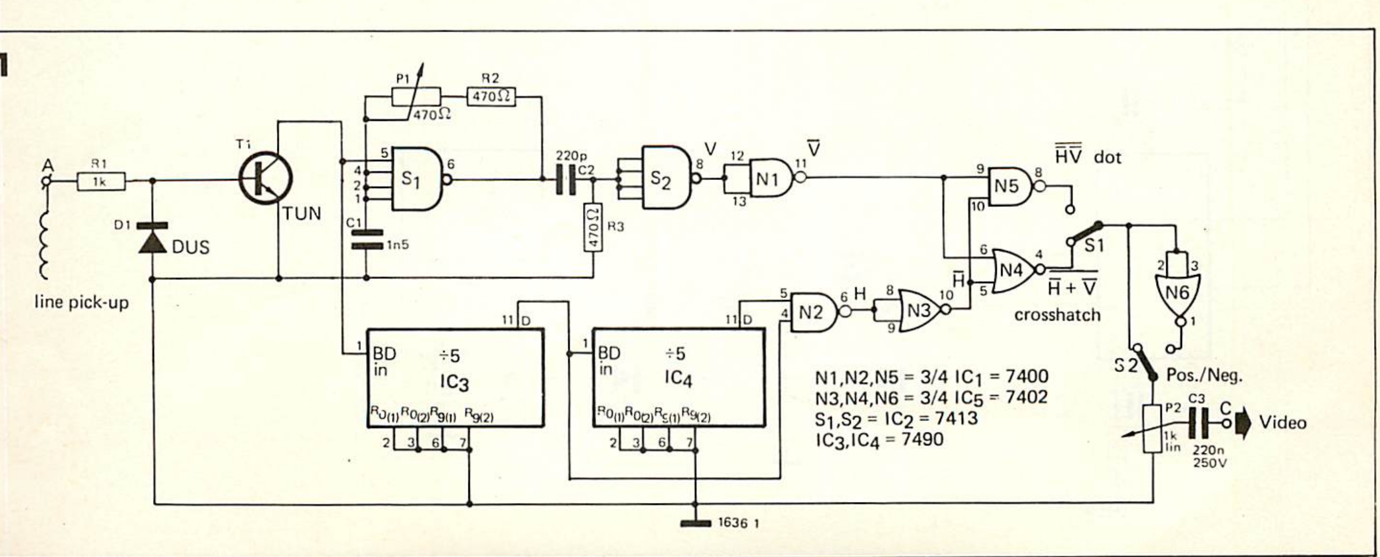
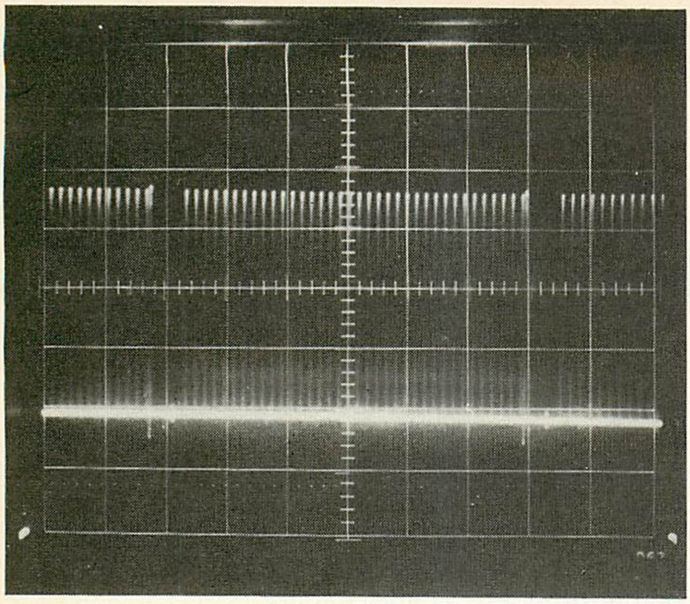
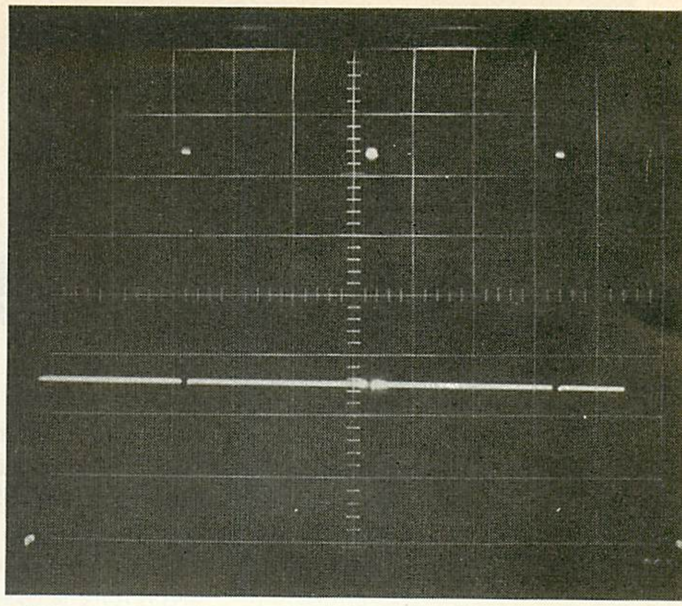


Figure 1. Circuit of the video generator section.

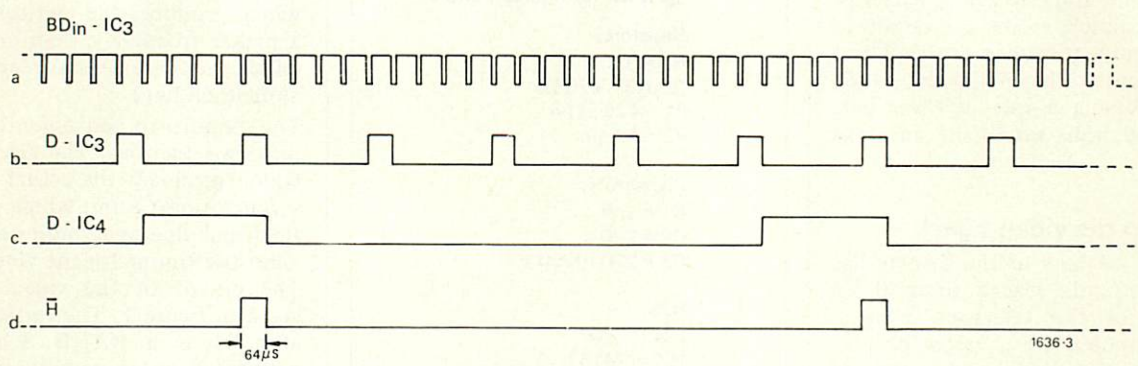


2



4

3


BDin - IC3
a
D - IC3
b
D - IC4
c
H̄
d
64μs
1636-3

5

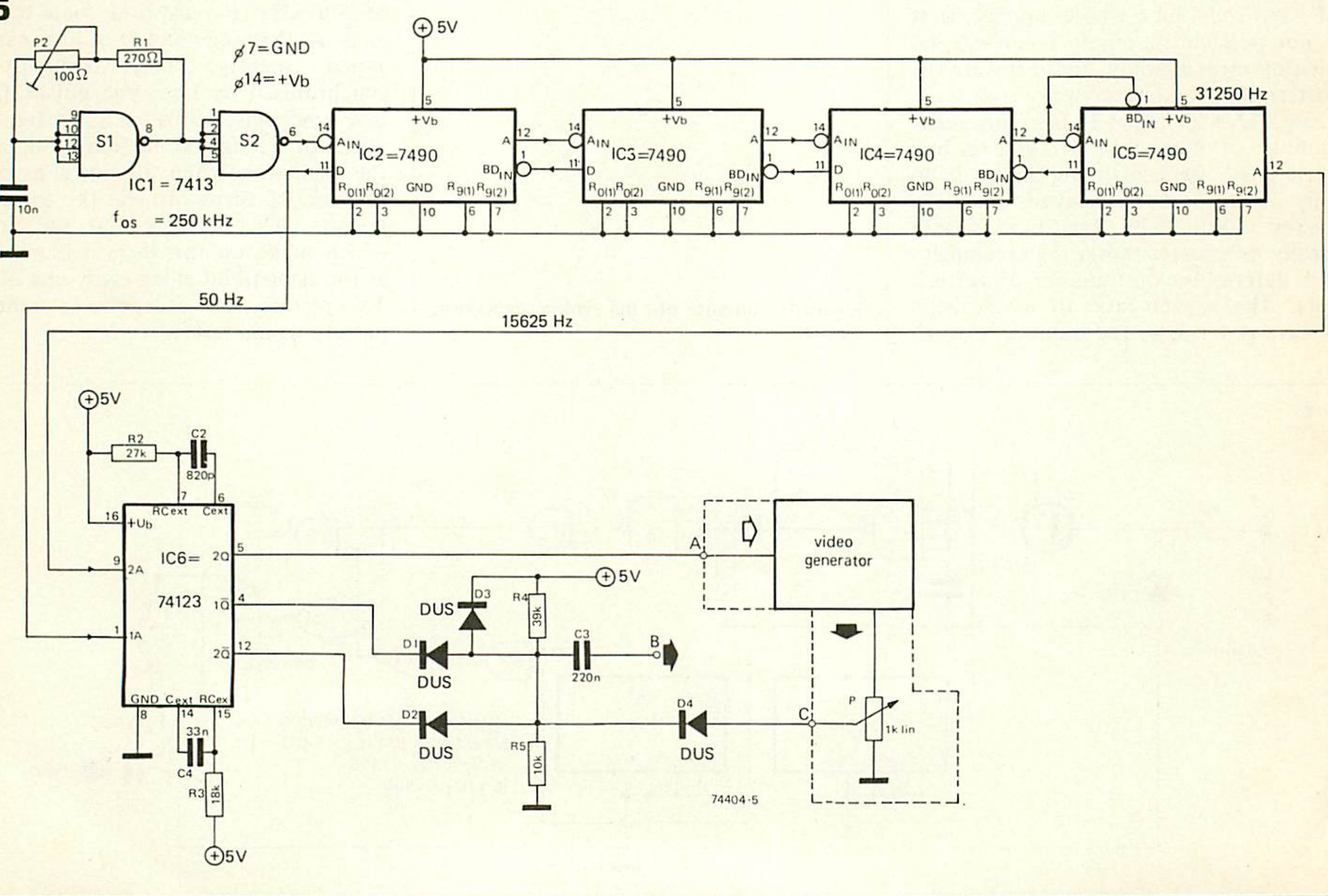

P2
100Ω
R1
270Ω
⌀7=GND
⌀14=+Vb
S1
S2
IC1 = 7413
C1
10n
fos = 250 kHz
+5V
+Vb
IC2=7490
IC3=7490
IC4=7490
IC5=7490
31250 Hz
50 Hz
15625 Hz
R2
27k
C2
820p
IC6=
74123
+Ub
RCext
Cext
2A
1A
2Q
1Q̄
2Q̄
GND
C4
33n
R3
18k
D1
D2
D3
D4
DUS
R4
39k
R5
10k
C3
220n
A
B
C
video generator
P
1k lin
74404-5

Figure 2. Oscillogram of the $\overline{V}$ signal at the output of N1.

Figure 3. Timing diagram for the generation of the $\overline{H}$ signal.

Figure 4. Oscillogram of the $\overline{H}$ signal.

Figure 5. Circuit of the sync generator, showing connections to the video generator.

Figure 6. P.c. board and component layout for the video generator.

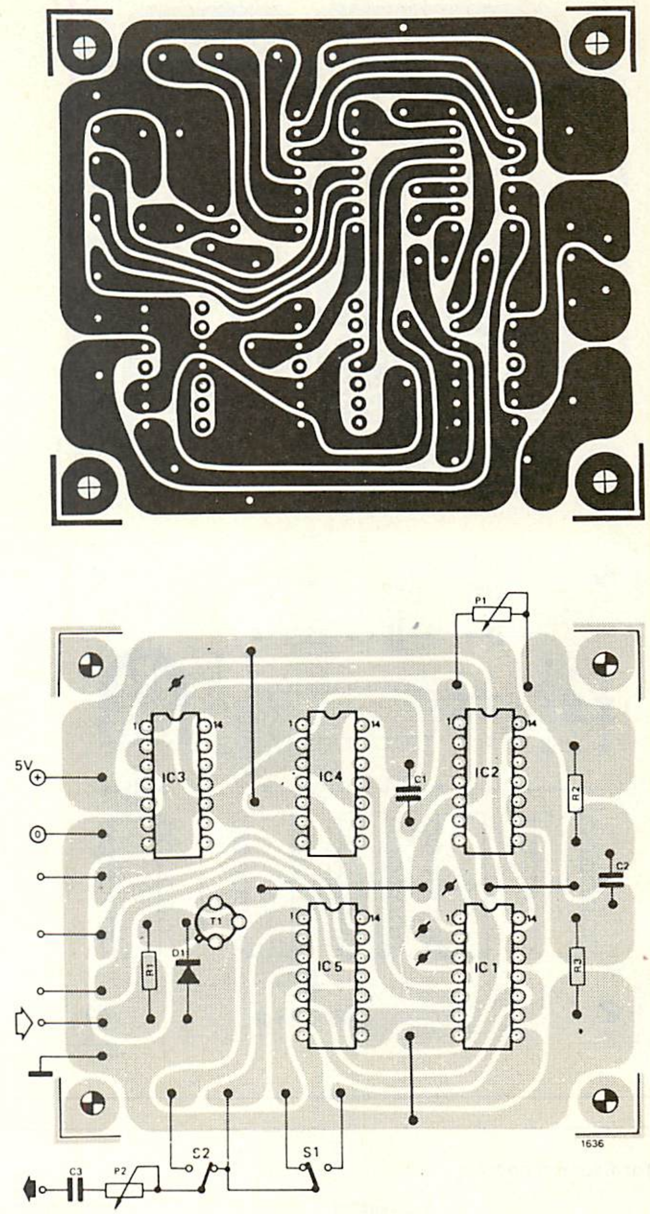
Figure 7. Photograph of the completed video generator.

The output of the astable has substantially a 1:1 mark space ratio. This would, if used as the video signal, produce black and white vertical bands of equal thickness. However, for the purposes of the pattern generator very narrow bands provide more information about the state of the video stages of the TV, since a narrow band requires a shorter pulse length and hence a greater bandwidth.

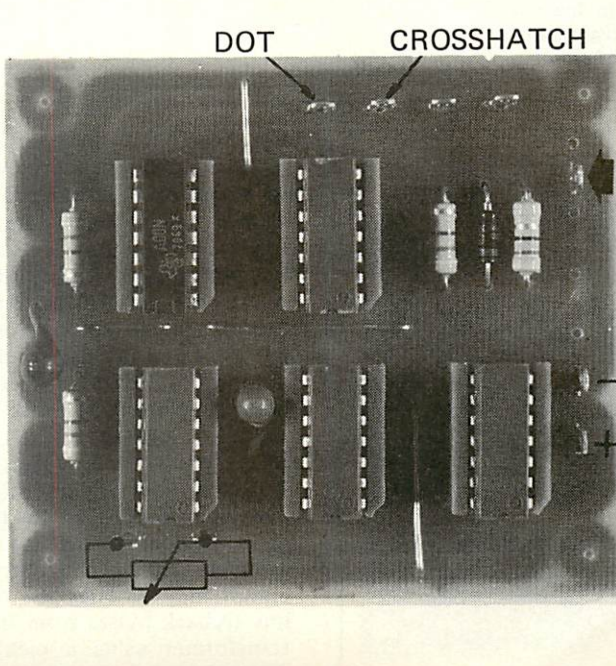
Accordingly the output of the astable is differentiated by C2 and R3, and the spiky pulses are fed into a second Schmitt trigger to square them up again. This also inverts the signal, so it is inverted a second time by N1 to appear in the correct sense. Figure 2 shows the vertical signal $\overline{V}$ as it appears at the output of N1. The absence of pulses where the sync pulses occur can be clearly seen. The pulse length of the $\overline{V}$ signal is about 200 ns.

Line sync pulses at the collector of T1 are also counted by IC3 and IC4, which are 7490's connected as divide-by-five counters. Output D of IC4 is therefore a pulse train at 1/25 of line frequency. The timing diagram for this division is shown in figure 3. Waveform 'a' is the line sync input. Waveform 'b' is the D output of IC3, and waveform 'c' is the D output of IC4. However, this waveform cannot be used directly as the horizontal video signal, as the pulse length is equal to 5 line periods, which would make the horizontal bars too thick. For this reason it is 'NANDed' with waveform 'b' in N2 and then inverted by N3 to produce waveform 'd' ($\overline{H}$). This has a duration of 64 μs or one line period. However, due to interlace each horizontal bar will actually have a thickness of two lines. Figure 4 shows an oscillogram of the $\overline{H}$ signal. To produce the complete video signal the $\overline{H}$ and $\overline{V}$ signals must be summed. To produce the crosshatch pattern the horizontal and vertical signals must be 'OR-d' together, as there must be a bar when vertical or horizontal pulses are present. For the dot pattern, which corresponds to the crossing points of

6



7



8

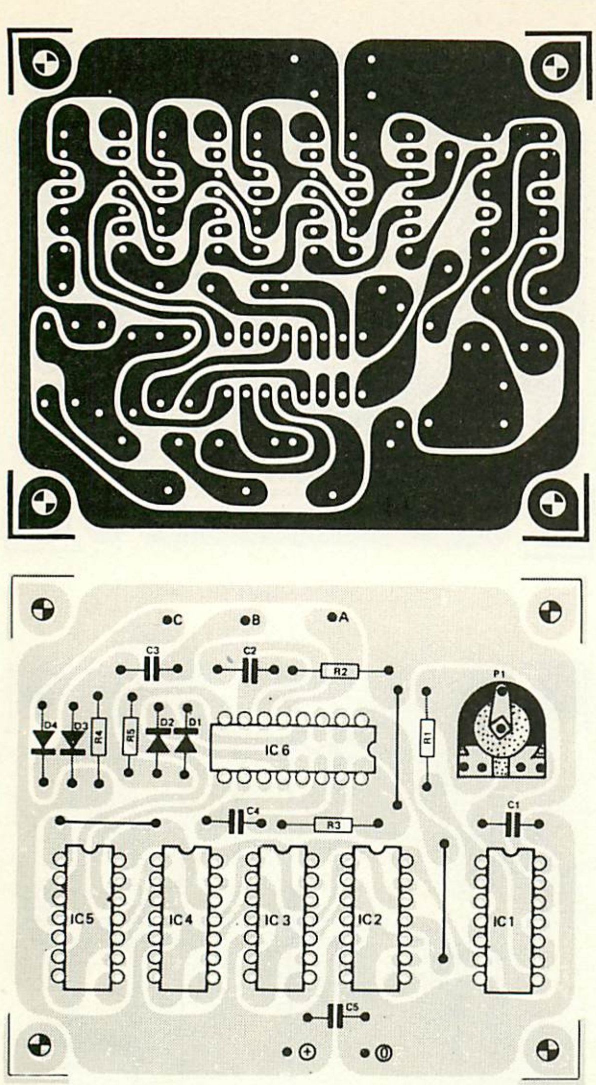


Figure 8. P.c. board and component layout for the sync generator.

Figure 9. Photograph of the completed sync generator.

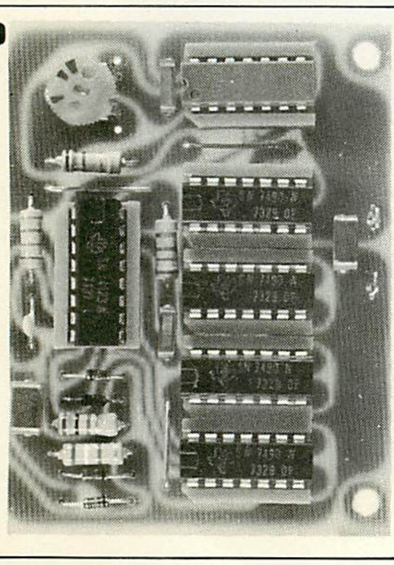
Parts list for figures 5 and 7

Resistors:
R1 = 270 Ω
R2 = 27 k
R3 = 18 k
R4 = 39 k
R5 = 10 k
P1 = 1 k lin. (part of video generator)
P2 = 100 Ω preset

Capacitors:
C1 = 10 n
C2 = 820 p
C3 = 220 n
C4 = 33 n

Semiconductors:
IC1 = 7413
IC2 - IC5 = 7490
IC6 = 74123
D1 - D4 = DUS

9



the horizontal and vertical bars, the pattern must appear only when horizontal and vertical information are present. The $\overline{H}$ and $\overline{V}$ signals are thus ANDed together. These functions are performed by N4 and N5 respectively, and S1 selects the pattern. N6 and S2 provide the option of a positive or negative pattern i.e. white pattern on black background or black pattern on white ground. Note that peak white corresponds to logic '0'.

It is possible to use this circuit as it stands without any additional circuitry. This is accomplished by tuning the set to a station so that sync pulses are available from the transmission. The circuit may be triggered by picking up line flyback pulses from the line output transformer using a pickup coil. The dimensions of this coil are not at all critical, and several turns of insulated connecting wire a few cm diameter should prove suitable. The video signal is then taken from P1 via C3 and is injected into the video stages of the TV. P1 adjusts the video level so that the signal does not interfere with the synchronisation of the set.

A more elegant solution is to employ a built-in sync generator, the circuit of which is given in figure 5. Again a Schmitt trigger operates as an astable multivibrator, this time at a frequency of 250 kHz. The divide-by-two stages of four 7490's are used to divide this down to the line frequency of 15625 Hz. The 50 Hz field sync pulses are produced by taking the output of the third divide-by-two stage (31250 Hz) and feeding it back through the divide-by-five stages of the four 7490's. Since the field and line sync pulses must have pulse lengths of about 250 μs and 4 μs respectively the 50 Hz and 15625 Hz outputs are used to trigger the two halves of a 74123 dual multivibrator, with appropriate time constants.

The line sync pulses are used to trigger the video generator, and are also mixed with the field sync pulses and the video signal using the diode-resistor mixer network. Note that the output capacitor of the video generator is replaced by D4 in this circuit. The video output is taken from point B, and may be injected directly into the video stages of the TV set. Alternatively, the VHF/UHF modulator for the TV-tennis (described elsewhere in this issue) can be used.

Construction

A printed circuit board and component layout for the video generator are shown in figure 6, and for the sync generator in figure 8. Photographs of the completed boards are shown in figures 7 and 9.

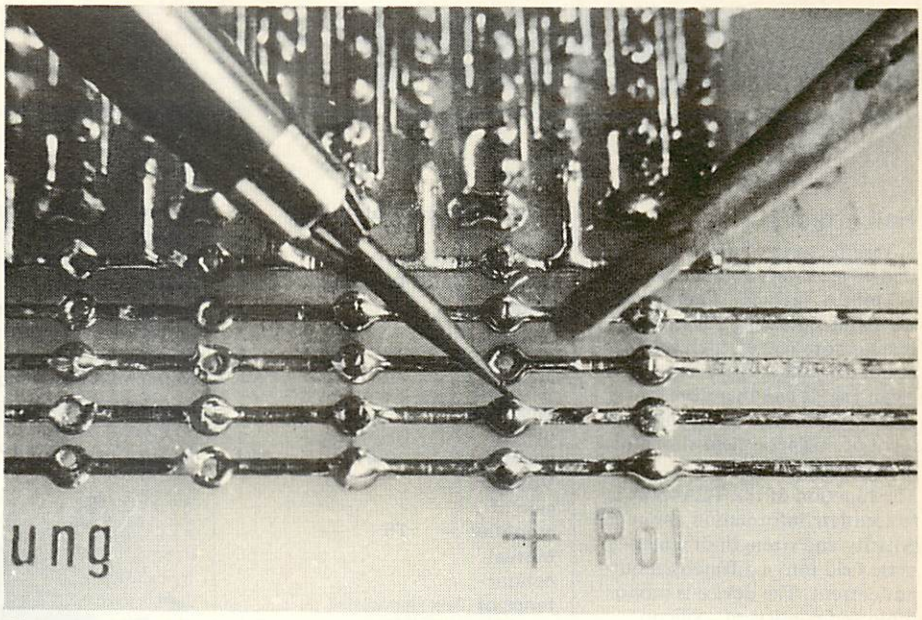
W. Schmidt

with a pencil point

Many electronics enthusiasts look on solder removing as a loathsome job. This is especially true of printed circuit boards with narrowly-spaced conductors. Things which often happen when one is trying to desolder are:
- The solder forms bridges between the conductors.
- Blobs of solder drop off the board.

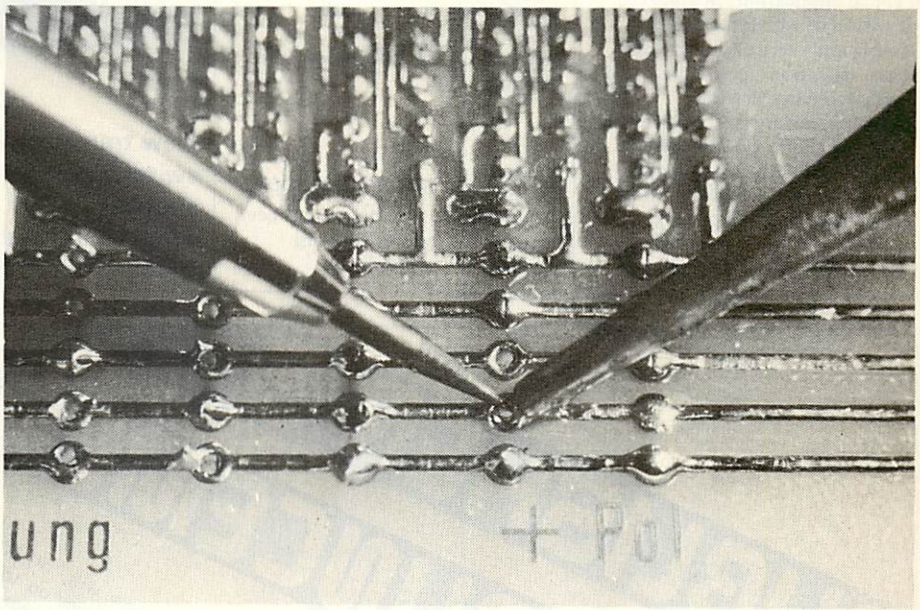
De-soldering tools or wicks are available commercially, but there is no need to lay out that kind of money. Any workshop toolbox should yield a really cheap device which will do the trick – a pencil. Propelling pencils with long leads of 2B or B hardness are particularly suitable (e.g. clutch pencils). To remove solder from a hole, the solder must be heated with a soldering iron until it melts (figure 1). The next step is to stick the pencil point in the hole, and take away the iron (figure 2). Where the pencil lead touches molten solder, the solder 'jumps' away, because of its surface tension, and the hole is cleared of solder (figure 3).

A similar method can be used for getting rid of bridges of solder between tracks. To do this, the pencil point is laid flat on the molten solder between the tracks.

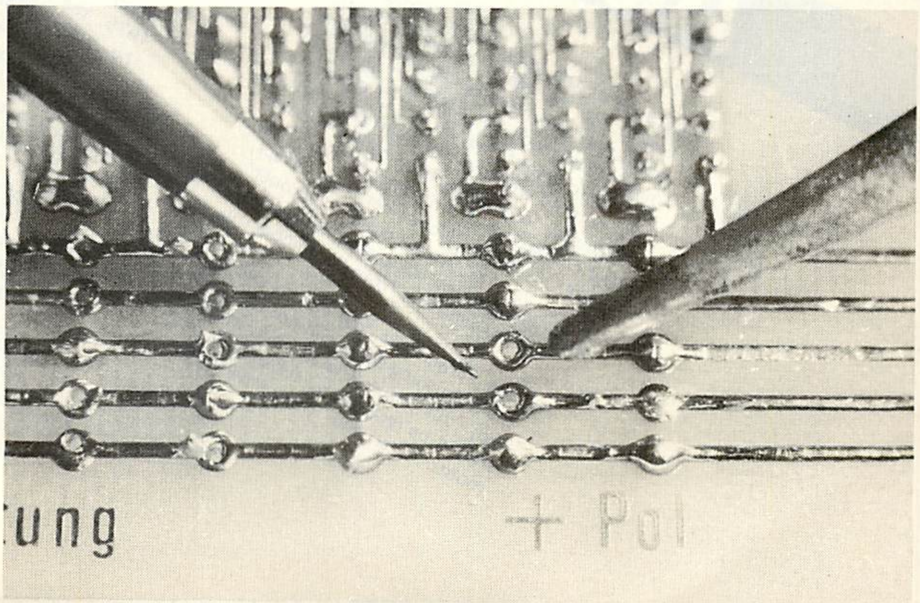


1

2



3



market

Hall effect IC

Special features of a new Mullard Hall-effect integrated circuit, type TCA450A, include: small physical size, wide operating voltage and temperature ranges, high sensitivity, low offset flux, and self balancing. It can therefore be used to advantage in the measurement of magnetic field strengths in small areas or gaps.

The function of the TCA450A is to translate information about the polarity and strength of a magnetic field into a differential output current. The device is monolithic and consists of a silicon Hall-effect element and two associated integrated amplifiers encapsulated in a miniature low profile plastic package.

Typical applications include the provision of isolated current sensing and control in high current applications, contactless and highly-reliable electronic switching, sensing and control in electromagnetic systems where the field strength must be maintained at a precisely determined level, the conversion of magnetic quantities into proportional currents and the detection and positional movement of rotating shafts.

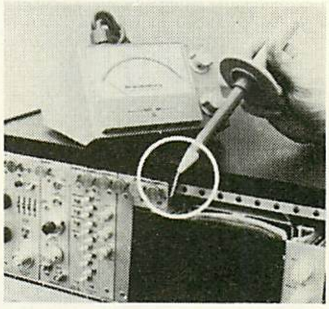
Brief Data	Min.	Typ.	Max.	
Supply voltage	4	8	16	V
Magnetic sensitivity of Hall element	–	0.4	—	V/T
Voltage gain of amplifier	–	15	—	
Mutual conductance of amplifier	–	±240	—	mA/V
Offset flux density in balanced condition	–	—	±25	mT

Mullard House, Torrington Place, London, W.C. 1.

C.R.T. probe attachment

A new probe attachment has been introduced by Brandenburg Limited for use with the company's direct-reading high-voltage meters. The beryllium-copper attachment which screws into the existing h.v. probe unit, is designed to be slipped beneath the anode connection on the c.r.t.

Brandenburg Limited, High Voltage Engineering Division, 939 London Road, Thornton Heath, Surrey, CR4 6JE.



New transistor for switched mode power supplies

The latest addition to the Mullard range of transistors for high-frequency switched mode power supplies operating direct from 'rectified mains' inputs is type BUX82.

It is intended for use in 400 W push-pull or 100 W to 200 W single-ended circuits. Together with other types in the same series, the BUX82 will not only operate satisfactorily at the 'rectified mains' level, but will also accommodate the ±10% voltage variations regularly experienced on mains supplies.

To meet these requirements, the device has an open base collector-emitter rating of 400 V and a collector breakdown rating of 800 V ($V_{BE} = 0$). The d.c. and peak collector current ratings are 5 A and 8 A respectively.

Fast switching characteristics not only minimise switching losses, but also facilitate high-frequency (25 kHz to 50 kHz) operation.

Mullard House, Torrington Place, London, W.C. 1.

PUBLISHER'S ANNOUNCEMENT

Because of the very strong demand for Elektor to be made available through bookstalls and newsstands, arrangements have been made for Elektor 7 to be on sale throughout the UK on 17 October. To comply with the timing arrangements necessary for this, we have had to re-date our magazines from October on. This issue is dated 'November'. In effect, there is no issue dated 'October', although Elektor has been published on a monthly schedule from September on.

For our subscribers, the effects will be:

– the publishing dates will not be affected; this issue (dated 'November') should be received by subscribers one month after the 'September' issue.

– subscribers will, of course, still receive magazines up to and including Elektor 9 this year, even though Elektor 9 will be dated 'January 1976'.

– when subscriptions are renewed for 1976, the invoices will be based on the subscription rate for February up to and including December 1976.

For non-subscribers, the effect will be that Elektor 7 will be on sale at newsagents and stationers throughout the UK on 17 October, and future issues will be available at the same place on the third Friday of every month. Of course, Elektor will continue to be available from leading electronic component suppliers throughout the UK and also direct from the publishers.

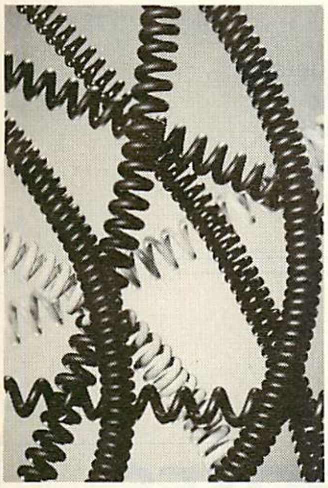
We apologize for any inconvenience that may be caused by the re-dating, but we feel that the advantages more than compensate for any disadvantages.

MARKET

Range of Coiled Cables Available from Lemo

Lemo (UK) can now supply a range of coiled cables, terminated or unterminated. Up to five conductors can be ordered, in a variety of uncoiled (maximum) lengths, and these can be either telecommunications light-current flexibles or with mains-carrying flex in the cores. Outer insulation can be either p.v.c. or rubber, with the conductor insulation following suit.

Lemo (UK) Ltd, 6 South Street, Worthing, Sussex BN11 3AE.



M-Tron industries establishes international division

M-Tron Industries of Yankton, South Dakota, has formed an International Division to sell their crystals to the overseas market. The new international division will be located at 2200 Shames Drive, Westbury, L.I., New York 11590. Telex 961474.
M-Tron Industries manufacture a wide line of quartz crystals. Producing over 10 million crystals a year, they are the number one manufacturer of CB and monitor crystals in the United States.

Combined C-MOS and bipolar relay driver package

The MM74C908/918 Dual High Voltage C-MOS driver consists of two C-MOS "NAND" gates driving a bi-polar emitter-follower Darlington to achieve high current drive and high voltage capabilities, while having the very low input-current characteristics of complementary-metal-oxide.
The MM74C908/918 specifications are at a min. 30 V breakdown voltage and an output current range between 250 mA and 350 mA. However, this component is aimed at the telecommunications market and was specifically designed to replace high voltage telephone relay drivers. Therefore, an improved version for this usage will be specified at 56 V min., packaged in a 14-lead, 2.5 Watt configuration.
The main advantage of this new C-MOS High Voltage Driver is its nil power consumption – just leakage current in the stand-by-mode, while a conventional telephone relay driver in the same mode uses about 10 to 20 mA.
The dual high-voltage C-MOS drivers will be available in two different versions, the MM74C908N 8-pin moulded dual-in-line package and the MM74C918N 16-pin moulded dual-in-line package.

National Semiconductor, The Precinct, Broxbourne, Herts. EN10 7HY.

'Switchmode' power transistors

Motorola have just introduced the switchmode series of power transistors. Designed for high-voltage power switching applications, the first devices in this series are designated 2N6542 to 2N6547 and are n-p-n triple-diffused silicon transistors. Before these devices were introduced, designers of power equipment had to use transistors that were often only specified for resistive loads at room temperature. Unfortunately, in real life things are seldom so simple and, consequently, the designer was often faced with the task of using power devices at high temperatures and with reactive loads without sufficient information as to how the transistors were likely to perform under these conditions.
Featured in the data sheets for these devices are all the significant specifications for high temperature use ($T_C = 100°C$) and for secondary breakdown under base forward-biased and base-reverse-biased conditions.
Dynamic voltage capabilities (sustaining voltages) are given for $V_{CEO\ (SUS)}$ and $V_{CEX\ (SUS)}$. Furthermore, $V_{CEX\ (SUS)}$ minimum is specified at two values of I_C at a case temperature of 100°C, with the device driving a clamped inductive load. A blocking voltage rating, V_{CEV}, is specified at the same case temperature and maximum values for $V_{CE\ (sat)}$, $V_{BE\ (sat)}$, I_{CEV} and I_{CER} are also provided.
Fall time and storage time, important parameters for switching performance, are specified at rated I_C, $V_{CEX\ (SUS)}$ and $T_j = 100°C$, with an inductive load.

CHARACTERISTICS OF NEW SWITCHMODE POWER TRANSISTORS

*T_C = +25°C, unless otherwise noted	2N6542	2N6543	2N6544	2N6545	2N6546	2N6547
V_{CEX} @T_C = +100°C	350 V	450 V	350 V	450 V	350 V	450 V
V_{CEV}	650 V	850 V	650 V	850 V	650 V	850 V
V_{CEO}	300 V	400 V	300 V	400 V	300 V	400 V
$V_{CE\ (SAT)}$ @T_C = 100°C	2 V	2 V	2.5 V	2.5 V	2.5 V	2.5 V
$V_{BE\ (SAT)}$ @T_C = +100°C	1.4 V	1.4 V	1.6 V	1.6 V	1.6 V	1.6 V
I_C peak (Amps)	10	10	16	16	30	30
I_C continuous (Amps)	5	5	8	8	15	15
$E_{s/b}$ (min) joules	180 µj	180 µj	500 µj	500 µj	2mj	2mj
H_{FE} (min)	7	7	7	7	6	6
t_d (max) µsec	.05	.05	.05	.05	.05	.05
t_r (max) µsec	0.7	0.7	1.0	1.0	1.0	1.0
t_s (max) µsec	4/4*	4/4*	4/4*	4/4*	4/5*	4/5*
t_f (max) µsec	0.8/ 0.8*	0.8/ 0.8*	1.0/ 0.9*	1.0/ 0.9*	0.7/ 1.5*	0.7/ 1.5*
P_D watts	100	100	125	125	175	175

*T_C = +100°C Inductive load operating conditions.

New Mains Filters for Electrical Equipment

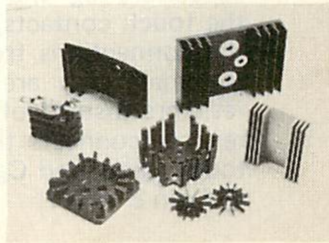
Tekdata announce the availability in U.K. of a new mains filter incorporating an I.E.C. socket. The units are Underwriters Laboratories approved and are designed in accordance with the I.E.C., V.D.E., C.S.A. and the proposed American Standards Association specifications.
Each filter measures only 40.6 mm square by 20.5 mm high, and is incorporated in the panel-mounted recessed connector on the equipment. Current ratings from 1 to 6 amps. are available, for voltages of 125/250 at 0 to 60 Hz. Equipment connection to the mains input/filter combination is by solder lugs. Maximum leakage to earth is 0.25 mA at 125 V, and 0.5 mA at 250 V; the filters will withstand a dielectric test of 2,100 V d.c.

Tekdata Ltd, Westport Lake, Canal Lane, Tunstall, Stoke on Trent, Staffs. ST6 4PA.

Heat sinks

The range of heat sinks produced by Dieter Assmann Electronics Limited now includes extruded metal, die cast, staggered finger and spring types.
More than 35 different versions of standard extruded metal heat sinks are stocked. The total range of standard products, which includes more than 80 heat sinks of a variety of shapes and dimensions, is one of the most comprehensive available from a single source.

Dieter Assmann Electronics Ltd, Victoria Works, Water Lane, Watford, Herts. WD1 2NW.

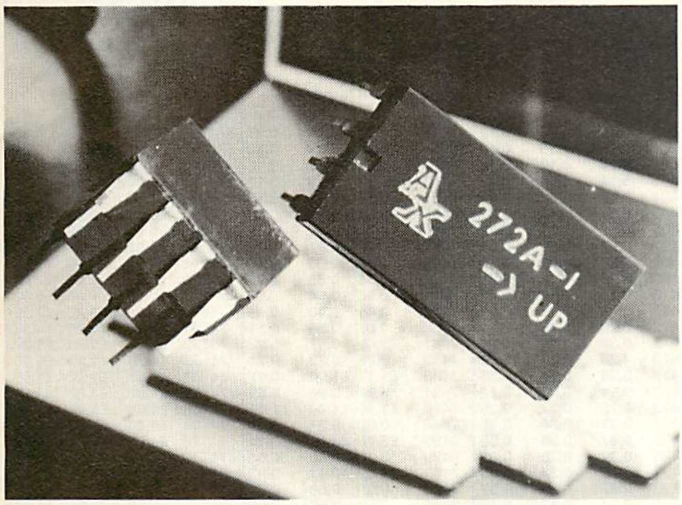


Missing link

The most recent experiments with the TAP-power (this issue, page 1130) have shown that the most reliable circuit for the touch inputs is as follows:

– capacitors C_a and C_d are included across the touch contacts, C_b and C_c are omitted;
– the connections from the touch panels to the main pcb are made via 1 MΩ series resistors instead of wire links, e.g. a 1 MΩ resistor connects the junction of the 'ON' touch panel and C_a to the junction of R20 and pin 8 of N1.

market



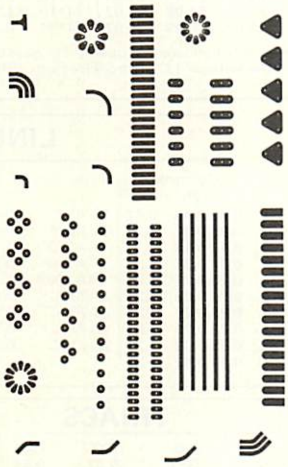
Mercury-wetted relays

From Astralux Dynamics Limited, the 270/280 series of miniature mercury-wetted reed relays are ideal for low-level switching applications. The mercury wetting of the relay contacts eliminates electrical contact 'bounce' and gives a stable contact resistance (initial contact rating 0.05 Ω maximum).
The avoidance of spurious operation means that the devices are suitable for interfacing with low-level logic equipment, while the relatively high power ratings enable the relays to be used for switching inductive loads. The life expectancy is also increased: up to 50 x 10^6 operations.
The relays are available in 1 Form A, 2 Form A, 1 Form C and 2 Form C configurations.
Ratings for the Form A types are: breakdown 1.2 kV d.c. minimum; switching 200 V, 1 mA and 28 V, 1 A (1 kV d.c. and 2 A d.c. maximum); d.c. contact rating 50 W maximum. The corresponding figures for the Form C types are: breakdown 1 kV d.c. minimum; switching 200 V, 1 mA and 28 V, 1 A (200 V d.c. and 1 A d.c. maximum); d.c. contact rating 14 W maximum.

Astralux Dynamics Limited, Brightlingsea, Colchester, Essex, CO7 OSW.

P.C.B. Transfer System

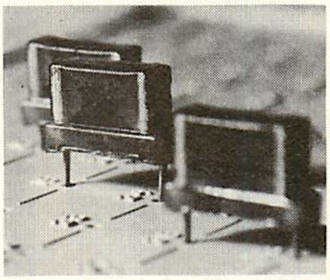
This system, from J.H. Equipment Ltd allows the production of high-quality one-off printed circuits without recourse to photography. The etch-resistant pads and tracks are laid out on the copper side of the board and the resulting circuit can then be etched. The manufacturers claim that their method of applying the adhesive to the symbols gives better definition than similar systems, as there is no adhesive overlap which can produce ragged edges.
The system is available in kits of ten sheets of symbols as illustrated.



Metallised plastic film capacitors

Designated Type MKM, these capacitors are the latest in a series developed by Siemens and feature exceptional compactness, stability, low loss and close tolerance. They have been introduced principally for use in completely automated production systems but, in a protected version, are also well suited to applications in both professional and semi-professional electronic equipment.
Individual capacitors are cut from a large 'mother' capacitor of known value, on which many of the processes necessary to the production of discrete units have already been carried out. In this way a uniformity of the electrical characteristics of the capacitors is achieved, which is not possible when produced individually.
Currently, LST Electronic Components stock the B32551 version of the MKM capacitor. This is available at voltage ratings of 100 V d.c. and preferred values of 10 to 68 nF, and at 250 V d.c. and preferred values of 100, 150 and 220 nF. The pin spacing of the B32551 is 10 mm.

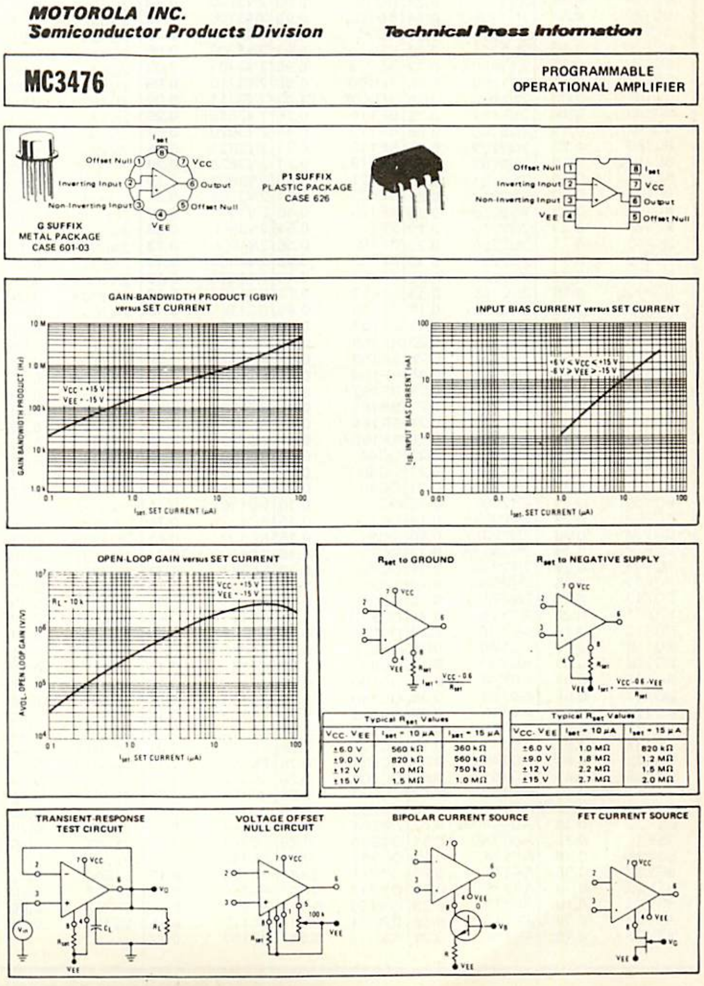
LST Electronic Component Ltd, Victoria Road, Chelmsford, Essex.



Inexpensive Programmable Op-Amp

A single external resistor allows the characteristics of a new Motorola op-amp to be optimised to suit power supplies from ±6 to ±15 V. Parameters which are programmed by the external resistor include input current and voltage, power consumption and current noise.
The new op-amp, designated type MC3476, does not require frequency compensation, has offset null capability and is fully protected against damage from short circuits. A typical power consumption of only 4.8 mW makes the MC3476 a good choice for use in battery powered equipment.
The data sheet gives the typical offset voltage, offset current and bias current as 2 mV, 2 nA and 15 nA respectively. Input resistance and capacitance are 5 MΩ and 2 pF, while input common-mode voltage range, common-mode rejection ratio and supply voltage rejection ratios are quoted as ±10 V, 70 dB and 25 μV/V respectively. The output resistance is 1 kΩ and the output current into a short circuit is typically 12 mA.
From the performance point of view the MC3476 offers a minimum large signal voltage gain of 50 kV/V (min) with a 10 kΩ load and an output voltage swing of ±10 V at 25°C. Slew rate with the same load is 0.8 V/μsec and the unity gain transient response is typically 0.35 μsec.

Motorola Ltd, Semiconductor Products Division, York House Empire Way, Wembley, Middlesex.



Typical R_{set} Values (R_{set} to ground)

V_{CC}, V_{EE}	I_{set} = 10 μA	I_{set} = 15 μA
±6.0 V	560 kΩ	360 kΩ
±9.0 V	820 kΩ	560 kΩ
±12 V	1.0 MΩ	750 kΩ
±15 V	1.5 MΩ	1.0 MΩ

Typical R_{set} Values (R_{set} to negative supply)

V_{CC}, V_{EE}	I_{set} = 10 μA	I_{set} = 15 μA
±6.0 V	1.0 MΩ	820 kΩ
±9.0 V	1.8 MΩ	1.2 MΩ
±12 V	2.2 MΩ	1.5 MΩ
±15 V	2.7 MΩ	2.0 MΩ

BI-PAK SEMICONDUCTORS

E1

TRANSISTORS

BRAND NEW FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	0.20	BSY40	0.29	AF125	0.31	P346A	0.20	BF173	0.22
AC113	0.19	BSY41	0.29	AF126	0.29	P397	0.43	BF176	0.36
AC115	0.20	BSY95	0.13	AF127	0.29	ST140	0.13	BF177	0.36
AC117K	0.30	BSY95A	0.13	AF139	0.31	ST141	0.18	BF178	0.31
AC122	0.12	BU105	£2.04	AF178	0.51	TIP29	0.44	BF179	0.31
AC125	0.18	C111E	0.51	AF179	0.51	TIP30	0.52	BF180	0.31
AC126	0.18	C400	0.31	AF180	0.51	TIP31A	0.56	BF181	0.31
AC127	0.19	C407	0.26	AF181	0.51	TIP32A	0.68	BF182	0.41
AC128	0.19	C424	0.26	AF186	0.51	TIP41A	0.68	BF183	0.41
AC132	0.15	C425	0.51	AF239	0.38	TIP42A	0.81	BF184	0.26
AC134	0.15	C426	0.36	AL102	0.68	TIS43	0.31*	BF185	0.31
AC137	0.15	C428	0.20	AL103	0.68	UT46	0.28*	BF187	0.28
AC141	0.19	C441	0.31	ASY26	0.26	ZN414	1.11	BF188	0.41
AC141K	0.30	C442	0.31	ASY27	0.31	2G301	0.19	BF194	0.12
AC142	0.19	C444	0.36	ASY28	0.26	2G302	0.19	BF195	0.12
AC142K	0.26	C450	0.22	ASY29	0.26	2G303	0.19	BF196	0.15
AC151	0.16	MAT100	0.19	ASY50	0.26	2G304	0.25	BF197	0.15
AC154	0.20	MAT101	0.20	ASY51	0.26	2G306	0.41	BF200	0.46
AC155	0.20	MAT120	0.19	ASY52	0.26	2G308	0.36	BF222	0.98
AC156	0.20	MAT121	0.20	ASY54	0.26	2N2926 G	0.13	BF257	0.46
AC157	0.25	MJE521	0.56	ASY55	0.26	2N2926 Y	0.11	BF258	0.61
AC165	0.20	MJE2955	0.88	ASY56	0.26	2N2926 O	0.10	BF259	0.87
AC166	0.20	MJE3055	0.57	ASY57	0.26	2N2926 R	0.10	BF262	0.56
AC167	0.20	MJE3440	0.51	ASY58	0.26	2N2926 B	0.10	BF263	0.56
AC168	0.25	MPF102	0.43	ASY73	0.26	2N3010	0.71	BF270	0.36
AC169	0.15	MPF104	0.38	ASZ21	0.41	2N3011	0.15	BF271	0.31
AC176	0.20	MPF105	0.38	BC107	0.08	2N3053	0.18	BF272	0.81
AC177	0.25	OC19	0.36	BC108	0.08	2N3054	0.47	BF272	0.81
AC178	0.29	OC20	0.65	BC109	0.08	2N3055	0.42	BF273	0.36
AC179	0.29	OC22	0.47	BD136	0.41	2N3319	0.15	BF274	0.36
AC180	0.20	OC23	0.49	BD137	0.46	2N3391 A	0.17	BFW20	0.61
AC180K	0.30	OC24	0.57	BD138	0.51	2N3392	0.15	BFX29	0.28
AC181	0.20	OC25	0.39	BD139	0.56	2N3393	0.15	BFX84	0.22
AC181K	0.30	OC26	0.30	BD140	0.61	2N3394	0.15	BFX85	0.31
AC187	0.22	OC28	0.51	BD155	0.81	2N3395	0.18	BFX86	0.22
AC187K	0.23	OC29	0.51	BD175	0.61	2N3402	0.21	BFX87	0.25
AC188	0.22	OC35	0.43	BD176	0.61	2N3403	0.21	BFX88	0.22
AC188K	0.23	OC36	0.51	BD177	0.67	2N3404	0.29	BFY50	0.20
ACY17	0.26	OC41	0.20	BD178	0.67	2N3405	0.43	BFY51	0.20
ACY18	0.20	OC42	0.25	BD179	0.71	2N3414	0.16	BFY52	0.20
ACY19	0.20	2N918	0.31	BD180	0.71	2N3415	0.16	2G309	0.37
ACY20	0.20	2N929	0.21	BD185	0.67	2N3416	0.29	2G339	0.20
ACY21	0.20	2N930	0.21	BD186	0.67	2N3417	0.29	2G339A	0.17
ACY22	0.17	2N1131	0.20	BD187	0.71	2N3525	0.77*	2G344	0.19
ACY27	0.19	2N1132	0.22	BD188	0.71	2N3614	0.69	2G345	0.17
ACY28	0.19	2N1302	0.15	BD189	0.77	2N3615	0.76	2G371	0.17
ACY29	0.36	2N1303	0.15	BD190	0.77	2N3616	0.76	2G371B	0.12
ACY30	0.29	2N1304	0.18	BD195	0.87	2N3646	0.09	2G373	0.18
ACY31	0.29	2N1305	0.18	BD196	0.87	2N3702	0.12	2G374	0.18
ACY34	0.21	2N1306	0.21	BD197	0.92	2N3703	0.12	2G377	0.31
BC173	0.15	2N1307	0.21	BD198	0.92	2N3704	0.13	2G378	0.17
BC174	0.15	2N1308	0.24	BD199	0.98	2N3705	0.12	2G381	0.17
BC175	0.22	2N1309	0.24	BD200	0.98	2N3706	0.12	2G382	0.17
BC177	0.19	2N1613	0.20	BD205	0.81	2N3707	0.13	2G401	0.31
BC178	0.19	2N1711	0.20	BD206	0.81	2N3708	0.08	2G414	0.31
BC179	0.19	2N1889	0.32	BD207	0.98	2N3709	0.09	2G417	0.26
BC180	0.25	2N1890	0.46	BD208	0.98	2N3710	0.09	2N388	0.36
BC181	0.25	2N1893	0.38	BDY20	£1.02	2N3711	0.09	2N388A	0.56
BC182	0.15	2N2147	0.73	BF115	0.25	2N3819	0.29	2N404	0.20
BC182L	0.15	2N2148	0.58	BF117	0.46	2N3820	0.51	2N404A	0.29
BC183	0.15	2N2192	0.36	BF118	0.71	2N3821	0.36	2N524	0.43
BC183L	0.15	2N2193	0.36	BF119	0.71	2N3823	0.29	2N527	0.50
BC184	0.20	2N2194	0.36	BF121	0.46	2N3903	0.29	2N598	0.43
BC184L	0.20	2N2217	0.22	BF123	0.51	2N3904	0.31	2N599	0.46
BC186	0.29	2N2218	0.20	BF125	0.46	2N3905	0.29	2N696	0.13
BC187	0.29	2N2219	0.20	BF127	0.51	2N3906	0.28	2N697	0.14
BC207	0.11	2N2220	0.22	BF152	0.56	2N4058	0.12	2N698	0.25
BC208	0.11	2N2221	0.20	BF153	0.46	2N40591	0.12	2N699	0.36
BC209	0.12	2N2222	0.20	BF154	0.46	2N4060	0.12	2N706	0.08
BC212L	0.13	2N2368	0.18	BF155	0.71	BC113	0.10	2N706A	0.09
BC213L	0.13	2N2369	0.15	BF156	0.49	BC114	0.16	2N708	0.12
BC214L	0.17	2N2369A	0.15	BF157	0.56	BC115	0.16	2N711	0.31
BC225	0.26	2N2411	0.25	BF158	0.56	BC116	0.16	2N717	0.36
BC226	0.36	2N2412	0.25	BF159	0.61	BC117	0.19	2N718	0.25
BC301	0.28	2N2646	0.48	BF160	0.41	BC118	0.10	2N718A	0.51
BC302	0.25	2N2711	0.21	BF162	0.41	BC119	0.81	2N726	0.29
BC303	0.31	2N2712	0.21	BF163	0.41	BC120	0.81	2N727	0.29
BC304	0.37	2N2714	0.21	BF164	0.41	BC125	0.12	2N743	0.20
BC440	0.31	2N2904	0.18	BF165	0.41	BC126	0.19	2N744	0.20
BC460	0.37	2N2904A	0.21	OC44	0.16	BC132	0.12	2N914	0.15
BCY30	0.25	2N2905	0.21	OC45	0.13	BC134	0.19	2N4061	0.12
BCY31	0.27	2N2905A	0.21	OC70	0.10	BC135	0.12	2N4062	0.12
BCY32	0.31	2N2906	0.16	OC71	0.10	BC136	0.16	2N4284	0.18
BCY33	0.22	2N2906A	0.19	OC72	0.15	BC137	0.16	2N4285	0.18
BCY34	0.26	2N2907	0.20	OC74	0.15	BC139	0.41	2N4286	0.18
BCY70	0.15	2N2907A	0.22	OC75	0.16	BC140	0.31	2N4287	0.18
BCY71	0.20	2N2923	0.15	OC76	0.16	BC141	0.31	2N4288	0.18
BCY72	0.15	2N2924	0.15	OC77	0.26	BC142	0.31	2N4289	0.18
BCZ10	0.20	2N2925	0.15	OC81	0.16	BC143	0.31	2N4290	0.18
BCZ11	0.26	ACY35	0.21	OC81D	0.16	BC145	0.46	2N4291	0.18
BCZ12	0.26	ACY36	0.29	OC82	0.16	BC147	0.10	2N4292	0.18
BD115	0.63	ACY40	0.18	OC82D	0.16	BC148	0.10	2N4293	0.18
BD116	0.81	ACY41	0.19	OC83	0.20	BC149	0.12	2N5172	0.12
BD121	0.61	ACY44	0.36	OC139	0.20	BC150	0.19	2N5194	0.56
BD123	0.67	AD130	0.39	OC140	0.20	BC151	0.20	2N5294	0.56
BD124	0.70	AD140	0.49	OC169	0.26	BC152	0.18	2N5296	0.56
BD131	0.51	AD142	0.49	OC170	0.26	BC153	0.29	2N5457	0.32
BD132	0.61	AD143	0.39	OC171	0.26	BC154	0.31	2N5458	0.32
BD133	0.67	AD149	0.51	OC299	0.26	BC157	0.19	2N5459	0.41
BD135	0.41	AD161	0.36	OC201	0.29	BC158	0.12	2N6122	0.69
BFY53	0.18	AD162	0.36	OC202	0.29	BC159	0.12	2S301	0.51
BSX19	0.16	AD161 &		OC203	0.26	BC160	0.46	2S302A	0.43
BSX20	0.16	AD162(MP)	0.69	OC204	0.26	BC161	0.51	2S302	0.43
BSY25	0.16	ADT140	0.51	OC205	0.36	BC167	0.12	2S303	0.56
BSY26	0.16	AF114	0.25	OC309	0.41	BC168	0.12	2S304	0.71
BSY27	0.16	AF115	0.25	OCP71	0.44*	BC169	0.12	2S305	0.80
BSY28	0.16	AF116	0.25	ORP12	0.44*	BC170	0.12	2S306	0.80
BSY29	0.16	AF117	0.25	ORP60	0.41*	BC171	0.15	2S307	0.80
BSY38	0.19	AF118	0.36	ORP61	0.41*	BC172	0.15	2S321	0.75
BSY39	0.19	AF124	0.31	P20	0.51*	BF167	0.22		

74 SERIES T.T.L. I.C's

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS.

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
7400	0.14	0.18	0.12	7448	£1.02	0.99	0.97	74122	0.65	0.63	0.60
7401	0.14	0.13	0.12	7450	0.14	0.13	0.12	74123	0.69	0.68	0.65
7402	0.14	0.13	0.12	7451	0.14	0.13	0.12	74141	0.79	0.76	0.73
7403	0.14	0.13	0.12	7453	0.14	0.13	0.12	74145	£1.20	£1.16	£1.11
7404	0.14	0.13	0.12	7454	0.14	0.13	0.12	74150	£1.39	£1.30	£1.20
7405	0.14	0.13	0.12	7460	0.14	0.13	0.12	74151	£1.02	0.97	0.93
7406	0.36	0.31	0.29	7470	0.30	0.27	0.25	74153	0.93	0.88	0.83
7407	0.36	0.31	0.29	7472	0.30	0.27	0.25	74154	£1.57	£1.48	£1.48
7408	0.28	0.22	0.21	7473	0.38	0.36	0.32	74155	£1.11	£1.06	£1.02
7409	0.23	0.22	0.21	7474	0.38	0.36	0.32	74156	£1.11	£1.06	£1.02
7410	0.14	0.13	0.12	7475	0.56	0.54	0.52	74157	0.93	0.88	0.83
7411	0.23	0.22	0.21	7476	0.41	0.40	0.39	74160	£1.30	£1.25	£1.20
7412	0.26	0.25	0.24	7480	0.56	0.54	0.51	74161	£1.30	£1.25	£1.25
7413	0.30	0.29	0.28	7481	£1.02	0.97	0.93	74162	£1.30	£1.25	£1.20
7416	0.28	0.27	0.26	7482	0.83	0.79	0.74	74163	£1.30	£1.25	£1.20
7417	0.28	0.27	0.26	7483	£1.11	£1.06	0.97	74164	£1.67	£1.62	£1.55
7420	0.14	0.13	0.12	7484	0.93	0.90	0.88	74165	£1.67	£1.62	£1.55
7422	0.28	0.27	0.26	7485	£1.48	£1.44	£1.39	74166	£1.48	£1.44	£1.39
7423	0.37	0.36	0.35	7486	0.32	0.31	0.30	74174	£1.48	£1.44	£1.39
7425	0.37	0.36	0.35	7489	£3.70	£3.47	£3.24	74715	£1.02	0.97	0.93
7426	0.37	0.35	0.33	7490	0.60	0.58	0.56	74176	£1.16	£1.11	£1.06
7427	0.37	0.35	0.33	7491	£1.02	0.97	0.93	74177	£1.16	£1.11	£1.06
7428	0.42	0.39	0.37	7492	0.69	0.66	0.59	74180	£1.16	£1.11	£1.06
7430	0.14	0.13	0.12	7493	0.69	0.66	0.59	74181	£3.66	£3.56	£3.47
7432	0.37	0.35	0.33	7494	0.79	0.76	0.69	74182	£1.16	£1.11	£1.06
7433	0.39	0.37	0.35	7495	0.79	0.76	0.69	74184	£1.67	£1.62	£1.55
7437	0.32	0.30	0.28	7496	0.89	0.86	0.80	74190	£1.81	£1.76	£1.71
7438	0.32	0.30	0.28	74100	£1.39	£1.34	£1.30	74191	£1.81	£1.76	£1.71
7440	0.14	0.13	0.12	74104	0.56	0.54	0.51	74192	£1.81	£1.76	£1.71
7441	0.69	0.66	0.59	74105	0.56	0.54	0.51	74193	£1.81	£1.76	£1.71
7442	0.69	0.66	0.59	74107	0.41	0.39	0.37	74194	£1.20	£1.16	£1.11
7443	£1.11	£1.06	£1.02	74110	0.56	0.51	0.46	74195	£1.02	0.97	0.93
7444	£1.11	£1.06	£1.02	74111	0.83	0.81	0.78	74196	£1.11	£1.06	£1.02
7445	£1.48	£1.44	£1.39	74118	0.93	0.88	0.83	74197	£1.11	£1.06	£1.02
7446	£1.11	£1.06	£1.02	74119	£1.39	£1.30	£1.20	74198	£2.55	£2.50	£2.45
7447	£1.02	0.99	0.97	74121	0.46	0.44	0.41	74199	£2.31	£2.21	£2.11

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

LINEAR I.C's

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
72702	0.46	0.44	0.42	SL701C	0.46	0.42	0.37	μA723C	0.45	0.43	0.40
72709	0.23	0.21	0.19	SL702C	0.46	0.42	0.37	76003	£1.39	£1.34	£1.30
72709P	0.19	0.18	0.17	TAA263	0.74	0.65	0.56	76023	£1.39	£1.34	£1.30
72710	0.32	0.31	0.28	TAA293	0.93	0.88	0.83	76660	0.88	0.86	0.83
72741	0.28	0.27	0.26	TAA350A	£1.71	£1.67	£1.57	LM380	0.93	0.90	0.88
72741C	0.26	0.25	0.24	μA703C	0.26	0.24	0.22	NE555	0.45	0.43	0.40
72741P	0.28	0.27	0.26	μA709C	0.19	0.18	0.17	NE556	0.88	0.86	0.83
72747	0.79	0.74	0.61	μA711C	0.32	0.31	0.28	TBA800	£1.39	£1.34	£1.30
72748P	0.35	0.33	0.31	μA712C	0.32	0.31	0.28	ZN414	£1.11	–	–
SL201C	0.46	0.42	0.37								

TRIACS

	Case	100V	200V	400V
2 Amp	TO5	0.31	0.51	0.71
6 Amp	TO66	0.51	0.61	0.77
10 Amp	TO48	0.77	0.92	£1.12

D.I.L. SOCKETS

	1	25	100+
TSO14 14 pin type	0.31	0.28	0.25
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

ALL PRICES
PLEASE ADD VAT
ITEMS EXCEPT
GIRO NUMBER
388-7006
Postage & Packing
Add extra for airmail

D.T.L. 930 SERIES

Type	Quantities 1	25	100+	Type	Quantities 1	25	100+	Type	Quantities 1	25	100+
BP930	0.14	0.13	0.12	BP944	0.15	0.14	0.13	BP962	0.14	0.13	0.12
BP932	0.15	0.14	0.13	BP945	0.28	0.26	0.23	BP9093	0.42	0.40	0.38
BP933	0.15	0.14	0.13	BP946	0.14	0.13	0.12	BP9094	0.42	0.40	0.38
BP935	0.15	0.14	0.13	BP948	0.28	0.26	0.23	BP9097	0.42	0.40	0.38
BP936	0.15	0.14	0.13	BP951	0.65	0.60	0.56	BP9099	0.42	0.40	0.38

SILICON RECTIFIERS

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	1N4001	0.05	0.07	0.14	0.19*	0.56*
100	0.05	0.07	1N4002	0.06	0.09	0.16	0.21*	0.69*
200	0.06	0.09	1N4003	0.07	0.12	0.20	0.23*	0.93*
400	0.07	0.14	1N4004	0.08	0.14	0.28	0.35*	£1.25*
600	0.08	0.16	1N4005	0.09	0.16	0.33	0.42*	£1.76*
800	0.11	0.18	1N4006	0.10	0.18	0.35	0.51*	£1.94*
1000	0.13	0.28	1N4007	0.11	0.23	0.44	0.60*	£2.31*
1200	–	0.32			0.28	0.54	0.69*	£2.88*

PO BOX 6 WARE HERTS

SUPER UNTESTED PAKS

Pak No.	Description	Price £p
U 1	120 Glass Sub-min. General purpose Germ. diodes	0.60
U 2	50 Mixed Germanium transistors AF/RF	0.60
U 3	75 Germanium gold bonded sub-min. like OA5, PA47	0.60
U 4	30 Germanium Transistors like OC81, AC128	0.60
U 5	60 200mA sub-min. silicon diodes	0.60
U 6	30 Sil. Planar trans. NPN like BSY95A, 2N706	0.60
U 7	16 Sil. rect. TOP-HAT 750mA, VLTG. RANGE up to 100	0.60
U 8	50 Sil. planar diodes DO-7 glass 250mA like OA200/202	0.60
U 9	20 Mixed voltages, 1 Watt Zener Diodes	0.60
U10	20 BAY50 charge storage diodes DO-7 glass	0.60
U11	20 PNP Sil. planar trans. TO-5 like 2N1132, 2N2904	0.60
U13	30 PNP-NPN Sil. transistors OC200 & 2S104	0.60
U14	150 Mixed silicon and germanium diodes	0.60
U15	20 NPN Sil. planar trans. TO-5 like 2N696, 2N697	0.60
U16	10 3 Amp sil. rectifiers stud type up to 1000 PIV	0.60
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0.60
U18	8 6Amp sil. rectifiers BYZ13 type up to 600 PIV	0.60
U19	20 Silicon NPN transistors like BC 108	0.60
U20	12 1-5 Amp sil. rectifiers top hat up to 1000 PIV	0.60
U21	30 AF. Germ. alloy transistors 2G300 series & OC71	0.60
U23	25 MADT's like MHz series PNP transistors	0.60
U24	20 Germ. 1 Amp rectifiers GJM series up to 300 PIV	0.60
U25	25 300 MHz NPN silicon transistors 2N708, BSY27	0.60
U26	30 Fast switching silicon diodes like 1N914 Micro-Min.	0.60
U29	10 1 Amp SCR's TO-5 can. up to 600 PIV CRS1/25-600	£1.20*
U32	25 Zener diodes 400 mW DO-7 case 3-33 volts mixed	0.60
U33	15 Plastic case 1 Amp sil. rectifiers 1N4000 series	0.60
U34	30 Silicon PNP alloy trans. TO-5 BCY26 2S302/4	0.60
U35	25 Silicon planar transistors PNP TO-18 2N2906	0.60
U36	20 Silicon planar NPN transistors TO-5 BFY50/51/52	0.60
U37	30 Silicon alloy transistors SO-2 PNP OC200, S2322	0.60
U38	20 Fast switching silicon trans. NPN 400 MHz 2N3011	0.60
U39	30 RF. Ger. PNP transistors 2N1303/5 TO-5	0.60
U40	10 Dual transistors 6 lead TO-5 2N2060	0.60
U43	25 Silicon trans. plastic TO-18 A.F. BC113/114	0.60
U44	20 Silicon trans. plastic TO-5 BC115	0.60
U45	7 3A SCR. TO-66 up to 600 PIV	£1.20*
U46	20 Unijunction transistors similar to TIS43	0.60*
U47	10 TO220 AB plastic triacs 50 V 6 A	£1.20*
U48	9 NPN Sil. power transistors like 2N3055	£1.20
U49	12 NPN Sil. plastic power trans. 60 W like 2N5294/5296	£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.

EXCLUDE VAT
AT 25% TO ALL
***ADD 8%**
NO VAT
add 20p overseas
Minimum order 75p

VOLTAGE REGULATORS

TO.3 Plastic Encapsulation
μA.7805/L129 5V (Equiv. to MVR5V) £1.25p
μA.7812/L130 12V (Equiv. to MVR12V) £1.25p
μA.7815/L131 15V (Equiv. to MVR15V) £1.25p
μA.7818 18V (Equiv. to MVR18V) £1.25p

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	0.62	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

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA119	0.08	BY101	0.12	BYZ16	0.41	OA85	0.09
AA120	0.08	BY105	0.18	BYZ17	0.36	OA90	0.07
AA129	0.08	BY114	0.12	BYZ18	0.36	OA91	0.07
AAY30	0.09	BY124	0.12	BYZ19	0.28	OA95	0.07
AAZ13	0.10	BY126	0.15	CG62		OA200	0.07
BA100	0.10	BY127	0.16	(OA91 Eq)	0.06	OA202	0.07
BA116	0.21	BY128	0.16	CG651 (OA70-		SD10	0.06
BA126	0.22	BY130	0.17	OA79)	0.07	SD19	0.06
BA148	0.15	BY133	0.21	OA5 Short		1N34	0.07
BA154	0.12	BY164	0.51	Leads	0.21	1N34A	0.07
BA155	0.15	BYX38/30	0.43	OA10	0.14	1N914	0.06
BA156	0.14	BYZ10	0.36	OA47	0.07	1N916	0.06
BA173	0.15	BYZ11	0.31	OA70	0.07	1N4148	0.06
BB104	0.15	BYZ12	0.31	OA79	0.07	1S021	0.10
BY100	0.16	BYZ13	0.26	OA81	0.07	1S951	0.70

QUALITY TESTED PAKS

Pak No.	Quality Tested Paks	Price
Q 1	20 Red spot transistors PNP	0.60
Q 2	16 White spot R.F. transistors PNP	0.60
Q 3	4 OC 77 type transistors	0.60
Q 4	6 Matched transistors OC44/45/81/81 D	0.60
Q 5	4 OC 75 transistors	0.60
Q 6	5 OC 72 transistors	0.60
Q 7	4 AC 128 transistors PNP high gain	0.60
Q 8	4 AC 126 transistors PNP	0.60
Q 9	7 OC 81 type transistors	0.60
Q10	7 OC 71 type transistors	0.60
Q11	2 AC 127/128 Complementary pairs PNP/NPN	0.60
Q12	3 AF 116 type transistors	0.60
Q13	3 AF 117 type transistors	0.60
Q14	3 OC 171 H.F. type transistors	0.60
Q15	7 2N2926 Sil. Epoxy transistors mixed colours	0.60
Q17	5 NPN 2 x ST.141. & 3 x ST.140	0.60
Q18	4 MADT'S 2 x MAT 100 & 2 x MAT 120	0.60
Q19	3 MADT'S 2 x MAT 101 & 1 x MAT 121	0.60
Q20	4 OC 44 Germanium transistors A.F.	0.60
Q21	4 AC 127 NPN Germanium transistors	0.60
Q22	20 NKT transistors A.F. R.F. coded	0.60
Q23	10 OA 202 Silicon diodes sub-min	0.60
Q24	8 OA 81 diodes	0.60
Q25	15 1N914 Silicon diodes 75 PIV 75 mA	0.60
Q26	8 OA 95 Germanium diodes sub-min-1N69	0.60
Q27	2 10A 600 PIV Silicon rectifiers 1S425B	0.60*
Q28	2 Silicon power rectifiers BYZ 13	0.60
Q29	4 Sil. transistors 2 x 2N696, 1 x 2N697, 1 x 2N698	0.60
Q30	7 Silicon switch transistors 2N706 NPN	0.60
Q31	6 Silicon switch transistors 2N708 NPN	0.60
Q32	3 PNP Sil. trans. 2 x 2N1131, 1 x 2N1132	0.60
Q33	3 Silicon. NPN transistors 2N1711	0.60
Q34	7 Sil. NPN trans. 2N2369, 500 MHz (code P397)	0.60
Q35	3 Silicon. PNP TO-5 2 x 2N2904 & 1 x 2N2095	0.60
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	0.60
Q37	3 2N3053 NPN Silicon transistors	0.60
Q38	5 PNP transistors 3 x 2N3703, 2 x 2N3702	0.60
Q39	5 NPN transistors 3 x 2N3704, 2 x 2N3705	0.60
Q40	5 NPN transistors 3 x 2N3707, 2 x 2N3708	0.60
Q41	3 Plastic NPN TO18 2N3904	0.60
Q43	5 BC 107 NPN transistors	0.60
Q44	5 NPN transistors 3 x BC 108, 2 x BC 109	0.60
Q45	3 BC 113 NPN TO-18 transistors	0.60
Q46	3 BC 115 NPN TO-5 transistors	0.60
Q47	4 NPN high gain transistors 2 x BC 157, 2 x BC 168	0.60
Q48	3 BCY 70 PNP transistors TO-18	0.60
Q49	3 NPN transistors 2 x BFY 51, 1 x BFY 52	0.60
Q50	7 BSY 28 NPN switch transistors TO-18	0.60
Q51	7 BSY 95A NPN transistors 300 MHz	0.60
Q52	8 BY 100 type silicon rectifiers	£1.20
Q53	25 Sil. & Germ. trans. mixed all marked new	£1.50
Q54	6 TIL 209 Red LED	£1.20*

UNTESTED T.T.L. PAKS

Manufacturers "Fall Outs" which include Functional and part Functional Units. These are classed as 'out-of-spec' from the makers' very rigid specifications, but are ideal for learning about I.C's and experimental work.

Pak No.	Contents	Price	Pak No.	Contents	Price
UIC00	= 12 x 7400	0.60	UIC72	= 8 x 7472	0.60
UIC01	= 12 x 7401	0.60	UIC73	= 8 x 7473	0.60
UIC02	= 12 x 7402	0.60	UIC74	= 8 x 7474	0.60
UIC03	= 12 x 7403	0.60	UIC75	= 8 x 7475	0.60
UIC04	= 12 x 7404	0.60	UIC76	= 8 x 7476	0.60
UIC05	= 12 x 7405	0.60	UIC80	= 5 x 7480	0.60
UIC06	= 8 x 7406	0.60	UIC81	= 5 x 7481	0.60
UIC07	= 8 x 7407	0.60	UIC82	= 5 x 7482	0.60
UIC10	= 12 x 7410	0.60	UIC83	= 5 x 7483	0.60
UIC13	= 8 x 7413	0.60	UIC86	= 5 x 7486	0.60
UIC20	= 12 x 7420	0.60	UIC90	= 5 x 7490	0.60
UIC30	= 12 x 7430	0.60	UIC91	= 5 x 7491	0.60
UIC40	= 12 x 7440	0.60	UIC92	= 5 x 7492	0.60
UIC41	= 5 x 7441	0.60	UIC93	= 5 x 7493	0.60
UIC42	= 5 x 7442	0.60	UIC94	= 5 x 7494	0.60
UIC43	= 5 x 7443	0.60	UIC95	= 5 x 7495	0.60
UIC44	= 5 x 7444	0.60	UIC96	= 5 x 7496	0.60
UIC45	= 5 x 7445	0.60	UIC100	= 5 x 74100	0.60
UIC46	= 5 x 7446	0.60	UIC121	= 5 x 74121	0.60
UIC47	= 5 x 7447	0.60	UIC141	= 5 x 74141	0.60
UIC48	= 5 x 7448	0.60	UIC151	= 5 x 74151	0.60
UIC50	= 12 x 7450	0.60	UIC154	= 5 x 74154	0.60
UIC51	= 12 x 7451	0.60	UIC193	= 5 x 74193	0.60
UIC53	= 12 x 7453	0.60	UIC199	= 5 x 74199	0.60
UIC54	= 12 x 7454	0.60	UIC XI 25 Assorted 74's		£1.50
UIC60	= 12 x 7460	0.60			
UIC70	= 8 x 7470	0.60			

MAMMOTH I.C. PAK

APPROX. 200 PIECES

Assorted fall-out integrated circuits, including: Logic, 74 series, Linear, Audio and D.T.L. Many coded devices but some unmarked – you to identify.

OUR SPECIAL PRICE £1.20p

WORLD SCOOP

JUMBO SEMICONDUCTOR PAK

Transistors–Germ. and Silicon. Rectifiers–Diodes–Triacs–Thyristors–I.C.'s and Zeners. ALL NEW AND CODED

APPROX 100 PIECES

Offering the amateur a fantastic bargain PAK and an enormous saving–identification and data sheet in every pak.

ONLY £1.85p

UNTESTED LIN PAKS

Manufacturers "Fall Outs" which include Functional and part Functional Units. These are classed as 'out-of-spec' from the makers' very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No.	Contents	Price
ULIC709	= 10 x 709	0.60
ULIC710	= 7 x 710	0.60
ULIC741	= 7 x 741	0.60
ULIC747	= 5 x 747	0.60
ULIC748	= 7 x 748	0.60

C280 CAPACITOR PAK

Containing 75 of the C280 range of capacitors assorted in values ranging from .01 μF to 2.2 μF. Complete with identification chart.

FANTASTIC VALUE
ONLY £1.20p.

SIL. G.P. DIODES

300 mW 40 PIV (min) SUB-MIN FULLY TESTED
Ideal for Organ builders
30 for 50p, 100 for £1.50, 500 for £5, 1000 for £9.

G.P. SWITCHING TRANS

TO18 SIM. TO 2N706/8 BSY27/28/95A
All usuable devices. No open and shorts. ALSO AVAILABLE IN PNP similar to 2N2906, BCY 70
20 for 50p, 50 for £1, 100 for £1.80, 500 for £8, 1000 for £14.
When ordering please state NPN or PNP

G.P. 100

30 WATT GERMANIUM TO3 METAL CASE
Vcbo 80 V, Vceo 50 V, IC 10 A, Hfe 30-170 replaces the majority of Germanium power Transistors in the OC, AD NKT range.

1-24	25-99	100+
44p	41p	37p

G.P. 300

115 WATT SILICON TO3 METAL CASE
Vcbo 100 V, Vceo 60 V, IC 15 A, Hfe, 20-100 suitable replacement for 2N3055, BDY11 or BDY20

1-24	25-99	100+
50p	48p	46p

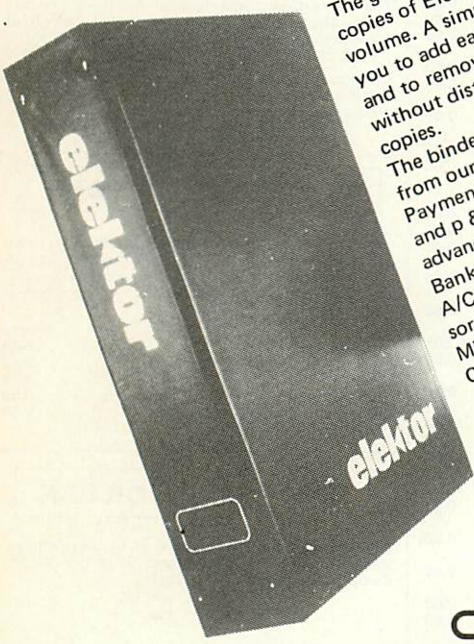
INDICATORS

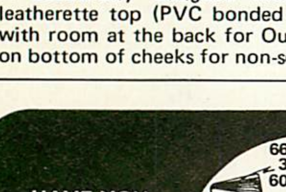
3015F	Minitron 7 Segment Indicator	£1.11p*
MAN 3M	L.E.D. 7 SEGMENT DISPLAY 0.127" High Characters	£1.76p*

ZENER DIODES

FULL RANGE IN STOCK
VOLTAGE RANGE 2-33 V

400 mW	1.5 W	10 W*
8p	17p	30p


elektor
elektor



BRITAIN'S PIONEERS IN QUADRAPHONY

LICENSEES FOR CBS SQ, JVC CD4 and SANSUI QS QUADRAPHONIC SYSTEMS

Complete kits of parts and P.C.B. to licenser's specification

CBS SQ MATRIX DECODER TYPE M1	KIT £ 8.00	BUILT £ 9.00
CBS SQ FULL LOGIC TYPE L1A	KIT £21.00	BUILT £23.00*
CBS SQ FULL LOGIC TYPE L2A	KIT £25.50	BUILT £27.50
CBS SQ FULL LOGIC TYPE L3A	KIT £29.50	BUILT £32.50
CBS SQ STEREO TO QUAD SYNTHESISOR	KIT £14.00	BUILT £15.50
CD4 DEMODULATOR	KIT £20.00	BUILT £22.00*
QS VARIOMATRIX DECODER	KIT £18.00	BUILT £20.00*

* As described in Elektor June 1975 "Quadro in Practice" Circuits 2, 4 an 6 on Pages 647, 649 and 650.

ALL KITS INCLUDE FINEST TOLERANCE COMPONENTS, FIBRE GLASS P.C.B.'s AND ALL IC's LICENSE FEE PAID

New range of ELEKTOR project kits complete with ELEKTOR P.C.B.'s

Equa Amplifier Kit	£ 9.00
Mos Clock 5314 Kit	£ 18.00
Mos Clock Timebase Kit	£ 10.00
Disc Pre-Amp 76131 Kit	£ 4.00
TV-Sound Kit	£ 9.90
Tap Pre-Amp Kit	£ 11.00
CA 3090 AQ Stereo Decoder Kit	£ 7.00
Electronic Loudspeaker Kit (2-Way)	£ 2.75
Electronic Loudspeaker Kit (3-Way)	£ 5.00

ALL PCB's & PARTS SOLD SEPARATELY
MINIMUM ORDER £ 1.00 plus 25% VAT

SOLE MANUFACTURERS OF THE COMPLETE RANGE OF THE RONDO QUADRAPHONIC SYSTEM AS DESCRIBED IN "PRACTICAL ELECTRONICS", SEPTEMBER 1973 TO JULY 1974. SUPERVISED AND APPROVED BY THE AUTHOR, R.A. COLE.

MAIL ORDER SUPERVISOR SHELAGH LONGMAN

PLEASE SUPPLY:

	KIT	BUILT		KIT
CBS SQ MATRIX DECODER TYPE M1			EQUA AMPLIFIER KIT	
CBS SQ FULL LOGIC TYPE L1A			MOS CLOCK 5314 KIT	
CBS SQ FULL LOGIC TYPE L2A			MOS CLOCK TIMEBASE KIT	
CBS SQ FULL LOGIC TYPE L3A			DISC PRE-AMP 76131 KIT	
CBS SQ STEREO TO QUAD SYNTHESISOR			TV SOUND KIT	
CD4 DEMODULATOR			TAP PRE-AMP KIT	
QS VARIOMATRIX			RONDO DETAILS	
CA 3090 AQ STEREO DECODER			ELECTRONIC LOUDSPEAKER 2	3

NAME ________
ADDRESS ________

TOTAL ENCLOSED £ ________

CASH ☐ CHEQUE ☐ P.O. ☐

ALL PRICES INCLUDE POSTAGE & PACKING.

PLEASE ADD 25% VAT TO ALL PRICES, EXCEPT MOS CLOCK (8%).

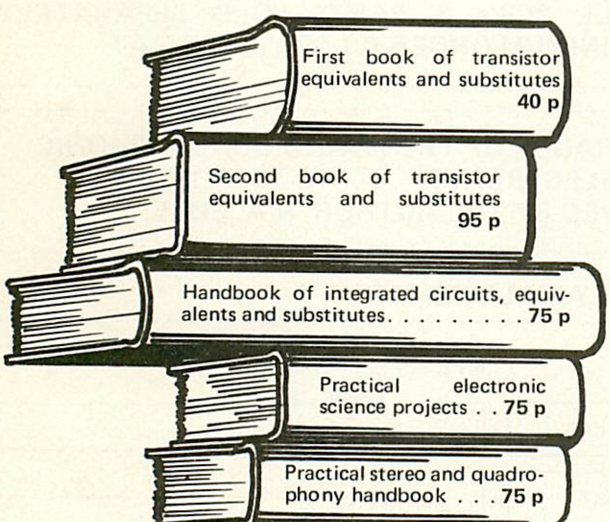
SONAX ELECTRONICS

10-14, BURWELL ROAD, LEYTON, LONDON, E.10. TELEPHONE 01-539 0347

babani press

You can now obtain these best-selling reference works through Elektor at Canterbury:

Please send me (tick circle)



I enclose remittance of ..... for the books and 20 p post and packing.

Name ....

Address ....

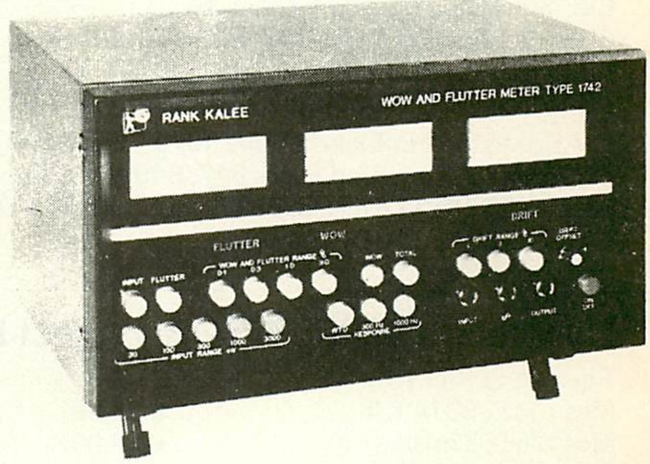
....

....

Postcode ....

E5

The new Rank WOW & FLUTTER Meter Type 1742



Fully transistorised
for high reliability

Versatile
Meets in every respect all current specifications for measurement of Wow, Flutter and Drift on Optical and Magnetic sound recording/reproduction equipment using film, tape or disc

High accuracy
with crystal controlled oscillator

Simple to use
accepts wide range of input signals with no manual tuning or adjustment

Two models available:
Type 1742 'A' BS 4847: 1972 DIN 45507
CC1R 409-2 Specifications
Type 1742 'B' BS 1988: 1953 Rank Kalee Specifications

For further information please address your enquiry to
Mrs B. Nodwell
Rank Film Equipment, PO Box 70
Great West Road, Brentford
Middlesex TW8 9HR
Tel: 01-568 9222· Telex 24408· Cables Rankaudio Brentford

RANK FILM EQUIPMENT

EK–11 FOR FURTHER DETAILS

order a subscription to elektor

Look through this issue of ELEKTOR and you will find that ELEKTOR is not just one more electronics magazine. ELEKTOR is different . . . .

. . . . **different**

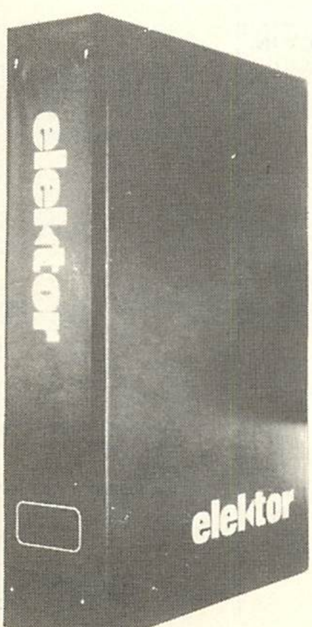
- in its presentation
- in its style and content
- in its use of new techniques and components in practical circuits.

ELEKTOR is the magazine for your profession, study or hobby. ELEKTOR avoids long-winded theoretical discussions and the like. Instead, it gives practical applications.

If you order a subscription, you will be sure to receive ELEKTOR regularly*.

Fill in the form overleaf and send it today to ELEKTOR PUBLISHERS LTD.

* ELEKTOR is also on sale at leading component shops, newsagents and stationers throughout the UK.



elektor binders

The dark green binder collects your loose copies of ELEKTOR into one handy volume.
Each copy is fastened simply and firmly with a metal pin, and any copy can easily be removed later without disturbing the others.
Matching self-adhesive labels are provided to show the year.
ELEKTOR binders can be ordered from our Canterbury office using the form overleaf.
Price: **£ 1.85** (incl. VAT and p&p).

Subscription rates (up to and including no.9 - January 1976):

– Subscription to 8 issues (no. 1 included free)	£ 3.60
– Trial subscription to 4 issues (no. 2 - no. 5)	£ 2.00
– From no. 2 (February 1975)	£ 3.60
– From no. 3 (April 1975)	£ 3.15
– From no. 4 (June 1975)	£ 2.70
– From no. 5 (July/August 1975)	£ 2.25
– From no. 6 (September 1975)	£ 1.80
– From no. 7 (November 1975)	£ 1.35
– From no. 8 (December 1975)	£ 0.90
– Single copies	£ 0.45

Please note that no. 5 (July/August) is a double issue; our 'Summer Circuits' issue.
All prices include Postage.

2. FOLD HERE

1. FOLD DOWN ALONG THE DOTTED LINE

Postage will be paid by Elektor

Do not affix Postage Stamps if posted in Gt. Britain, Channel Islands or N. Ireland

BUSINESS REPLY SERVICE
Licence No. CU 203

ELEKTOR PUBLISHERS LTD.,

6, Stour Street,

CANTERBURY CT1 2BR

3. FOLD HERE AND TUCK IN

I would like to receive a

☐ copy of ELEKTOR no. ....

☐ subscription to ELEKTOR, starting with no. ....

☐ trial subscription to ELEKTOR.

☐ dark green ELEKTOR binder.

I am not enclosing money, but await your invoice

Name ______________________________

Address ______________________________

______________________ **Post code** __________

Cut out address and glue it on envelope; cut out order slip and enclose it in envelope.

or:

Remove page then fold and tuck in as indicated.
No stamp is needed.

ELEKTOR PC BOARDS

Full range of Elektor boards ex-stock.

NUMBER	PRICE
1437	£1.65
1443	£0.90
1457	£0.60
1465A	£0.80
1465B	£0.55
1465C	£1.05
1499	£1.20
1527	£0.50
1540	£1.05
1590	£0.55
1607A	£1.15
1607B	£0.85
1621A	£0.70
1621B	£1.10
1621C	£0.55
1661	£0.95
1668	£0.95
4029 1	£1.40
4029 2	£1.40
4029 3	£1.40
4039	£0.50
4040A	£0.95
4409	£1.50
5027A & B	£1.85
5028	£1.25
6019A	£1.20
6025	£1.40
1492	£2.20
1563	£1.25
1592	£1.40
1620	£0.70
4003	£1.80
9076	£1.70
9076/2A	£1.90

AMTRON

ELECTRONIC KITS

UK 92	TELEPHONE AMPLIFIER	£ 8.27
UK 105/C	F.M. MICROTRANSMITTER	£ 8.07
UK 115	HI FI AMPLIFIER 8 W.	£ 4.50
UK 165	R.I.A.A. EQUALIZED STEREO PREAMPLIFIER	£ 5.64
UK 167	STEREO PREAMPLIFIER RIAA & CCIR STANDARDS	£ 6.98
UK 195	MINIATURE AMPLIFIER 2W.	£ 3.67
UK 220	SIGNAL INJECTOR	£ 3.53
UK 230	AM/FM ANTENNA AMPLIFIER	£ 4.16
UK 275	MIKE PREAMPLIFIER	£ 6.98
UK 285	VHF/UHF ANTENNA AMPLIFIER	£ 8.87
UK 302	RADIO CONTROL TRANSMITTER	£17.50
UK 305	FM TRANSMITTER	£ 3.38
UK 330	GCX2 CHANNEL SPLITTING UNIT 1500 & 2500 HZ.	£ 8.34
UK 345/A	SUPERHET RADIO CONTROL RECEIVER	£ 8.81
UK 555	RADIO CONTROL STRENGTH METER	£ 9.65
UK 710/C	FOUR CHANNEL A.F. MIXER	£11.12
UK 715	PHOTOELECTRIC CELL SWITCH	£ 7.74
UK 780	ELECTRONIC UNIT FOR METAL DETECTOR	£11.65
UK 832	PHOTO ELECTRONIC REVOLUTION COUNTER	£17.71
UK 855	ELECTRONIC FUZZ BOX	£ 7.23
UK 875	CAPACITIVE DISCHARGE ELECTRONIC IGNITION UNIT NEG. EARTH	£17.33
UK 930	R.F. POWER AMPLIFIER 3 to 30 MHz.	£ 2.65
UK 3009/00	METAL CABINET	£ 6.26
UK 3009/10	METAL CABINET	£ 6.08
UK 3009/20	METAL CABINET	£ 6.98

LINEAR IC's

723 — FAIRCHILD — 14 Pin D.I.L. Var. Voltage Reg. — **65p**

741 — FAIRCHILD — 8 Pin D.I.L. Op.Amp — **33p**

LM 380 — NATIONAL semiconductor — 14 Pin D.I.L. 2 Watt Audio Amp. — **£ 1.20**

LM 1303 — NATIONAL semiconductor — 14 Pin D.I.L. Stereo Pre-Amp — **£ 1.65**

MC 1310P — MOTOROLA — 14 Pin D.I.L. Coiless Stereo Decoder — **£ 2.30**

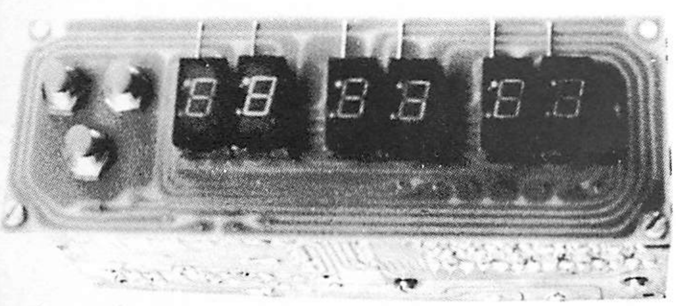
ZN 414 — FERRANTI radio chip — **£ 1.25**

NE 555V — SIGNETICS — 8 Pin D.I.L. Timer — **70p**

MM 5314 — NATIONAL semiconductors — 24 Pin Clock Chip — **£ 4.35**

Elektor MOS Clock

KIT £19.45



ALL PRICES INCLUDE VAT
PLEASE ADD 20p FOR P&P.

L.E.D. DISPLAYS TYPE EP27 7 SEGMENT 4 FOR £5.00

BOOKS

MULLARD FET'S	£1.80
MULLARD MOS I.C.'S	£2.00
MULLARD DATA BOOK 1974/75	£0.40
MULLARD TRANSISTOR AUDIO & RADIO CIRCUITS	£1.80
ELEKTOR BACK ISSUES NOS. 1,2,3,4	£0.35
NO. 5 ISSUE	£0.70

I.C. INSERTION TOOL £1.45 each

I.C. EXTRACTION TOOL £0.45p EACH

MACK'S ELECTRONICS

283 Edgware Road, London W2.
Tel. 01-262 8614

Hours of business 9.30 - 6.00
Monday to Saturday

callers welcome


Motorola LED sentries never die.
Unlike filament indicator lamps, Motorola Light Emitting Diodes don't die.
They come in three colours—red, yellow and green—and in viewing angles to suit all applications.
We're so confident of your determination to be up-to-date, that we've invested heavily to give you the LEDs you want, when you want them.
Use indicator lamps that are worthy of your equipment. Use Motorola LEDs as sentries to watch over it.
To find out more about the design possibilities of these high-reliability products, just send for the new Motorola Opto Electronics brochure, which gives you information about our light detectors and couplers too.
You'll find it profitable reading.