Australia 95c New Zealand 95c South Africa 90c Malaysia $2.75

PRACTICAL ELECTRONICS

AUGUST 1979

50p

COMPUKIT UK 101
SINGLE BOARD COMPUTER

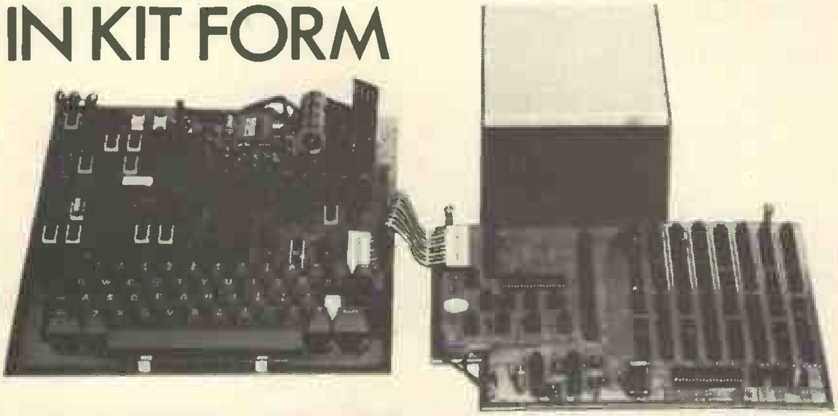
* 8K HIGH SPEED BASIC
* FULLY EXPANDABLE

Also: HOME FREEZER ALARM

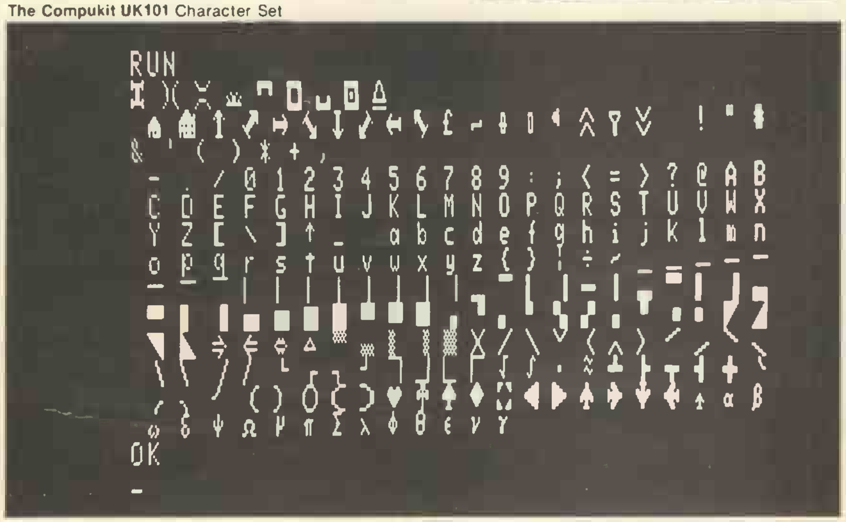
COMPUKIT UK101

SAMPLE TAPE included FREE

LOW COST SUPERBOARD IN KIT FORM



The Compukit UK101 Character Set



The Compukit UK101 has everything a one board 'superboard' should have.

- ★ Uses ultra-powerful 6502 microprocessor.
- ★ 50Hz Frame refresh for steady clear picture (U.S.A. products with 60Hz frame refresh always results in jittery displays)
- ★ 48 chars by 16 lines — 1K memory mapped video system providing high speed access to screen display enabling animated games and graphs.
- ★ Extensive 256 character set which includes full upper and lower case alphanumerics, Greek symbols for mathematical constants and numerous graphic characters enabling you to form almost any shape you desire anywhere on the screen.
- ★ 8K full Microsoft Basic in ROM compatible with PET, APPLE SORCERER hence taking the headache out of programming by using simple English statements. Much faster than currently available personal computers.
- ★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software.
- ★ Video output and UHF Highgrade modulator (8Mz Bandwidth) which connects direct to the aerial socket of your T.V. Channel 36 UHF.
- ★ Fully stabilised 5V power supply including transformer on board.
- ★ Standard KANSAS city tape interface providing high reliability program storage — use on any standard domestic tape or cassette recorder.
- ★ 4K user RAM expandable to 8K on board £49 extra.
- ★ 40 line expansion interface socket on board for attachment of extender card containing 24K RAM and disk controller. (Ohio Scientific compatible).
- ★ 6502 machine code accessible through powerful 2K machine code monitor on board.
- ★ High quality thru plated P.C.B. with all I.C.'s mounted on sockets.

FULL CONSTRUCTION DETAILS IN P.E. AUG 1979 EDITION

Delivery date June 1979
at the 1979 MicroComputer Show
Customer orders in strict rotation only.

A tape of 10 programs on cassette — educational games, etc. will be supplied free of charge with each kit.

Simple Soldering due to clear and consise instructions compiled by Dr. A.A. Berk, BSc.PhD

NO EXTRAS NEEDED JUST HIT 'RETURN' AND GO.

Build, understand, and program your own computer for only a small outlay.

ONLY **£219** + VAT
Including RF Modulator & Power supply.
Absolutely no extras.

Due to the new prices of TTL this price will be increased shortly. So order now to beat the price increases and the rush.

SPECIAL CHARACTERS

@ Erases line being typed, then provides carriage return, line feed.
◀ Erases last character typed.
CR Carriage Return — must be at the end of each line.
: Separates statements on a line.
CONTROL/C Execution or printing of a list is interrupted at the end of a line.
"BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.
CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.
? Equivalent to PRINT

COMMANDS

CONT	LIST	NEW	NULL	RUN	

STATEMENTS

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

EXPRESSIONS

OPERATORS

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

VARIABLES

A, B, C, ...Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus $, e.g. A$

FUNCTIONS	ABS(X) LOG(X) SPC(I)	ATN(X) PEEK(I) SQR(X)	COS(X) POS(I) TAB(I)	EXP(X) RND(X) TAN(X)	FRE(X) SGN(X) USR(I)	INT(X) SIN(X)
STRING FUNCTIONS	ASC(X$) RIGHT$(X$,I)	CHR$(I)	FRE(X$) STR$(X)	LEFT$(X$,I)	LEN(X$) VAL(X$)	MID$(X$,I,J)

COMP COMPUTER COMPONENTS

Please make cheques and postal orders payable to COMP, or phone your order quoting BARCLAYCARD, ACCESS, DINERS CLUB or AMERICAN EXPRESS number.
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PRACTICAL
ELECTRONICS

VOLUME 15 No. 8 AUGUST 1979

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, 10 AUGUST 1979
(for details of contents see page 61)

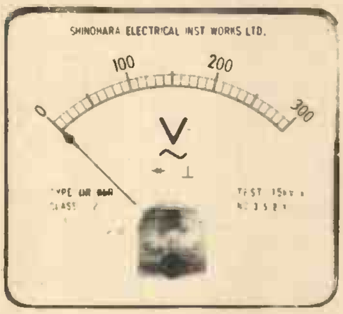
PROOPS

BROTHERS LIMITED

Special purchase of Shinohara's SEW Panel meters at fantastic low prices

MR RANGE – DC MOVING COIL TYPE

(Accuracy ± 2%)



DIMENSIONS

110 x 120 x 47 mm	Ref 85P	**£3.00**
78 x 86 x 41 mm	Ref 65P	**£2.50**
60 x 60 x 40 mm	Ref 52P	**£2.50**
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42 x 42 x 32 mm	Ref 38P	**£1.50**

Prices inclusive of VAT. Add 25p per item carriage and packing.

References:

±50μA	50mA – DC	5V – DC
±100μA	100mA – DC	10V – DC
±500μA	200mA – AC	15V – AC
±1mA	500mA – AC	15V – DC
50μA	500mA – DC	50V – AC
200μA	1A – AC	50V – DC
1mA 'S'	1A – DC	150V – AC
5mA	10A – DC	150V – DC
10mA	30A – DC	300V – AC
50mA – AC	50A – AC	300V – DC
	50A – DC	500V – AC

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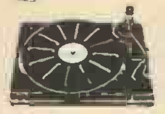
Great effect at discos. 7 metres long. Multiway connectors. 4 channel. £43.20 (inc.pack of spare bulbs)



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Our unsurpassed Disco experience has enabled us to select the best turntables for your requirements. For example the new BSR P200 belt drive. ONLY £28.12.

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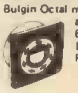

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4 core (6A) 59p/metre
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5426	90p
5427	90p
5430	90p
5432	90p
5437	90p
5440	90p
5442	150p
5445	150p
5446	225p
5447	400p
5450	90p
5451	90p
5453	90p
5454	90p
5460	90p
5470	120p
5472	120p
5473	150p
5474	150p
5475	150p
5476	150p
5480	150p
5483	400p
5485	300p
5490	300p
5491	200p
5493	200p
5495	400p
5496	150p
54100	400p
54107	200p
54109	150p
54121	200p
54125	200p
54126	200p
54132	400p
54145	300p
54150	400p
54151	300p
54153	300p
54154	400p
54155	300p
54157	200p
54164	300p
54165	300p
54166	300p
54170	500p
54174	500p
54177	400p
54180	300p
54181	400p
54182	300p
54185	400p
54190	400p
54191	400p
54193	400p
54194	400p
54195	400p
54197	300p
54221	600p
54251	600p

74xxTTL

7400	10p
7401	10p
7402	10p
7403	10p
7404	12p
7405	15p
7406	25p
7407	25p
7408	15p
7409	15p
7410	12p
7411	18p
7412	15p
7413	21p
7414	40p
7416	24p
7417	24p
7420	20p
7421	25p
7423	20p
7425	20p
7426	20p
7427	20p
7430	12p
7432	20p
7437	22p
7438	22p
7439	30p
7440	16p
7441	58p
7442	38p
7443	100p
7444	100p
7445	70p
7446	82p
7447	57p
7448	60p
7450	15p
7451	15p
7453	15p
7454	12p
7459	20p
7460	16p
7470	27p
7472	24p
7473	20p
7474	22p
7475	30p
7476	30p
7480	45p
7482	65p
7483	58p
7485	55p
7486	27p
7489	135p
7490	25p
7491	55p
7492	30p
7493	25p
7494	50p
7495	45p
7496	45p
7497	197p
74107	24p
74109	45p
74121	24p
74122	35p
74123	35p
74125	35p
74126	35p
74132	50p
74141	55p
74145	60p
74147	150p
74148	90p
74150	75p
74151	55p
74152	80p
74153	58p
74154	90p
74155	50p
74156	50p
74157	50p
74158	80p
74150	80p
74160	80p
74161	80p
74162	80p
74163	80p
74164	80p
74165	75p
74166	120p
74167	175p
74170	125p
74173	110p
74174	75p
74175	75p
74176	70p
74177	70p
74178	130p
74179	150p
74180	70p
74181	140p
74182	80p
74184	125p
74185	125p
74188	200p
74190	85p
74191	85p
74192	80p
74193	80p
74194	80p
74195	90p
74196	80p
74197	70p
74198	120p
74199	120p
74251	130p
74279	100p
74283	150p
74290	125p
74293	125p
74298	175p
74365	110p
74366	110p
74367	110p
74368	110p

74LSxxTTL

74LS00	13p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	14p
74LS05	20p
74LS08	20p
74LS09	20p
74LS10	18p
74LS11	20p
74LS12	20p
74LS13	30p
74LS14	65p
74LS15	25p
74LS20	16p
74LS21	20p
74LS22	25p
74LS26	30p
74LS27	25p
74LS30	20p
74LS32	25p
74LS37	32p
74LS38	32p
74LS40	25p
74LS42	75p
74LS47	60p
74LS48	95p
74LS51	23p
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74LS55	25p
74LS73	40p
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74LS76	40p
74LS78	40p
74LS83	60p
74LS85	90p
74LS86	40p
74LS90	40p
74LS92	68p
74LS93	60p
74LS95	80p
74LS107	40p
74LS109	40p
74LS112	40p
74LS113	40p
74LS114	40p
74LS123	60p
74LS125	56p
74LS126	55p
74LS132	80p
74LS133	55p
74LS136	45p
74LS138	60p
74LS139	60p
74LS151	60p
74LS152	80p
74LS153	60p
74LS154	130p
74LS155	75p
74LS156	75p
74LS157	70p
74LS158	70p
74LS160	100p
74LS161	100p
74LS162	100p
74LS163	90p
74LS164	100p
74LS168	130p
74LS169	130p
74LS170	175p
74LS173	95p
74LS174	70p
74LS175	70p
74LS181	270p
74LS190	95p
74LS191	95p
74LS192	95p
74LS193	95p
74LS194	75p
74LS195	75p
74LS196	70p
74LS197	80p
74LS221	90p
74LS251	95p
74LS253	95p
74LS257	95p
74LS258	75p
74LS259	140p
74LS260	45p
74LS266	40p
74LS279	60p
74LS283	100p
74LS290	90p
74LS295	120p
74LS298	120p
74LS365	60p
74LS366	60p
74LS367	60p
74LS368	80p
74LS386	40p
74LS390	150p
74LS393	130p
74LS490	160p
74LS670	180p

74CxxTTL

74C00	24p
74C02	24p
74C04	26p
74C08	25p
74C10	24p
74C14	90p
74C20	25p
74C30	24p
74C32	25p
74C42	94p
74C48	96p
74C73	62p
74C74	48p
74C76	65p
74C83	128p
74C85	120p
74C86	40p
74C89	395p
74C90	92p
74C93	92p
74C95	104p
74C107	68p
74C151	178p
74C154	290p
74C157	178p
74C160	108p
74C161	108p
74C162	108p
74C163	108p
74C164	108p
74C165	108p
74C173	116p
74C174	108p
74C175	104p
74C192	130p
74C193	130p
74C195	110p
74C200	750p
74C221	138p
74C901	48p
74C902	48p
74C903	48p
74C904	48p
74C905	600p
74C906	18p
74C907	48p
74C908	96p
74C909	[illegible]
74C910	600p
74C914	90p
74C918	116p

74HxxTTL

74H00	25p
74H01	30p
74H04	25p
74H05	40p
74H08	40p
74H10	25p
74H11	30p
74H20	30p
74H21	30p
74H22	60p
74H30	30p
74H37	30p
74H38	30p
74H40	25p
74H50	25p
74H51	25p
74H52	25p
74H53	30p
74H54	30p
74H55	30p
74H60	25p
74H61	30p
74H62	30p
74H71	30p
74H72	30p
74H73	30p
74H74	30p
74H76	40p
74H78	75p
74H101	90p
74H103	90p
74H106	90p
74H108	90p
74H183	90p
74H572	90p

74LxxTTL

74L00	70p
74L02	50p
74L03	40p
74L04	50p
74L05	40p
74L10	40p
74L20	40p
74L30	70p
74L42	250p
74L51	40p
74L54	40p
74L72	45p
74L73	60p
74L74	60p
74L75	120p
74L78	75p
74L85	150p
74L86	75p
74L89	250p
74L90	150p
74L91	120p
74L93	140p
74L95	140p
74L98	250p
74L123	200p
74L154	500p
74L164	300p
74L165	300p
74L182	325p
74L193	325p
74L368 (80L98)	200p

74SxxTTL

74S00	70p
74S02	70p
74S03	70p
74S04	80p
74S05	80p
74S08	80p
74S09	75p
74S10	70p
74S11	70p
74S15	65p
74S20	70p
74S22	90p
74S30	60p
74S32	70p
74S40	70p
74S51	40p
74S64	70p
74S65	70p
74S74	90p
74S112	150p
74S113	175p
74S114	150p
74S132	150p
74S133	70p
74S134	65p
74S135	105p
74S138	175p
74S139	150p
74S140	70p
74S151	195p
74S153	210p
74S157	275p
74S158	150p
74S174	280p
74S175	175p
74S189	175p
74S194	150p
74S200	325p
74S253	180p
74S257	115p
74S258	120p
74S280	225p
74S287	280p
74S300	400p
74S305	190p
74S310	285p
74S312	105p
74S313	155p
74S316	730p
74S341	110p
74S342	120p
74S343	495p
74S346	125p
74S367	215p
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4000	13p
4001	13p
4002	13p
4006	90p
4007	16p
4008	80p
4009	45p
4010	45p
4011	16p
4012	16p
4013	40p
4014	80p
4015	80p
4016	40p
4017	85p
4018	85p
4019	40p
4020	90p
4021	85p
4022	83p
4023	16p
4024	66p
4025	16p
4027	40p
4028	75p
4029	98p
4030	50p
4031	200p
4034	190p
4035	100p
4040	100p
4041	75p
4042	70p
4043	85p
4044	85p
4046	100p
4047	90p
4048	60p
4049	45p
4050	45p
4051	65p
4052	65p
4053	65p
4060	100p
4066	54p
4068	22p
4069	20p
4070	32p
4071	20p
4073	21p
4075	21p
4076	80p
4077	40p
4078	25p
4081	20p
4085	70p
4086	70p
4089	150p
4093	85p
4099	145p
4104	240p
4503	65p
4507	35p
4510	99p
4511	140p
4512	90p
4516	120p
4518	100p
4519	50p
4520	100p
4527	150p
4528	90p
4532	86p
4539	110p
4555	67p
4556	88p
4582	88p
4584	74p
4702	710p
4703	825p
4704	730p
4705	925p
4706	975p
4707	925p
4708	1435p
4710	640p
4720	695p
4721	3135p
4723	93p
4724	129p
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40014	72p
40085	147p
40097	54p
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MODEL OPTO 8000.1A
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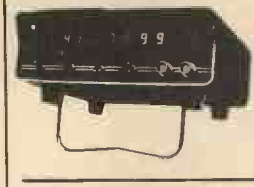

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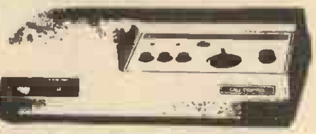

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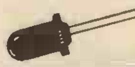

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MAN 84	Common Cathode yellow	300	99p
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MAN 3630	Common Anode orange ±1	300	99p
MAN 3640	Common Cathode orange	300	99p
MAN 4610	Common Anode orange	.300	99p
MAN 4640	Common Cathode orange	400	99p
MAN 4710	Common Anode-red	.400	99p
MAN 4730	Common Anode red ±1	.400	99p
MAN 4740	Common Cathode red	400	99p
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MAN 6640	Common Cathode orange D D	560	99p
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MAN 6660	Common Anode orange	560	99p
MAN 6680	Common Cathode orange	560	99p
MAN 6710	Common Anode red D D	560	99p
MAN 6730	Common Anode red ±1	560	99p
MAN 6740	Common Cathode red D D	560	99p
MAN 6750	Common Cathode red ±1	560	99p
MAN 6760	Common Anode red	560	99p
MAN 6780	Common Cathode red	560	99p
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DL 750	Common Cathode red	600	149p
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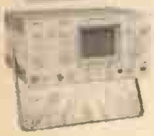

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DC volts (4 ranges) 1MV to 1000V AC volts 1V to 500V DC current (6 ranges) 1nA to 200MA. Resistance (5 ranges) 1Ω to 20 MEGΩ. **PRICE £34·95.** AC Adaptor **£3·95** de luxe padded carrying case £3·50 MN 1604 Battery **£1·14.**
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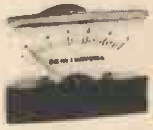

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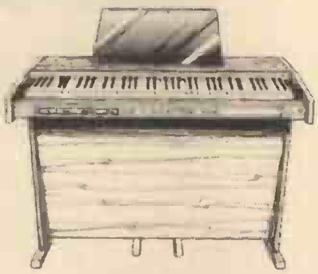

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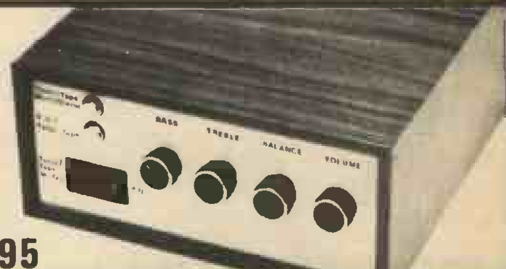
£14.95 Per stereo pair + £3.40 p&p.

10 + 10 AMPLIFIER KIT



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BSR

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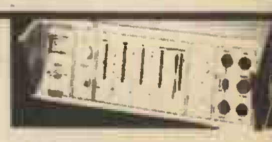

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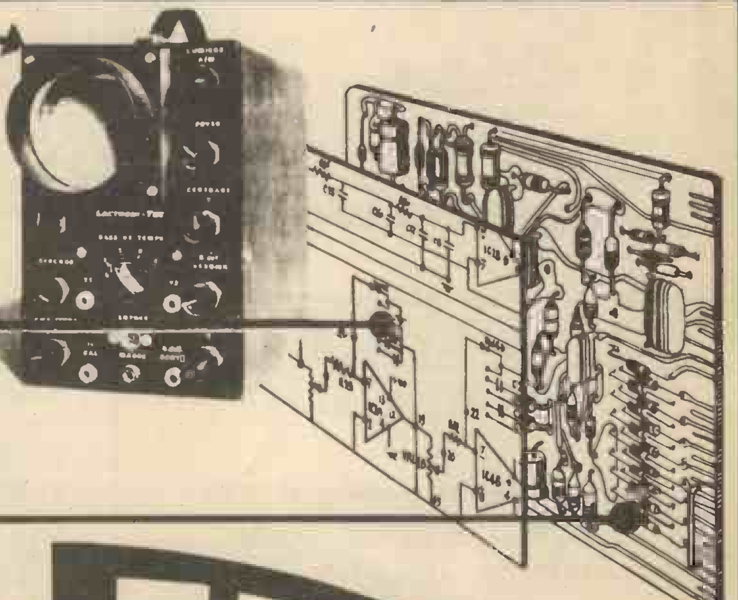

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BEAR BAG No. 23	77-68 32K DYNARAM Kit	t.b.a.
	77-68 MANUAL	£7.50

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77-68	MON 2 P.C.B.	£10.00
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77-68	PIO P.C.B.	£10.00
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(P & P 75p)

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	74N	74LSN
7400	0.12	0.21
7401	0.12	0.21
7402	0.12	0.21
7403	0.12	0.21
7404	0.13	0.21
7405	0.13	0.21
7406	0.28	
7407	0.28	
7408	0.14	0.21
74S08	0.40	
7409	0.14	0.21
7410	0.13	0.22
7411	0.18	0.21
7412	0.21	0.21
7413	0.25	0.46
7414	0.54	1.05
7415		0.21
7416	0.27	
7417	0.27	
7420	0.13	0.21
7421	0.28	0.21
7422	0.17	0.21
7423	0.25	
7425	0.20	
7426	0.25	0.28
7427	0.25	0.30
7428	0.34	0.34
7430	0.13	0.21
74S30	0.30	
7432	0.24	0.31
7437	0.24	0.26
7438	0.24	0.26
7440	0.13	0.22
7441	0.52	
7442	0.55	0.70
7443	0.90	
7444	0.90	
7445	0.70	
7446	0.70	
7447A	0.60	0.94
7448	0.80	0.94
7449		0.94
7450	0.13	
7451	0.13	0.21
7453	0.13	
7454	0.13	0.21
7455		0.26
7460	0.13	
7470	0.28	
7472	0.22	
7473	0.28	0.36
7474	0.28	0.38
73S74	0.50	
7475	0.30	0.42
7476	0.28	0.38
7478		0.39
7480	0.46	
7481	0.90	
7482	0.76	
7483	0.72	0.97
7484	0.90	
7485	0.88	0.97

	74N	74LSN
7486	0.26	
74S86	1.50	
7489	2.00	
7490	0.35	0.95
7491	0.65	
7492	0.44	0.82
7493	0.40	0.95
7494	0.80	
7495	0.54	1.05
7496	0.60	1.30
7497	2.00	
74100	0.94	
74104	0.40	
74105	0.40	
74107	0.28	0.40
74109	0.45	0.40
74110	0.48	
74111	0.70	
74112		0.40
74113	0.30	0.40
74114		0.40
74116	1.60	
74118	0.82	
74119	1.25	
74120	0.82	
74121	0.25	
74122	0.40	
74123	0.50	0.59
74124		1.25
74125	0.40	0.46
74126	0.45	0.46
74128	0.82	
74132	0.68	0.82
74134	0.36	
74135	0.88	
74136	0.55	0.40
74137	0.94	
74138		0.62
74139		0.62
74141	0.58	
74142	2.00	
74143	2.00	
74144	2.00	
74145	0.84	1.20
74147	1.30	
74148	1.15	
74150	0.99	
74151	0.60	0.90
74153	0.60	0.58
74154	1.00	1.32
74155	0.63	0.98
74156	0.62	0.98
74157	0.63	0.80
74158	0.58	0.62
74159	1.70	
74160	0.80	1.30
74161	0.90	0.80
74162	0.80	1.30
74163	0.80	0.82
74164	0.88	1.20
74165	0.89	
74166	0.88	

	74N	74LSN
74167	2.70	
74169		2.10
74170	1.68	1.94
74172	4.00	
74173	1.18	1.12
74174	0.89	1.12
74175	0.68	1.12
74S175	3.25	
74176	0.80	
74177	0.82	
74178	1.20	
74179	1.10	
74180	0.90	
74181	1.75	3.38
74182	0.75	
74S182	2.30	
74H183	0.99	
74184	1.20	
74185A	1.20	
74186	7.20	
74188	2.70	
74189		3.60
74190	1.05	0.96
74191	0.99	0.96
74192	0.99	1.50
74193	1.05	1.50
74194	0.90	2.00
74195	0.84	1.40
74196	0.90	1.15
74197	0.90	1.15
74198	1.48	
74199	1.48	
74221	1.50	1.05
74247		0.80
74248		0.95
74249		0.95
74251	1.00	0.95
74253		1.10
74257		1.12
74258		1.15
74260		0.28
74261		3.25
74266		0.43
74273	2.15	1.80
74279	1.25	0.55
74283	1.70	1.05
74284	6.85	
74289		3.92
74290		0.95
74293	1.35	1.00
74298	1.92	1.40
74352		1.00
74353		1.05
74365		0.52
74366		0.52
74367		0.46
74368		0.52
74386		0.58
74390	1.92	
74393	2.00	
73670		2.30

LINEARS

CA3045	–14	0.45
CA3046	–14	0.70
LM380N	–14	0.82
LM381N	–14	1.20
LM710N	–14	0.32
LM711N	–14	0.32
MC1310P	–14	1.50
NE555N	–8	0.30
NE556N	–14	0.65
NE25018	–14	2.00
SN72702N		0.50
SN75110N		0.50
SN76003N		1.95
SN76013N		1.35
SN76023N		1.35
SN76033N		1.95
TAA550P		0.35
TAA6818		1.40
TBA120S		0.64
TBA641A		1.88
TBA800		0.75
TBA810S		1.04
TCA270SQ		2.00
TDA2020		3.20
ZN414		1.00

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CA3130	–T099	1.00
LM301A	–8	0.30
LM301A	–T099	0.46
LM348N	–14	1.00
LM709	–8	0.40
LM709	–14	0.42
LM709	–T099	0.50
LM741	–8	0.22
LM741	–14	0.20
LM741	–T099	0.45
LM747	–14	0.70
LM3900N		0.50
MC1458P	–8	0.42

VOLTATE REG

LM300	–T099	1.00
LM309K	–T03	1.30
uA723	–14	0.40
7805	T0220	0.85
7812	T0220	0.85
7815	T0220	0.85
7824	T0220	0.85
7905	T0220	1.10
7912	T0220	1.10
7915	T0220	1.10

DIL SOCKETS

8 pin	0.11
14 pin	0.12
16 pin	0.13
18 pin	0.23
20 pin	0.27
22 pin	0.29
24 pin	0.30
28 pin	0.44
40 pin	0.55

CMOS

4000	0.14	4067	3.50
4001	0.15	4068	0.24
4002	0.16	4069	0.17
4006	0.92	4070	0.17
4007	0.16	4071	0.17
4008	0.92	4072	0.17
4009	0.45	4073	0.17
4010	0.48	4075	0.17
4011	0.15	4076	1.05
4012	0.18	4077	0.46
4013	0.42	4078	0.22
4014	0.80	4081	0.17
4015	0.77	4082	0.20
4016	0.42	4085	0.72
4017	0.77	4086	0.76
4018	0.87	4089	1.55
4019	0.42	4093	0.65
4020	0.92	4094	1.80
4021	0.82	4095	1.10
4022	0.82	4096	1.10
4023	0.15	4097	3.50
4024	0.66	4098	1.12
4025	0.15	4099	1.90
4026	1.28	4404	1.00
4027	0.50	4412	0.30
4028	0.67	4428	0.80
4029	0.86	4445	1.50
4030	0.48	4449	0.30
4031	2.34	4501	0.17
4033	1.25	4502	0.88
4034	2.00	4507	0.50
4035	1.00	4508	2.25
4036	2.40	4510	1.05
4037	0.99	4511	0.98
4038	1.00	4512	0.92
4039	2.80	4514	2.85
4040	0.88	4515	2.80
4041	0.77	4516	1.02
4042	0.72	4518	0.99
4043	0.82	4519	0.50
4044	0.82	4520	1.05
4045	1.40	4521	2.00
4046	1.32	4522	1.35
4047	0.96	4527	1.60
4048	0.60	4528	0.82
4049	0.42	4529	1.10
4050	0.42	4536	3.56
4051	0.84	4553	4.20
4052	0.84	4555	0.85
4053	0.84	4556	0.85
4054	1.10	4558	1.25
4055	1.00	4566	1.40
4060	0.98	4583	0.75
4068	0.48	4585	1.03

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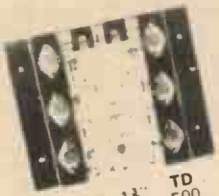


7" x 9" x 1¾" TD 500

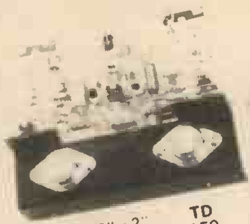
Featuring
Electronic Short Open & Thermal Overload Protection.

Brief Spec.
Input Sensitivity 0.775.v. R.M.S. (O.D.B.) at 25 K Ohms
Frequency Response 20 Hz-20 KHz
Hum & Noise - 100 dB Relative full output

T.H.D. at full power 0.1%

T.D. 500 300W into 2 Ohms 220W into 4 Ohms 140W into 8 Ohms	£45.00
Power supply P.S. 300	£30.00
T.D. 150 150W into 4 Ohms 100W into Ohms	£26.25
Power supply P.S. 150	£19.75
T.D. 150. 60 Version 60W into 8 Ohms 40W into 15 Ohms.	£19.75
Power supply P.S.60	£15.50

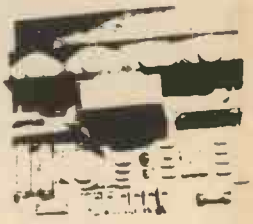
Note P.S. 300 will drive 2 T.D. 150 amplifiers



5" x 5" x 2" TD 150

All output ratings are R.M.S. continuous sine wave output.

AMPLIFIER MODULES



SPEC. INPUT SENSITIVITY 60 mV for full output
Frequency response 20 Hz-20 KHz
HUM & NOISE 70dB

TL30 5" x 5" x 2" • 35 watt 10 amp output transistors	£13.25
TL60 5" x 5" x 3" • 60 watt R.M.S. continuous sine wave output • 2 R.C.A. 110 watt 15 amp outpout transistors	£18.50
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TP125 7" x 6½" x 3" • 125 watt R.M.S. continuous sine wave output • 4 R.C.A. 150 watt 15 amp output transistors	£27.50

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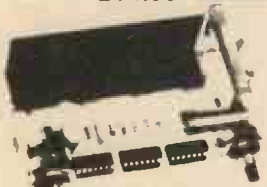
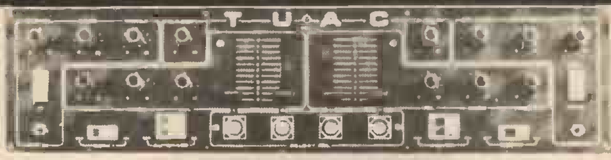
- Full wave control
- RCA 8A Triacs
- 1000W per channel
- Fully supressed and fused
- Switched master control for sound operation from ¼W to 125W
- Speed control for fixed rate sequence from 8 per minute to 50 per second
- Full logic integrated circuitry with optical isolation for amplifier protection

£21.50

Model 501 500W per channel as above without sound triggering

£14.00





STEREO DISCO MIXER
With touch sensitive switching and auto fade

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

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

P.F.L.: Output 250mV into 8 ohms. Rotary volume control. Monitoring facility for all 4 channels. Selection via touch sensitive illuminated switches. Switched visual cue indicator

Miscellaneous Facilities: Two illuminated deck on off switches. Mains illuminated on off switches. Auto fade illuminated on off switch. Mains powered with integral screen and back cover. Complete with full instructions

Size 25in long · 6in high · 3in deep

£189.00

Mono Disco Mixer with autofade **£52.00**

3 CHANNEL LIGHT MODULATOR SILMB

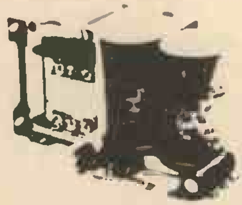
- RCA 8A Triacs
- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 125W
- Full wave control

£20.75

Single Channel Version 1500 Watts

£9.75

POWER SUPPLIES



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

PS250 for supplying 2 TP125s	£30.00
PS200 for supplying to TL100s	£30.00
PS60/60 for supplying 2 TL60s	£30.00
PS125 ± 45 volts for TP125	£18.50
PS100 ± 43 volts for TL100	£17.00
PS60 ± 38 volts for TL60	£15.50
PS30 ± 25 volts for TL30	£11.75
PSU 2 for supplying disco mixer	£7.50

FRONT PANEL FOR LIGHTING EFFECT MODULES
(complete with switches, neons and knobs) as illustrated

For S1LMB **£7.25**
Size 8" x 4½"

4LSM1 **£6.00**
Size 6½" x 4½"

FUZZ LIGHTS
Red, Green, Blue, Amber. **£24.50**

S1LMB **£8.25**
Combined with 3SDM1
Size 9" x 4½"

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Garland Bros. Ltd., Deptford Broadway, London 01-692 4412
Luton Disco Centre, 88, Wellington Street, Luton (Tel Luton 411733)
Session Music, 163, Mitcham Road, Tooting (Tel 01-672 3413). Mon-Sat 10am to 6pm. Closed Wed.
Electrosure Ltd., Four St., Exeter. Tel. 56687.
Salcoglen Ltd., 43 Borough Rd., Cleveland, Middlesbrough. (Tel. 242851).
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ADD SEQUENCE CHASING + DIMMING EFFECTS FOR TUAC 3 CHANNEL LIGHT MODULATOR

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

3SDMI **£15.25**

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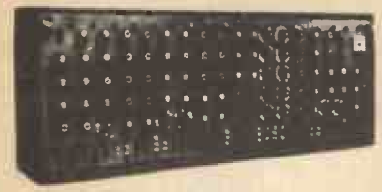
KITS FOR SYNTHESISERS, SOUND EFFECTS



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

CIRCUIT AND LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

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

PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

P.E. MINISONIC Mk. 2 SYNTHESISER

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

Set of basic component kits (excl. KBD R's and tuning pots – see list for options available).	from £61·00
Set of printed circuit boards	£8·99

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

The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage. Details in our lists.

FORMANT SYNTHESISER (Elektor 1977/78)

Very sophisticated music synthesiser for the advanced constructor who puts performance before price. Details in our lists.

128-NOTE TUNE-PROGRAMMABLE SEQUENCER (P.E. Nov/Dec 77)

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable. (Please use order codes quoted in brackets.)

Main Circuit (Nov) excl. sw's (KIT 76-1)	£18·03
Power Supply (KIT 76-3)	£4·72
Trigger Inverter and Alt. Output (KIT 76-2)	£1·15
LED Counter (KIT 76-4)	£2·10
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2·61
PCB for KITS 76-2 & 4 (PCB 76B)	£2·54

P.E. STRING ENSEMBLE (PE Mar-July 78)

The new keyboard string-instrument synthesiser.

Basic component sets:

Power Supply (KIT 77-1)	£8·77
Tone Generator (KIT 77-2)	£14·66
Diode Gates (KIT 77-3)	£18·81
Chorus Generator (KIT 77-4)	£19·08
Voicing System (KIT 77-5)	£7·38

Printed Circuit Boards:

Double-sided PCB for Power Supply, Tone Generator & Diode Gates with most of the Matrix wiring as printed tracking (PCB 77L/R)	£18.40
PCB for Chorus Generator (PCB 77C)	£2.65
PCB for Voicing System (PCB 77D)	£2.62

Fuller details of kits & PCBs are in our lists.

P.E. JOANNA PLUS ORGAN VOICING

The basic five octave electronic piano (P.E. May/Sept 75 and Sound Design) has switchable alternative voicings for Honky-Tonk, ordinary piano, and Harpsichord or a mixture of any of these three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The modification retains all the circuitry associated with the piano but in addition provides an organ-voice envelope facility with 5 switchable pitches, variable attack and sustain, phasing and vibrato.

Set of components (excl switches) for PSU, Frequency generator, Pitch and Note Divider, Envelope Shapers, Voicings, and Control circuitries. (Order as KIT 71-5)	£99·25
Set of PCBs (Order as PCB SET 71-6)	£29·18

GUITAR EFFECTS PEDAL (P.E. July 75)

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

Component set with special foot operated switches	£7·69
Alternative component set with panel switches	£5·05
Printed circuit board	£1·43

ELEKTOR ELECTRONIC PIANO (Elektor Sept 78)

A touch-sensitive, multiple-voicing 5 octave piano using the latest integrated-circuit techniques for the keying and envelope shaping and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos. Details in our lists.

DIGITAL REVERBERATION UNIT (Elektor May 78)

A very advanced unit using sophisticated i.c. techniques instead of mechanical spring-lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main component set (KIT 78-1)	£45·45
Extension component set (KIT 78-2)	£43·36
PCB for Kit 78-1 (PCB 78A)	£2·86
PCB for Kit 78-2 (PCB 78B)	£1·06

ANALOGUE REVERBERATION UNIT (Elektor Oct 78)

Using i.c.s instead of spring-lines, the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main component set (KIT 83-1)	£26·18
Additional Delay Set (KIT 83-2)	£18·25
PCB (as published) to hold both above kits (PCB 9973)	£4·31

RESONANCE FILTER (Elektor Oct 78)

This filter module has been designed to allow a synthesiser to produce a more realistic simulation of natural musical instruments.

Basic component set (KIT 82-1)	£15·10
PCB (as published) (PCB 9951)	£3·29

SYNTHESISER EXTERNAL INPUT INTERFACE (P.E. Oct 78)

This unit allows external inputs, such as guitars, microphones etc. to be processed by the circuits within a synthesiser.

Basic component set (incl PCB) (KIT 81-1)	£2·94

GUITAR MULTIPROCESSOR (P.E. Dec/Feb 78)

An extremely versatile sound processing unit capable of producing, for example, Flanging, Vibrato, Reverb, Fuzz and Tremolo as well as other fascinating sounds. May be used with most electronic instruments. Details in our lists.

RHYTHM GENERATOR KITS

Several available – details in our lists.

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

A modified and extended version of the circuit published.

Component set and PCB	£4·52

GUITAR SUSTAIN (P.E. Oct 77)

Maintains the natural attack whilst extending note duration.

Component set, PCB and foot switches	£5·13
Component set, PCB and panel switches	£3·71

WIND AND RAIN UNIT

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

Component set (incl. PCB)	£4·26

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

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

Component set using dual slider pot	£7·58
Component set using dual rotary pot	£6·89
Printed circuit board	£1·62

FUZZ UNIT

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

Component set (incl. PCB)	£2·05

TREMOLO UNIT

Based upon P.E. "Sound Design" circuit.

Component set (incl. PCB)	£2·94

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

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

Component set (incl. PCB)	£2·51

WAVEFORM CONVERTER

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

Component set (incl. PCB but excl. sw/s)	£8·40

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

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

Component set (incl. PCB) (Order as Kit 65-1)	£7·17

RING MODULATOR (P.E. Jan. 75)

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

Component set (incl. PCB) (Order as Kit 59-1)	£5·50

NOISE GENERATOR (P.E. Jan. 75)

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

Component set (incl. PCB) (Order as Kit 60-1)	£3·64

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

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

Component set (incl. PCB)	£4·77

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

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

Component set (incl. PCB)	£6·68

TRANSIENT GENERATOR (P.E. Apr. 77)

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

Component set	£4·87
Printed circuit board	£1·82

SOPHISTICATED PHASING AND VIBRATO UNIT

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

Component set	£17·38
Printed circuit board	£2·33

PHASING UNIT (P.E. Sept. 73)

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

Component set (incl. PCB)	£3·20

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

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

Component set (incl. PCB)	£4·74

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

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

Component set (incl. PCB)	£3·63

AUTOWAH UNIT (P.E. Mar. 77)

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

Component set, PCB, special foot switches	£7·67
Component set and PCB, with panel switches	£4·83

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

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

Component set (incl. PCB)	£3·97

10% DISCOUNT VOUCHER (PE 74)

TERMS: Goods in current adverts & lists over £50 goods value (excl P&P & VAT). Correctly costed, C.W.O., U.K. orders only. This voucher must accompany order. Valid until end of month on cover of P.E.

ADD: POST & HANDLING

U.K. orders – Keyboards add £2·00 each plus VAT. Other goods: under £15 add 25p plus VAT, over £15 add 50p plus VAT. Recommended: optional insurance against postal mishaps, add 50p for cover up to £50, £1·00 for £100 cover, etc. pro-rata.

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EXPORT ORDERS ARE WELCOME but to avoid delay we advise you to see our list for postage rates. All payments must be cash-with-order, in Sterling by International Money Order or through an English Bank. To obtain list – Europe send 20p, other countries send 50p.

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TERMS: C.W.O., MAIL ORDER OR COLLECTION BY APPOINTMENT (TEL 01-302 6184)

AND OTHER PROJECTS

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

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

OVERSEAS enquiries for list: Europe—send 20p: other countries—send 50p.

KIMBER-ALLEN KEYBOARDS AND CONTACTS

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

3 Octave (37 notes)	£25·50
4 Octave (49 notes)	£32·25
5 Octave (61 notes)	£39·75

Contact Assemblies (gold-clad wire) for use with the above KBDS (1 for each note):

Type GJ: Single-pole change-over	each 25½p
Type GA: 1 pair of contacts, normally open	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 28½p
Type GC: 3 pairs of contacts, each pair normally open	each 37½p
Type GE: 4 pairs of contacts, each pair normally open	each 46½p
Type GH: 5 pairs of contacts, each pair normally open	each 58½p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 57p

Printed Circuit Boards for use with most contacts (thus eliminating much interwiring) are available. Details in our lists.

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

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

Main component set (incl. PCB)	£14·93
Power supply set (incl. PCB)	£6·28

SYNTHESISER TUNING INDICATOR (P.E. July 77)

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

Component and PCB (but excl sw.)	£7·45

CONSTANT DISPLAY FREQUENCY METER (PE AUG 78)

A 5-digit frequency counter for 1Hz to 99999Hz with a 1Hz sampling rate. Readout does not count visibly or flicker due to display blanking.

Component set	£24·05*
Printed circuit board	£3·03*

*This kit & PCB are at 8% VAT (all others are 12½%)

TAPE NOISE LIMITER

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

Standard tolerance set of components	£2·96
Superior tolerance set of components	£3·76
Regulated power supply (will drive 2 sets)	£4·69

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

Automatically controls sound output to within a preset level.

Component set (incl. PCB)	£4·68

DISCOSTROBE (P.E. Nov. 76)

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

Basic component set	£18·19
Printed circuit board	£3·45

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

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

Pre-Amp Module Components set (incl. PCB)	£3·95
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6·59
Audio Amplifier Module Type PC7	£7·75

SOUND BENDER (P.E. May 74)

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

Details in lists.

SOPHISTICATED POWER SUPPLIES

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

NEW PCB SERVICE

PCBS FOR ALL NEW P.E. & E.E. PROJECTS FOR WHICH PCB LAYOUTS HAVE BEEN PUBLISHED AND FOR WHICH FULL COPYRIGHT CLEARANCE IS AVAILABLE.

LIMITED QUANTITIES ONLY FOR AN EXPERIMENTAL PERIOD.

LET US KNOW YOUR NEEDS AND WE WILL ADVISE YOU OF AVAILABILITY AND PRICES.

INTEGRATED CIRCUITS

301	8-pin DIL	48p
318	8-pin DIL	220p
320-15	---	195p
324	14-pin DIL	87p
341-15	---	87p
709	8-pin DIL	48p
723	TO5	87p
723	14-pin DIL	51p
726	TO5	1005p
741	8-pin DIL	24p
748	8-pin DIL	57p
4007	14-pin DIL	17½p
4011	14-pin DIL	17½p
4024	14-pin DIL	46½p
4069	14-pin DIL	18p
4136	14-pin DIL	126p
AM2833	8-pin DIL	360p
AY10212	16-pin DIL	617p
AY16721/6		188p
CA3046	14-pin DIL	71p
CA3080	8-pin DIL	63p
CA3084	14-pin DIL	209p
FX209	16-pin DIL	729p
LM323	---	562p
M252	16-pin DIL	680p
MC3340	8-pin DIL	150p
MCM6810	24-pin DIL	670p
SG3402N	14-pin DIL	262p
STK025	---	595p
TDA1022	16-pin DIL	582p
XR2207	14-pin DIL	420p
ZN425E	16-pin DIL	375p

TRANSISTORS

AC128	32p
AC176	28p
BC107	13p
BC108	13p
BC109	15p
BC109C	16p
BC177	18p
BC184	11p
BC187	18p
BC204	10p
BC209C	13p
BC213	11p

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Write to the Secretary, Department of Electronic and Communications Engineering, Polytechnic of North London, Holloway Road, London N7 8DB for details.

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PRIMARY 220–240 50HZ.
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AVAILABLE BY SERIES OR PARALLEL CONNECTION

Type	Voltage	Curent	£	p/p
06FE06	6+6	0·5A EACH	1·71	54p
08FE06	6+6	0·6A EACH	2·05	54p
12FE06	6+6	1A EACH	2·27	65p
20FE06	6+6	1·6A EACH	2·96	76p
50FE06	6+6	3A EACH	3·51	76p
60FE06	6+6	4A EACH	4·30	92p
06FE09	9+9	0·3A EACH	1·71	54p
08FE09	9+9	0·5A EACH	2·05	54p
12FE09	9+9	0·75A EACH	2·27	65p
20FE09	9+9	1A EACH	2·96	76p
50FE09	9+9	2·5A EACH	3·51	76p
6DFE09	9+9	3A EACH	4·30	92p
06FE12	12+12	0·25A EACH	1·71	54p
08FE12	12+12	0·3A EACH	2·05	54p
12FE12	12+12	0·5A EACH	2·27	65p
20FE12	12+12	0·8A EACH	2·96	76p
50FE12	12+12	2A EACH	3·51	76p
60FE12	12+12	2·5A EACH	4·30	92p
80FE12	12+12	3A EACH	5·10	1·08p
06FE15	15+15	0·2A EACH	1·71	54p
08FE15	15+15	0·25A EACH	2·05	54p
12FE15	15+15	0·4A EACH	2·27	65p
20FE15	15+15	0·6A EACH	2·96	76p
50FE15	15+15	1·6A EACH	3·51	76p
60FE15	15+15	2A EACH	4·30	92p
80FE15	15+15	3A EACH	5·10	1·08p
06FE20	20+20	0·15A EACH	1·71	54p
12FE20	20+20	0·25A EACH	2·27	65p
20FE20	20+20	0·5A EACH	2·95	76p
50FE20	20+20	1·2A EACH	3·51	76p
60FE20	20+20	1·5A EACH	4·30	92p
80FE20	20+20	2A EACH	5·10	1·08p

CHARGER TRANSFORMER

48FE12	0-6-12	4A	3·51	76p
66FE12	0-6-12	5A	4·32	92p
70FE12	0-6-12	6A	5·50	1·08p

Type	Voltage	Current	£	p/p
12FE24	24+24	0·2A EACH	2·27	65p
60FE24	24+24	1·2A EACH	4·30	92p
80FE24	24+24	1·5A EACH	5·10	1·08p
50FE28	28+28	0·75A EACH	3·51	76p
60FE28	28+28	1·1A EACH	4·30	92p
80FE28	28+28	1·4A EACH	5·10	1·08p
20FE30	30+30	0·35A EACH	2·96	76p
50FE30	30+30	0·75A EACH	3·51	76p
60FE30	30+30	1A EACH	4·30	92p
80FE30	30+30	1·2A EACH	5·10	1·08p

MULTI TAP RANGE
VOLTAGES AVAILABLE 12-0-12 or 15-0-15
3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30

30FE30		1A	3·83	76p
60FE36		2A	5·16	92p
80FE36		3A*	6·48	1·08p

CENTRE TAP SECONDARY

06FE30	6-0-6	1A	1·66	54p
08FE40	9-0-9	1A	2·00	54p
12FE50	12-0-12	1A	2·21	65p
20FE80	15-0-15	1A	2·89	76p
50FE80	20-0-20	2A	3·43	76p
60FE100	28-0-28	2·2A	4·05	92p
80FE70	24-0-24	3A	4·97	1·08p
90FE60	20-0-20	4A	5·24	1·24p
100FE26	26-0-26	3·5A	5·40	1·24p
100FE28	28-0-28	3·5A	5·40	1·24p
100FE30	30-0-30	3A	5·40	1·24p
100FE36	36-0-36	3A	5·40	1·24p
150FE26	26-0-26	5A	7·02	1·40p
150FE30	30-0-30	4A	7·02	1·40p
150FE36	36-0-36	4A	7·02	1·40p
150FE42	42-0-42	3A	7·02	1·40p

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Quality audio modules and accessories for

S450

STEREO FM TUNER Fitted with phase lock-loop

£26·14 + 40p p&p

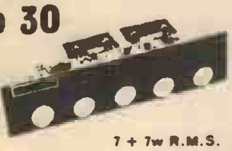
FREQUENCY RANGE	88–108 Mhz
SENSITIVITY	3·0 μV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo Indicator.

Stereo 30

COMPLETE AUDIO CHASSIS

£21·57 + 66p p&p



7 + 7w R.M.S.

OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than ·5% (Typically ·3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm × 130mm × 33mm

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60

25w R.M.S.

AUDIO AMPLIFIER MODULE 25 Watts RMS

£5·27 + 35p p&p

OUTPUT POWER	25 Watts RMS
SUPPLY	30–50 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0·1%.

AL80

35w R.M.S.

AUDIO AMPLIFIER MODULE

£7·92 + 35p p&p

OUTPUT POWER	35 Watts RMS
SUPPLY	40–60 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0·1%.

AL250

125w R.M.S.

POWER AMPLIFIER

£19·24 + 66p p&p

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50–80 V
LOADS	4–16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION 50 WATTS into 4 ohms	0·1%
50 WATTS into 8 ohms	0·06%

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A

10w R.M.S.

AUDIO AMPLIFIER MODULES

£4·26 + 35p p&p

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than ·25%
LOAD IMPEDANCE	8–16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz–25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm × 63mm × 28mm

These low cost 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80

STABILISED POWER SUPPLY

£4·95 + 35p p&p

INPUT A.C. VOLTAGE	33–40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA–1·5 amps
OVERLOAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100

STEREO PRE-AMPLIFIER

£18·05 + 40p p&p

FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB	
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·07%)	
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms	For an output 250 mV
2. RADIO TUNER	100 mV/100 K ohms	
3. MAGNETIC P.U.	3·5 mV/50 K ohms	
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz	
BASS CONTROL RANGE	± 15 dBs at 75 Hz	
TREBLE CONTROL RANGE	+ 10–20 dBs at 15 kHz	
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)	
INPUT OVERLOAD	Better than 26 dBs (All inputs)	
SUPPLY	20 to 40 V	
DIMENSIONS	300 × 90 × 33mm (less controls)	

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

MPA30

MAGNETIC CARTRIDGE PRE-AMPLIFIER

£3·35 +35p p&p

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3·5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—ve earth
DIMENSIONS	110 × 50 × 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER

£8·75 + 35p p&p

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz–20 kHz (—3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	—60 dB
SIGNAL/NOISE RATIO	—65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450 etc.
Transformer T538.

Input A.C. Voltage 15–20V.
Output D.C. Voltage 22–30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60 x 43 x 26mm.

£2·13 + 35p p&p.

BP124 SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £3·78 + 35p p&p. 5 WATTs —

MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-kits modules, 2 × AL60 amps, 1 × PA100 pre-amp, 1 × SPM80 stab. power supply, 1 × BMT80 transf. giving 15 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.
Price £36·00 + 62p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm × 290mm × 95mm.
Price £22·44 + 86p p&p.

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T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3·60 + 55p p&p.
T2050 For use with Stereo 30
Order No. 2050 Price: £3·66 + 55p p&p.
BMT80 For use with AL60 SPM80
Order No. 2034 Price: £6·08 + 86p p&p.
BMT250 For use with AL250
Order No. 2035 Price: £7·14 + £1·10p p&p.
2040. For use with AL60
Order No. 2040 Price: £5·85 + 80p p&p.
2041. For use with AL80, AL120 and AL250
Order No. 2041. Price: £7·65 + 86p p&p.

CASES

TEAK 30, 32 x 23 x 8cm, designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. £6·69. p&p 70p.

TEAK 60, 42 x 29 x 9cm, for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve — has no front or back panel. o/n 140. £7·87. p&p 85p.

Professionals and Enthusiasts from BI-PAK

AL120 — 50W R.M.S.

AUDIO AMPLIFIER (With integral heat sink and short-circuit protection).

£12·91 + P. & P. 35p

OUTPUT POWER	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	05% Max. (Typically 02%)
FREQUENCY RESPONSE ± 1dB	25Hz-20kHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP.	45 deg. C
DIMENSIONS	192 x 89 x 49 mm

Introduced to fulfill the demand for a fully protected power amp., capable of driving high quality speaker systems at up to 50w., with distortion levels below 05%. Ideal for domestic use, Discos, P.A. systems, electronic organs etc. The generously rated components ensure continuous operation at high output levels.

SPM120 — STABILISED POWER SUPPLIES

SPM120/45
SMP120/55
SMP120/65

£6·52 + P. & P. 35p

AC INPUTS	
SPM120/45	40-48v
SPM120/55	50-55v
SPM120/65	60-65v
OUTPUT CURRENT	2.5A
RIPPLE	1A 100mV 2A 150mV

SPM120 is a fixed voltage stabiliser available with an o/p voltage of either 45v, 55v, or 65v. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A., operates direct from a mains transformer requiring only the addition of 2 Electrolytic capacitors to complete the s/c protection.

GE100 Mk2.

10 CHANNEL MONOGRAPHIC EQUALISER

£22·50 + P. & P. 35p

Control Range	±12dB
Dynamic Range	110dB
Maximum Output	+15dB
Frequency Response	30Hz-20KHz (±1dB)
Power Supply	15–0–15v.
Voltage Handling Input	3v R.M.S.
T.H.D.	005%

Only 155mm x 65mm x 50mm including the 10 x 10K 1in slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20KHz you can cut and boost ±12dB with the 10 sliders, each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, P.A. systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power Supply for GE100. o/d SG30 £3.80.

VPS30

REGULATED VARIABLE STABILISED POWER SUPPLY

£8·20 +.P. & P. 35p

AC Input Maximum	25v
Voltage Regulation	2-30v
Regulated Current	0-2A
Incorporating short circuit protection	

This NEW versatile Regulated Variable Stabilised Power Supply with short circuit protection and current limiting, is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2v–30v, with a current limiting range of 0–2A. With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 2033), 0–1ma (o/d 1310 or 1305), plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899), it can be used again and again as a self-contained bench, power supply, eliminating the use of batteries and thus saving ££'s!

PA200

STEREO PRE-AMPLIFIER

£18·61 P. & P. 40p

FREQUENCY RESPONSE		20Hz to 20kHz x 1dB	
TOTAL HARMONIC DISTORTION		Less than 1% (Typically ·70%)	
SENSITIVITY INPUTS	1. TAPE	100mV/100 K ohms	For an
	2. RADIO TUNER	100mV/100 K ohms	output
	3. MAGNETIC P.U.	3·5mV/50 K ohms	500mV
EQUALISATION		Within ± 1dB from 20Hz to 20kHz	
BASS CONTROL RANGE		± 15dBs at 75Hz	
TREBLE CONTROL RANGE		+ 10-20dBs at 15kHz	
SIGNAL/NOISE RATIO		Better than 65dBs (All inputs)	
INPUT OVERLOAD		Better than 2dBs (All inputs)	
SUPPLY		35 to 706v	
DIMENSIONS		300 x 90 x 33mm (less controls)	

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

HEADPHONES

A top quality headphone with cushioned earpads and headband. Separate balance/volume controls. Stereo or Mono switch. Impedance: 8 ohms. Frequency: 30-18,000Hz. **o/n 884. £9·78. p&p 70p.**

A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi-Fi. Impedance 8 ohms. Frequency: 30-15,000Hz. **o/n 885. £4·95. p&p 50p.**

BIB HI-FI ACCESSORIES

Parallel Tracking GROOV KLEEN
The very latest in automatic record cleaning. Designed to suit all modern single play decks. Simple to fit, it is extremely efficient. Complete with two types of base and three height extensions. **o/n 8101. £3·97. p&p 35p.**

Cassette Tape Editing Kit
Enables cassette tapes to be edited and joined easily, quickly and accurately. Kit comprises: Tape Splicer ⅛" (3.2mm). 2 Precision Tape Cutters. Tape Piercer. 9 Self-adhesive Labels. Reel of Splicing Tape. 3 Winders and removers and instructions, all in a handy wallet. **o/n 811. £2·59. p&p 35p.**

GROOV-STAT
The BIB Groov-Stat static reducer neutralises the static charge on records and other plastic surfaces. **o/n 8103. £5·89. p&p 35p.**

Cassette Head Cleaner
Essential for cleaning of tape heads, capstans and rollers. Pack contains Tape Head Applicator and tape head polisher tools. Plus bottle of special formula cleaning fluid and full instructions. **o/n 832. £0·72. p&p 35p.**

METERS

Miniature Balance & Tuning Meter
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity: 100 0-100MA Dimensions: 23 x 22 x 26mm. **o/n 1318. £2·11. p&p 35p.**

Balance and Tuning Meter
Clear view edgewise meter. Centre zero application. Sensitivity: 100 0 100UA. Dimensions: 45 x 22 x 34mm. **o/n 1319. £2·16. p&p 35p.**

Miniature Level Meter
Moving coil, for accurate level indication for tape recorders, amplifiers etc. Neat design, rugged construction will withstand five times rated value. Sensitivity: FSD. 200UA. OdB. 130UA. Dimensions: 23 x 22 x 26mm. **o/n 1320. £3·02. p&p 35p.**

Vu Meter
Calibrated 20 to +3 and 0-100%, making it suitable for use as a recording level meter or as a power output indicator Sensitivity 130uA. Dimensions: 40 x 29mm. **o/n 1321. £2·16. p&p 35p.**

ADAPTORS

AC-DC enables a large range of battery powered radios, recorders, calculators to be run off the mains. (220-240v AC). Switchable for 3-6-9-12 volts. Current rating 300mA. Polarity reversing switch. Universal plug incorporated. **o/n 137. £4·05. p&p 35p.**

DC-DC for use in all cars, boats etc., with pos. or neg. earth for a regulated output of 6, 7·5 or 9 volts DC at 300mA. For radios, recorders etc. **o/n 138. £3·15. p&p 35p.**

CROSSOVER NETWORKS

2-WAY channels for high and low frequencies to correct speakers – high to tweeters, low to woofers. Complete with instructions. Frequency: 3,000Hz. **o/n 1904. £1·24. p&p 35p.**

2-WAY for 8 ohm speakers up to 30 watts. Frequency: .3KHz. **o/n 1905. £1·81. p&p 35p.**

3-WAY for 8 ohms speakers up to 30 watts. Frequency: 800Hz and 4.5KHz. **o/n 1906. £3·32. p&p 35p.**

MICROPHONES

DYNAMIC CASSETTE
For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick-up pattern is omnidirectional. On/Off switch. 1 metre of tough lead with floating 2.5 and 3.5mm plugs. Matching moulded strut. Impedance: 200 ohms. Sensitivity: 90dB. Frequency: 90-10,000Hz. Size: 20mm dia x 120mm. **o/n 1326. £1·80. p&p 35p.**

DYNAMIC MICROPHONE
Superior quality portable cassette recorder mike with built-in remote control switch and lead fitted with 5-pin 240° DIN plug (remote switch) and 3-pin DIN plug (microphone). Provides a direct replacement for those supplied with recorders. With detachable stand. Omnidirectional. Impedance: 200 ohms. Freq. response: 100 to 10,000Hz. Sensitivity: 79dB at 1,000Hz. **o/n 1327. £2·98. p&p 35p.**

RE – 317: DYNAMIC MICROPHONE
Highly sensitive, high-grade desk or hand mike suitable for use with many popular cassette decks. Incorporates On/Off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance: 5,000 ohms. Freq. response: 100, at 12,000Hz. Sensitivity: (–7dB at 1,000Hz). **o/n 1336. £4·48. p&p 35p.**

OMNIDIRECTIONAL CARDIOID
Powered by a 1½v battery located within the aluminium body. Satin silver finish with front disk protection to the diaphragm housing. On/Off switch. Also with 'Busby' type windshield, "U" bracket and stem and extremely supple cable. Consumption: 0.2mA from 1½v battery providing approx., 8-10,000 hours continuous life. Impedance: 600 ohms. Sensitivity: 70dB. Frequency: 30-16,000Hz. Size: 23mm dia + 267mm. **o/n 1329. £14·40. p&p 35p.**

UNIDIRECTIONAL CARDIOID
Dual imp. 600 and 50,000 ohms. Response 50 to 14,000Hz. Sensitivity 54dB at 50K/ohms. Size: 1½" dia x 6½" long. Weight approx., 190gm. **o/n 1328. £12·32. p&p 35p.**

STANDS

GOOSENECK CHROME FLEXIBLE HOLDERS
Length 320mm. **o/n 1333. £2·70. p&p 35p.**
Length 515mm. **o/n 1334. £3·83. p&p 35p.**

FLOOR STAND Heavy chrome. Stow-away feet with rubber ends for maximum stability. Draws to a height of 5' maximum. o/n 1335. + **£10·69. p&p 85p.**

BOOM ARM for use with the above stand. Heavy chromed metal, it gives 30" reach from the stand. **o/n 1337. £10·35. p&p 70p.**

WINDSHIELD COVERS

o/n 1331 Medium per pair **£1·35. p&p 35p. o/n 1332** Large per pair **£2·03. p&p 35p.**

AUDIO LEADS

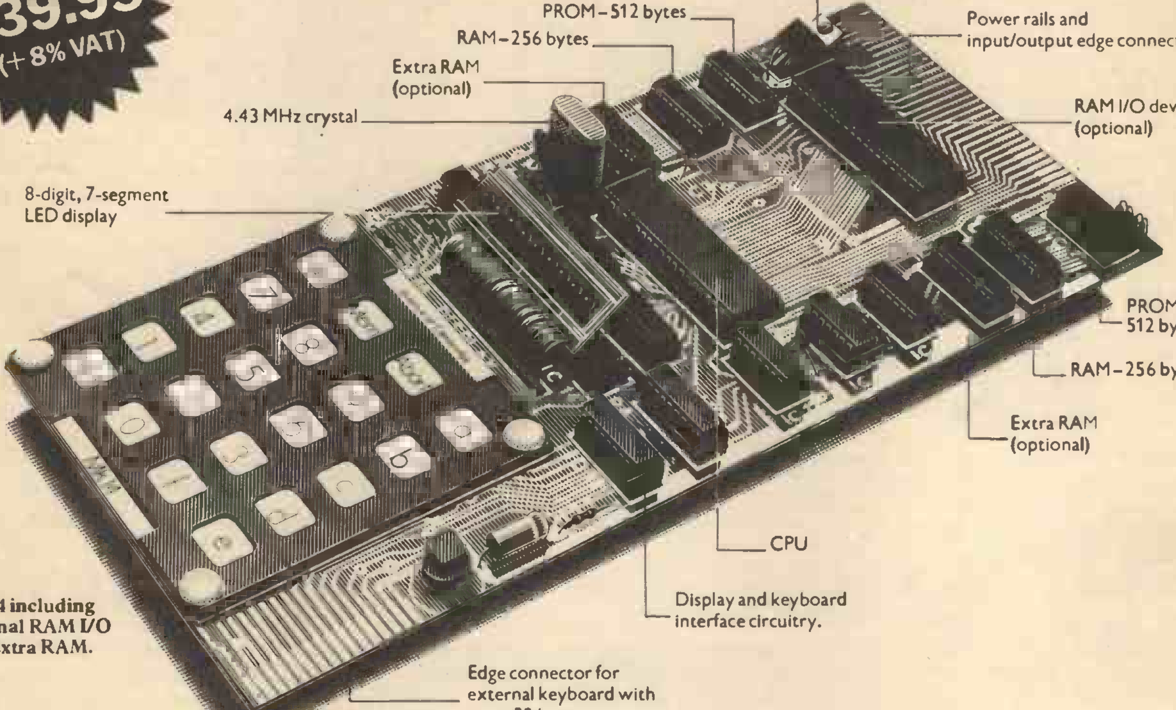
107	FM Indoor Ribbon Aerial	£0·68
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0·84
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0·95
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0·96
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·24
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0·76
118	5 pin DIN phono plug to stereo headphone jack socket	£1·18
119	2 + 2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0 2m	£1·01
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0·68
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·62
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0·84
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0·84
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0·84
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1·46
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0·90
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1·18
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·76
131	5 pin DIN plug to 3 pin DIN plug 1&4 and 3&5. Length 1.5m	£0·93
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1·10
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0·84
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0·76
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0·76
136	Coiled stereo headphone extension lead. Black. Length 6m	£1·97
178	AC mains lead for calculators etc.	£0·54

BI-PAK

DEPT. PE8, P.O. Box 6,
18 Baldock Street, Ware, Herts.

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

only £39.95 (+8% VAT)



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

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

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

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

More memory – and peripherals!

Optional extras include:

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

All are available now to owners of MK 14.

A valuable tool – and a training aid

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

SPECIFICATIONS

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

Free Manual

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

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

How to get your MK 14

Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

Science of Cambridge Ltd,
6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.

Please send me the following, plus details of other peripherals:

☐ MK 14 Standard Microcomputer Kit @ £43.55 (inc 40p p&p.)
☐ Extra RAM @ £3.88 (inc p&p.)
☐ RAM I/O device @ £8.42 (inc p&p.)

I enclose cheque/money order/PO for £________ (indicate total amount.)

Name ____________

Address (please print) ____________

PE8 Allow 21 days for delivery.

Science of Cambridge

PE VOLUME 15 No. 8 AUGUST 1979

WARMING UP

THE QUESTION of C.B. in Britain has been a debating point for many years, recently however the debates have been warming up—not at government level but down here among the people and technical press. Not only has the argument warmed but so have the air waves, with an estimated 18,000 illegal users in the U.K. We hope to be looking in more depth at this use and at what the equipment is, where it's coming from etc. in the near future.

It would appear that whether the government likes it or not C.B. is here and it is highly unlikely that it will ever go away or that the Home Office will ever be able to totally stamp out it's use. It is also a fact that because people are prepared to break the law and use such equipment, they are not particularly bothered about power output and possible interference etc. Obviously it is better from a detection viewpoint not to use an easily spotted C.B. aerial on a vehicle and therefore many sets are being used with ordinary car aerials which cause increased interference problems.

"In for a penny, in for a pound", as the saying goes and since it is just as easy to buy high power linear amplifiers as C.B. gear, these are now being used to boost outputs up to 50 or even 100 watts which, of course, compounds all the problems caused to other, legal systems. Clearly we are fast approaching a situation which is far worse than we might have if C.B. were legalised and legislation drawn up and enforced to control the problems now being caused.

From recent raids on C.B.'ers and the confiscation of the equipment, the Home Office are obviously trying to track down and deal with offenders but can they realistically expect to achieve a C.B. free community? The Home Office recently commented to us that they are endeavouring to control illegal use especially where interference is being caused. They also made the point that the whole area of C.B. use is under review. Presumably our "new" Government will be looking at all the facts.

Of course, C.B. is legal in many continental countries and with the ever increasing flow of commercial and holiday traffic across the channel, not only is it impossible to keep out equipment but it also poses problems for Customs and Excise when a vehicle which has been fitted—quite legally—with C.B. equipment in say, Germany or Spain comes across the channel. To comply with the law the equipment should be torn out and confiscated before the vehicle is allowed in.

One other interesting fact is that if you look in the "for sale" pages of one well known weekly "classified magazine", you will regularly discover secondhand and sometimes new C.B. equipment being openly advertised for sale. Of course, there is nothing illegal in this. You can own it, even sell it, but you must not use it and, of course, you must not import it.

What does this really mean? Since you must not import C.B. equipment, any that is in the country has been smuggled in and can therefore be confiscated. If it can be proven that any individual has smuggled it in, a fine or worse could be the result and, of course, even if you purchased the gear secondhand it can still be confiscated even if you never use it. If you built it yourself you can keep it, but you must not use it.

What a ridiculous situation! Any further comments anyone—Home Office, Minister of Posts and Telecommunications, readers?

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We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only**.

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

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

HOME FREEZER ALARM

P.E. CHAPLIN

MANY people now own a deep freezer or fridge-freezer unit and anyone who has suffered a "thaw-out" will never want a repeat of that experience.

If the contents are insured, it is true that the insurance company will pay compensation for the loss, but if the freezer is full of home and local farm produce this cannot be replaced out of season, and considerable inconvenience is felt.

This is where the freezer alarm can help. Although it cannot prevent the possibility of such a catastrophe, it can give some warning of impending disaster!

Thaw-out of the freezer can be caused either by failure of the power supply, or by mechanical failure of the freezer itself. This unit is designed to cope with each of these events.

ELECTRICAL/MECHANICAL FAILURE

An essential feature of any freezer alarm should be the ability to detect mains failure and still continue to function.

Mains failure could be due to a power cut (in which case it is usually known) or a blown fuse at either the distribution board or in the freezer's own plug. The power can even be accidentally switched off before going on holiday by an over-enthusiastic desire to have everything turned off!

Similarly, it must have the ability to detect a rise in temperature because of a fault in the freezer's own mechanism.

When all is well, the alarm is silent and each l.e.d. remains illuminated, red for mains and green for temperature.

Failure of the mains supply causes the audible alarm to sound intermittently and the red l.e.d. to flash at a set rate. In the same way, increase in temperature will trigger the alarm and cause the green l.e.d. to flash at a different rate from the red (just to make things extra clear in an emergency!)

In addition, a test circuit was added for checking that the temperature sensor and connecting wires have not become open circuit. This was felt necessary owing to the negative temperature characteristics of the temperature sensor.

CIRCUIT DESCRIPTION

The complete circuit diagram of the alarm is shown in Fig. 1. When the unit is operated from the mains, the voltage at pin 4 of IC1 will be zero; the NE555 will sink current in this condition and l.e.d. D8 will be illuminated.

If the mains fails, the voltage at pin 4 will rise above the threshold value of 0·4V to about 2V via R2, as pin 4 is isolated from the 0V rail by D6 and the rectifier diodes. When this happens IC1 will be triggered and run in the astable mode, the mark to space ratio being governed by the values of R3, R4 and C2. The duration of high output t_1 is given by:

$$t_1 = 0{\cdot}693(R3 + R4)C2 \text{ seconds.}$$

and the low output t_2 by:

$$t_2 = 0{\cdot}693(R4)C2 \text{ seconds.}$$

The frequency of operation is given by:

$$f = \frac{1}{(t_1 + t_2)} \text{ Hz.}$$

In the prototype, the frequency of oscillation was chosen to be about 1Hz.

TEMPERATURE DETECTION

The temperature detection circuit is a Wheatstone Bridge, one arm formed by R6, VR1 and R7, and the other by R8 and the thermistor TH1 (via JK1).

The operational amplifier (IC3) acts as a comparator across the bridge circuit. A polarity change of a few millivolts across the input of the 741 is sufficient to swing the output from a low to high state or vice versa.

As TH1 cools down, its resistance increases, thus swinging the voltage at pin 2 slightly positive relative to pin 3 for a particular setting of VR1. Further cooling down of TH1 maintains pin 2 positive with respect to pin 3. The output of IC3 will be low in this condition, allowing the NE555 timer (IC4) to sink current, thus l.e.d. D10 will be illuminated.

If the temperature rises above the pre-set level, the voltage at pin 2 will be negative with respect to pin 3 and

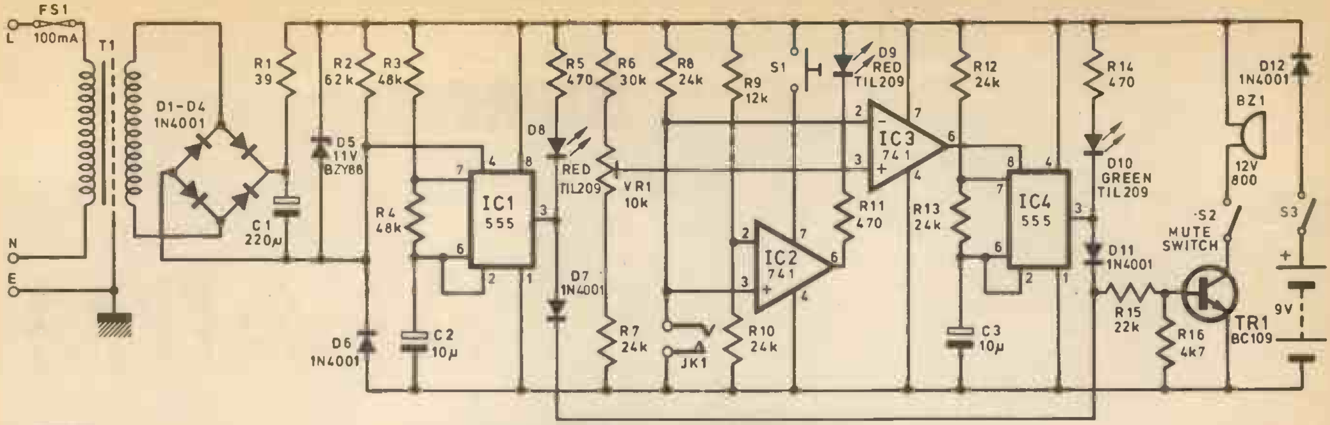


Fig 1. Circuit diagram of the Freezer Alarm.

the output of IC3 will be high, thus energising IC4, causing l.e.d. D10 to flash. In the prototype, the values of R12, R13 and C3 were chosen so that the frequency of operation was twice that of the mains failure circuit.

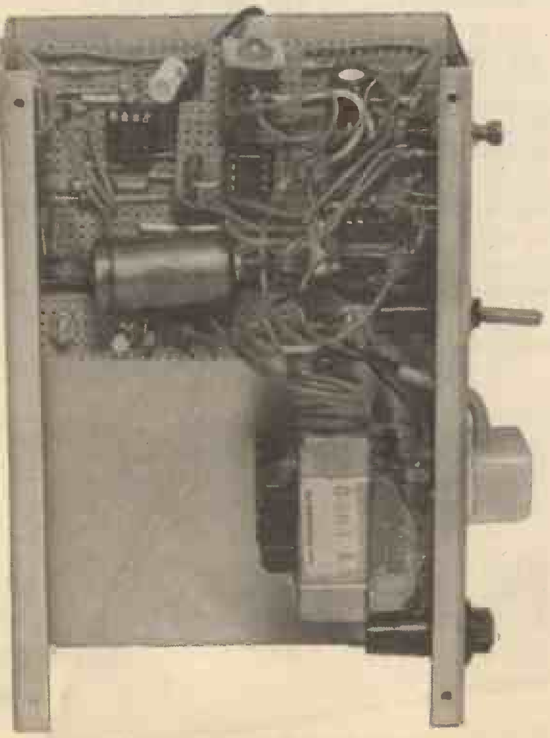
TEST CIRCUIT

The test circuit consists of another bridge circuit, one arm common with the temperature sensing circuit comprising R8 and TH1 and the other by R9 and R10. The values of R9 and R10 were chosen to allow for a thermistor at −22°C at its extreme tolerance limit of +20 per cent of its nominal value. When the test button (S1) is pressed, IC2 is energised and under normal conditions pin 2 will be positive with respect to pin 3. The output of the operational amplifier will be low and sink current, thereby illuminating l.e.d. D9. If, on the other hand, open circuit conditions have occurred, then pin 3 will be positive with respect to pin 2 and the output will be high and the l.e.d. will not be illuminated.

REMAINDER OF CIRCUIT

Diodes D7 and D11 isolate the outputs of IC1 and IC4 from each other. The voltage at the common ends of the diodes was found to be about 2V under normal conditions and this was sufficient to make the audible alarm hum. So TR1 was introduced to act as a switch, and R15 and R16 prevent the transistor from switching on until the outputs of IC1 and/or IC4 goes high. D12 in effect isolates the battery from the rail, and prevents current drain into the battery.

The output voltage of the power supply unit is not too critical provided it is greater than the no load potential of the battery plus the voltage drop across D6. Therefore the unit was designed for 11V output. The value of C1 should be kept to about 220µF—otherwise a time delay in excess of 10 seconds will occur between mains failure and the flashing of the l.e.d. D8. This is important if the power supply is inadvertently turned off, and the unit is near the switch board.



Internal view of the Freezer Alarm

COMPONENTS . . .

Resistors

R1	39
R2	62k
R3, R4	48k (2 off)
R5, R11, R14	470 (3 off)
R6	30k
R7, R8, R10, R12, R13	24k (5 off)
R9	12k
R15	22k
R16	4k7

All resistors ½W 0·5% except where stated

Capacitors

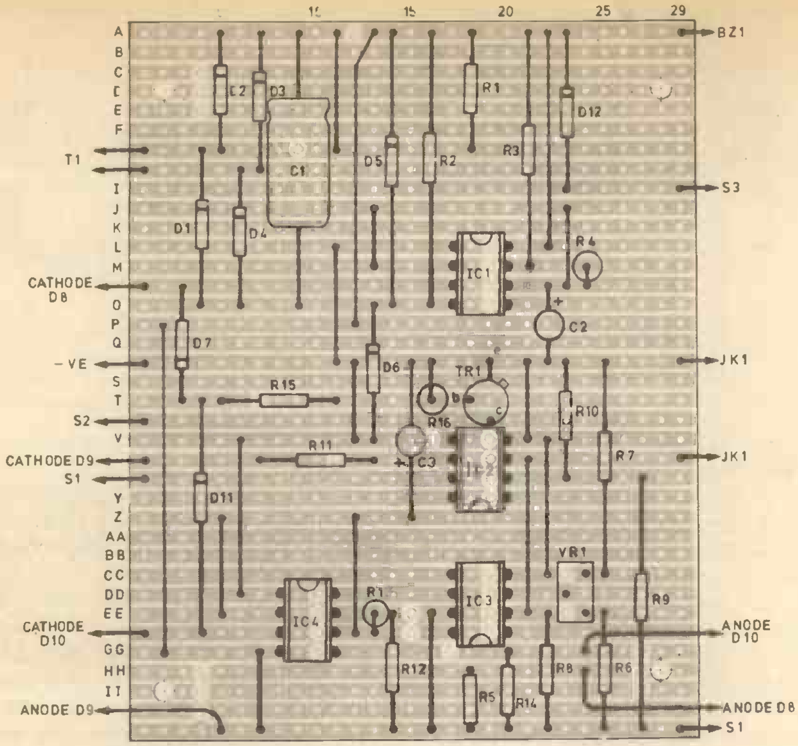
C1	220µ 16V
C2, C3	10µ 16V (2 off)

Semiconductors

TH1	VA1066S rod thermistor
D1–D4, D6, D7, D11, D12	IN4001 (8 off)
D5	BZY88 11V Zener
D8, D9, D10	TIL 209 l.e.d. (3 off)
TR1	BC109
IC1, IC4	NE555 (2 off)
IC2, IC3	741 op amp (2 off)

Miscellaneous

BZ1	Buzzer 12V 800Ω (Maplin)
T1	12V mains transformer
S1	push button
S2	S.p.s.t.
S3	Min slide switch
FS1	100mA fuse and holder
JK1	3·5 mm jack socket



EG146 A

Fig 2. Veroboard layout

A battery switch was added so that the unit could be turned off during de-frosting.

CONSTRUCTION

The circuit was assembled on a piece of 0·1in matrix Veroboard and a suggested layout is shown in Fig. 2. The board and mains transformer were mounted in a pressed aluminium box measuring 150 x 100 x 50mm deep. The circuit board was spaced off the floor of the box on plastic collars. They were made by cutting the barrel of a ball point pen into 6mm lengths.

The internal layout of the aluminium box and front panel were arranged to be suitable for sitting on top of an upright freezer. Constructors with chest freezers may wish to devise their own internal layouts, for example to make the unit suitable for wall-mounting. The layout was detailed so that no wires were attached to the lid of the box, thus making battery replacement simple.

Two wire links are required which are not shown on the Veroboard layout: BZ1 to S2 and S3 to +9V.

THERMISTOR PROBE ASSEMBLY

The thermistor was mounted on a small piece of Veroboard and thin wires were anchored and soldered to the board. The board and thermistor were then covered with Araldite.

Providing the wires are thin enough, they can pass between the freezer cabinet and door or lid without causing any problems. Connection to the unit was by a 3·5mm jack plug and socket.

When finished, it is advisable to measure the resistance of the probe to ensure that there are no short circuits, and to see that the resistance changes with temperature.

SETTING UP

The freezer should be maintained at a temperature of −18°C or less. The unit was designed to trigger at about −10°C, thus giving some margin before setting off the alarm. The higher the trigger temperature, the less warning time is available.

The ice box of the refrigerator was used for setting up the unit. The probe and a freezer thermometer were positioned in the ice box, and the thermostat of the refrigerator was gradually lowered until the thermometer read the desired temperature. VR1 is adjusted so that the unit is just triggered.

Finally, it is advisable to plug the alarm unit into the same socket as the freezer! ★

AF/RF SIGNAL GENERATOR

TROUBLE shooting radios or audio gear can be a time consuming task, particularly without the aid of proper test gear. The same can be said of design work.

One of the most valuable instruments must be the signal generator. The unit described here is a versatile little thing with a square wave output over the a.f. frequencies which should prove useful for those jobs where portability and a wide frequency range are advantageous.

Whereas a.f. signal generators are two a penny, r.f. generators are generally not so common—and they are expensive to buy or make. This unit tries to bridge the gap in that it provides 1kHz to 25kHz on one control, and 25kHz to 3MHz on the other; all done with one chip and a few discrete components.

THE ZN459

The ZN459 is a wide band low noise amplifier. What's a nice chip like that doing in a circuit like this, I hear you say. Well, with its high gain and wide frequency band, it oscillates at around 500kHz with no input. This natural ability to oscillate is the basis on which the signal generator is built. Varying degrees of both positive and negative feedback are applied to the input to produce controlled oscillations.

CIRCUIT DESCRIPTION

The complete circuit diagram for the signal generator is shown in Fig. 1. The ZN459 is operated at about 4V supplied by R1 and decoupled by C1. The output from IC1 drives TR1 via R2 and C2, and provides base bias. TR1 has a dual function; it provides buffering for the output, and introduces a phase shift in the output signal, which is taken from its collector.

The output is taken from across R3. L1 prevents any r.f. coupling through the battery.

SPECIFICATION

Frequency coverage	**1kHz to 3MHz**
Range 1	1kHz to 25kHz
Range 2	25kHz to 3MHz
Output voltage	2·5V peak-to-peak
Current consumption	3mA

Fig. 2 shows the feedback paths in simplified form. With the wiper of VR1 turned fully to C3, the high frequency output from IC1 is fed back into the input. Because of the internal phase shift in the i.c. at high frequencies, this signal is in phase with the input. Oscillation increases until a maximum

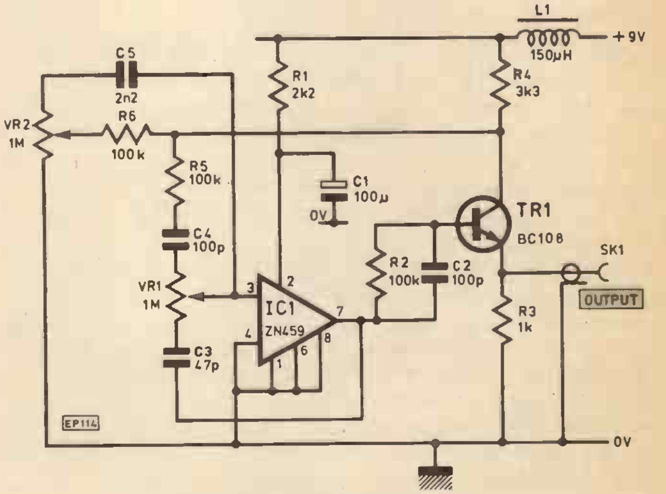


Fig. 1. Circuit of Generator

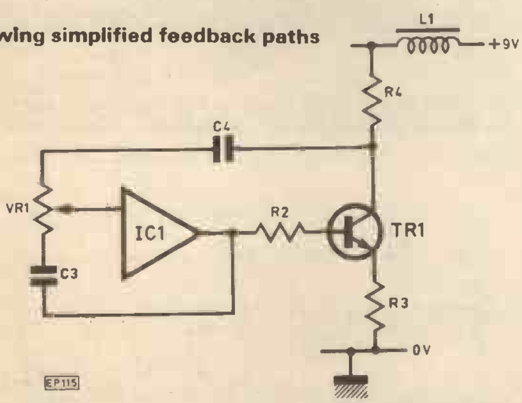
J.Gerrard

frequency is reached governed by the value of C3 and associated circuitry. Turning the wiper of VR1 to C4 decreases the feedback applied by C3, and increases the feedback via TR1 and C4. Because the output of the i.c. is out of phase with the input at low frequencies, taking the signal from the collector of TR1 and applying that to the input provides positive feedback at low frequencies. C4 determines the low frequency limit. Referring back to Fig. 1, R5 is in series with C4 to keep the mark/space ratio of the oscillations fairly even at low frequencies. C5 and R6 apply more feedback from TR1 through VR2, thus reducing the frequency of oscillations still further.

The components are mounted on a piece of Veroboard 75mm x 30mm (Fig. 3). The potentiometers should be put on last of all. The type used on the prototype were Radiohm, and it was found necessary to enlarge the holes for the pots with a 1·2mm drill. Care should be taken when soldering to prevent accidental shorts, and excessive flux between tracks should be cleaned off. The author finds an old toothbrush and white spirit very effective.

Keep the component leads as short as possible to avoid stray r.f.

Fig. 2. Showing simplified feedback paths



If the Veroboard layout is changed, and the pots mounted off the board, there may be trouble with stray capacitance. The board, BNC output socket and switch should be mounted in an all metal box for screening. For the prototype a 40 x 100 x 70mm aluminium box was used, with the pots mounted on the lid. These were considered sufficient support for the board.

There is plenty of room for the 9V battery. In fact, if the unit were to be used for long periods, two batteries could be utilised, with a double pole on/off switch.

The board should be checked over for errors. Then, if all is in order, the signal generator should be connected up to an oscilloscope and frequency meter if available. Check that there is about 4V across pin 2 and 0V; the total current consumption should be about 3mA. The frequency controls are adjusted so that they work in series. For example, for a frequency of 25kHz or less, VR1 is turned to 25kHz, and VR2 to the required frequency. For over 25kHz, VR2 is turned to 25kHz and VR1 to the required frequency. The output voltage should be 2·5V peak-to-peak, measured at 1kHz. The unit should produce a good square wave up to 25kHz.

Calibration should ideally be done with a frequency meter, but if one is not available compare the signal generator frequency to that of a known one. Alternatively, for r.f. calibration a wire from the output thrown over a radio can be used.

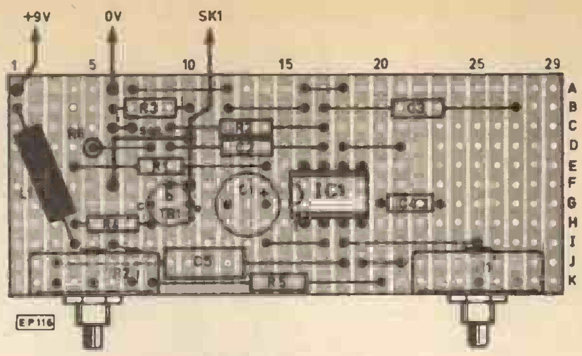
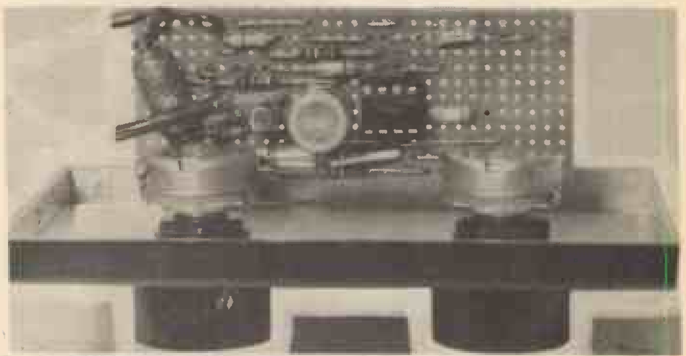


Fig. 3. Board layout

The radio is tuned into the signal generator's frequency, and the reading taken off the radio tuner.

When using the unit, loading should be kept to a minimum of 10kΩ, as the frequency does vary with load. It also varies with supply voltage, and this could be largely overcome by using a Zener regulated supply, at the cost of greater current consumption.



Resistors

R1	2k2
R2, R5, R6	100k (3 off)
R3	1k
R4	3k3

All ¼W 5% carbon

Capacitors

C1	100µ 16V elect
C2, C4	100p
C3	47p
C5	2n2

Semiconductors

IC1	ZN459
TR1	BC108

Potentiometers

VR1, VR2	1M (2 off)

Inductors

L1	150µH

Miscellaneous

BNC output socket, on/off switch, metal case, 9V battery, battery connector, holder for 8 pin i.c. (if required), Veroboard 0·1 in matrix, knobs (2)

Should an output voltage control be required, R3 could be replaced by a 1kΩ pot with the wiper going to the output socket.

Although the prototype oscillated up to 7·5MHz, it was only calibrated up to 3MHz, because of the cramping of frequency above this. With a little thought, a fine tuning contol could be connected around VR1 to make these frequencies available.

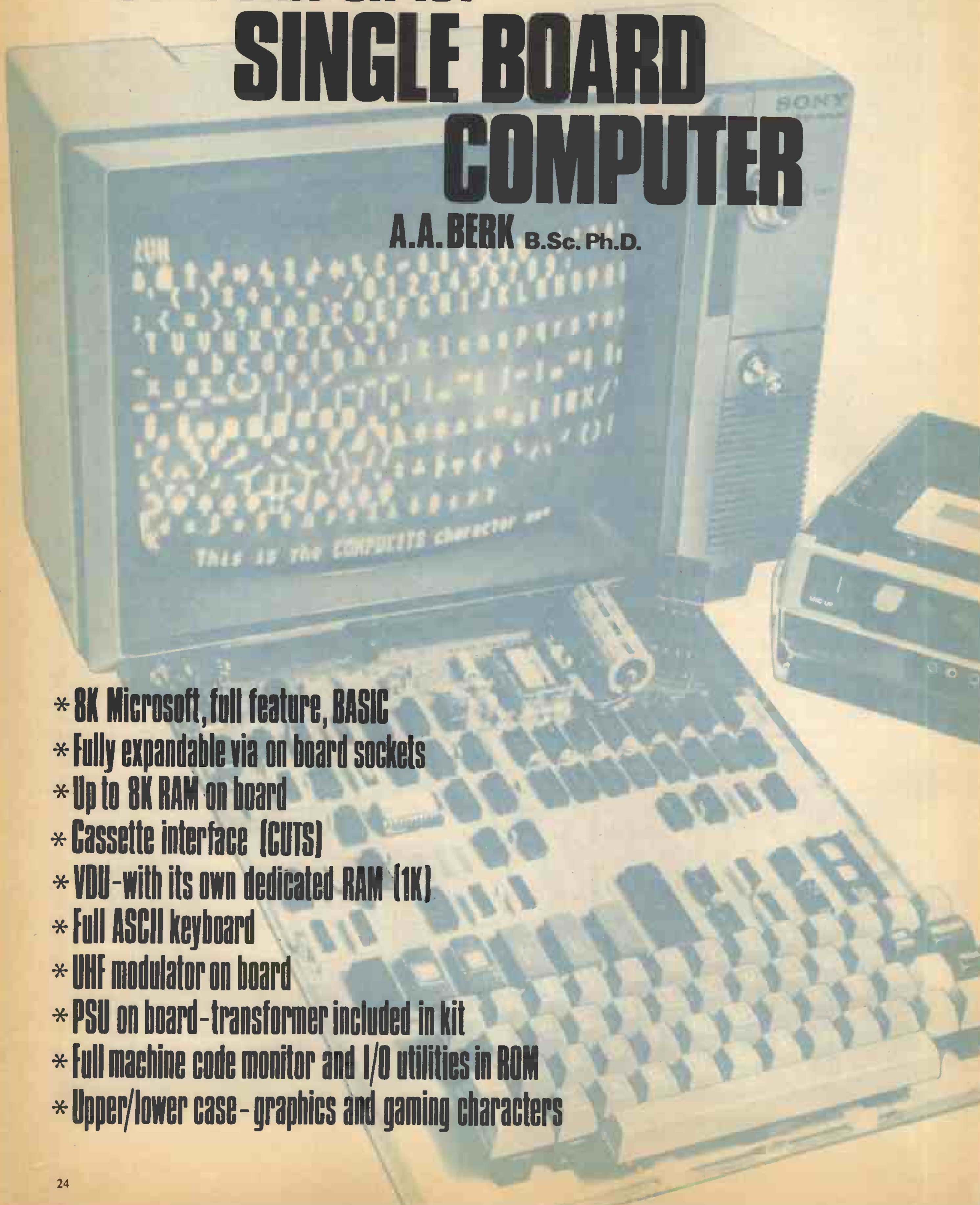
The harmonics generated by the unit go well past 100MHz, making it suitable for f.m. radio and TV work.

When using the unit at r.f. frequencies, it should be earthed, and for direct coupling into a radio, for example, a small capacitor should be connected in the output.

Although this unit is by no means a precision generator, for its size and cost to build, it should prove to be a useful tool in the field or at the workbench. ★

COMPUKIT UK 101
SINGLE BOARD COMPUTER

A.A. BERK B.Sc. Ph.D.



* 8K Microsoft, full feature, BASIC
* Fully expandable via on board sockets
* Up to 8K RAM on board
* Cassette interface (CUTS)
* VDU-with its own dedicated RAM (1K)
* Full ASCII keyboard
* UHF modulator on board
* PSU on board-transformer included in kit
* Full machine code monitor and I/O utilities in ROM
* Upper/lower case-graphics and gaming characters

THE COMPUKIT UK-101 has been prepared to provide all sectors, from the amateur constructor/hobbyist to the engineer, programmer, teacher, business man and scientist, with the cheapest computer on the market which is programmable using an 8K BASIC package. In addition, it is fully expandable, capable of being programmed in machine code, and absolutely complete from mains input to TV Aerial feed output. It includes full typewriter-style keyboard, printer, and cassette-storage interface. The BASIC package employed is the industry standard Microsoft interpreter, and will run much of the available software for many other more expensive machines on the market with little modification. Floating-point calculations in this BASIC are extremely fast and versatile, making scientific calculation projects of the most complex kind perfectly feasible in one's own home. The areas of suitable use for the COMPUKIT stretch fully across the board.

The business man will find that the string handling facilities and excellent video display of the COMPUKIT make the machine perfectly fitted for everything from general accounts and planning calculations, to formatting of invoices and stationery to be printed out on hard copy when complete.

The Statistician will find that the high speed of calculation with facilities such as random number generation and user-defined functions, enable analyses of data and simulation of models to be performed particularly easily. The results may then be displayed with the graphics available in almost any form from bar-charts to tree-diagrams!

The Engineer wishing to control equipment with a computer, will benefit from being able to write the necessary routines in BASIC (making the software easy to design) while being able to jump to fast and efficient machine-code routines for servicing external hardware.

Perhaps most importantly; for the first time, anyone, technical or otherwise, can have an affordable easily programmable home-computer for domestic use—a much neglected area at the moment, but one which is about to take off.

Imagine being able to run a program to help your child (or yourself) revise for exams. Animated diagrams are possible, such as an internal combustion engine shown reciprocating, with mathematical equations to match. Picture an *automobile* program designed to accept daily input from you on petrol and oil use, along with mileage, etc. The machine could accumulate information, and at any time give you the average m.p.g., plot performance versus time or some other parameter, and remind you when to check the tyres and drive to the Garage for a service.

The UK-101 introduces itself at switch-on.

- ★ ***Based on the popular 6502 micro***
- ★ ***Supports all Ohio Scientific expansions including floppy disc***
- ★ ***Fast resident BASIC***
- ★ ***Total of 19K addressable memory on p.c.b.***
- ★ ***Memory mapped VDU. Line width selectable from 16 to 49 characters by 16 lines***

IMPROVEMENT

This computer is based on the Ohio Scientific Superboard *(reviewed PE June 79)*, which only displayed 23 characters per line on a normal TV, and produced the USA standard 60Hz frame frequency unsuited to UK TVs. These and other disadvantages have been rectified in the COMPUKIT UK-101. For example, the keyboard has been altered to show certain missing characters on the Superboard, and the BREAK key is less prone to accidental operation.

This month, the COMPUKIT hardware is briefly described in block diagrammatic form, along with some technical details of the 6502 Microprocessor. A section on the specifications of the BASIC package is included, for which the reader will require some previous knowledge of BASIC—a library book would be useful at this point for those just beginning in the world of programming.

A BASIC primer article is to be published in this magazine very soon and will help with an understanding of this very popular microcomputer language.

HARDWARE

Based around the 6502 MPU and a set of binary counters as clocks, the COMPUKIT has been designed and set out to be as flexible and easily modified as possible while making no compromises for those who will only use the machine as it stands.

The 6502 is a reasonably typical 8-bit microprocessor with a 16-bit address bus and 8-bit data bus (see Fig. 1) and the control lines are similar to the 6800. There are two interrupt lines: IRQ and NMI. When forced low, the latter will interrupt execution at the end of the current instruction cycle and branch to a routine whose address (vector) is stored in two bytes at the top of memory. IRQ is similar but may be rendered inoperative by setting (to "1") the MASK flag of the P-register. RES is a reset line whose vector is also stored at the top of memory.

There are five more control lines which have the following effects. R/W informs the system as to whether a READ or WRITE operation is being performed. SYNC is used to identify an Op-Code fetch cycle. RDY is used to halt the processor for DMA or slow memory, etc. S.O. is a line which may be used to set the Overflow bit in the P-Register. Ø1out and Ø2out are system clock lines.

Other pins on the MPU's 40-pin package are used for Data, Address and Power Supply (+5V).

The register set of the 6502 is smaller than that of the 6800 and Z80 as only one primary accumulator is included and there are no 16-bit data or index registers available to the user. This is partly made up for by an enhanced set of addressing modes which use pairs of memory locations to hold addresses. However, there are no 16-bit Load, Store or Compare instructions to manipulate these pairs directly and all such operations must be constructed from 8-bit arithmetic operations.

WARNING: Computing is highly addictive.

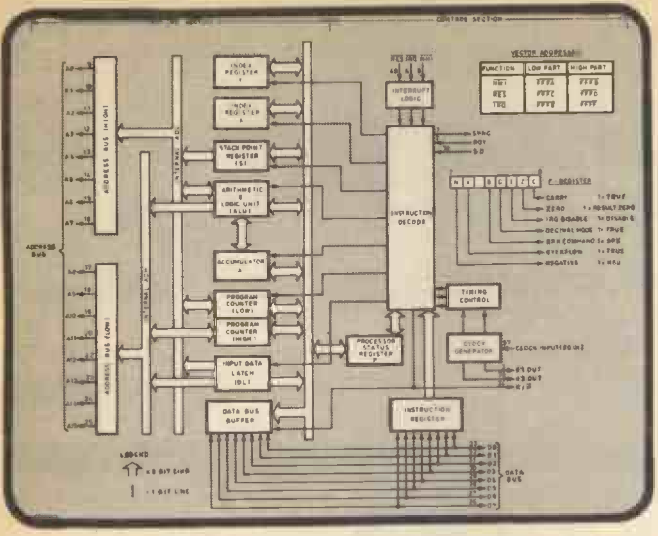


Fig. 1. 6502 internal architecture

The Stack is implemented in Page One (the second 256 bytes of memory), as the Stack pointer is only of 8-bit length—a ninth bit exists but is permanently set to "1".

Page Zero (the first 256 bytes of memory) is very heavily used by the 6502 instruction set as its two Index registers are both 8-bits in length. However, as referred to above, indirect addressing exists whereby an instruction may take its effective address for execution from a pair of bytes, stored anywhere in memory. Various Offset modes exist using the index registers. In this way, pairs of memory locations act as 16-bit registers; but, again, they are not able to be manipulated with 16-bit instructions. Try writing a program to clear a block of memory greater than 256 bytes in length and you'll see what I mean!

If you have worked on the Z80 or 6800 you will find certain aspects of the 6502 code most frustrating while others you will discover to be something of a breakthrough. Readers who are used to the SC/MP or 1802 instruction set will probably be most surprised at the difference when working on such an advanced machine.

The speed of processing is similar to the Z80 and 6800 and all three exist in various speed options. One interesting point is the 6502's "rise to power" as probably the most widely used Micro on the market. APPLE, PET and KIM all use the 6502 and there are several other 6502-based systems in the pipeline, all of which implies that the software backup for the 6502 is very wide and increasing in size.

SYSTEM DESCRIPTION

The Block Diagram, Fig. 2, shows the main parts of the COMPUKIT in a condensed form. The heart of the system is a set of binary clocks fed from an 8MHz crystal controlled clock generator. The clocks are not only used for the MPU but form the main control for the VDU, which is continually polling the VDU RAM for information to be displayed at exactly the right time on the screen. Those familiar with the PE VDU (*P.E. Oct.–Dec., 1978*) will note that the clocks perform most of the functions associated with the Thompson CSF Cathode Ray Tube Controller chip.

The most dominant block on the diagram, is in fact the VDU—a fairly typical memory mapped system run from the binary counters. The screen of information to be presented is stored in the VDU RAM in a binary-coded form (ASCII) for the 128 ASCII characters, and extended to include codes for the various graphic characters (128 in all) available on the COMPUKIT.

Address bits are sent to the VDU RAM from the binary counters in sequence starting at the location to be displayed at top left of the screen. As the counters ripple through all the addresses, the full screen of (theoretically) 1024 characters is accessed and the data at each location passed on to the character generator which interprets it as video dots to be displayed on the TV. Each character occupies 16 TV lines (in pairs to form eight vertically arranged dots) and the binary counters supply the necessary counting information along the character generator row-address lines.

When the MPU wishes to interrupt this process and access the VDU RAM, it switches the Address Switches and tri-state buffers over to the MPU Buses.

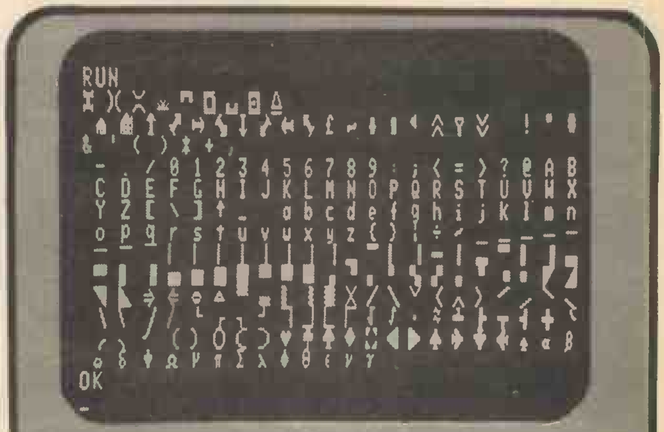
In order to display the information from the character generator on a TV, it must be serialised by the Parallel In Serial Out (PISO) device, mixed with Frame and Line synchronisation pulses, converted from TTL levels and fed to the UHF modulator. The output may then be plugged directly into a TV aerial socket and the TV tuned to around Channel 36.

The Sync. pulses for the TV are generated by a set of monostables from the main binary counter chain and the design includes a display-blanking stage to prevent MPU access to the VDU from causing excessive "noise" on the screen. This allows fast real-time updating of the video information without upsetting the display.

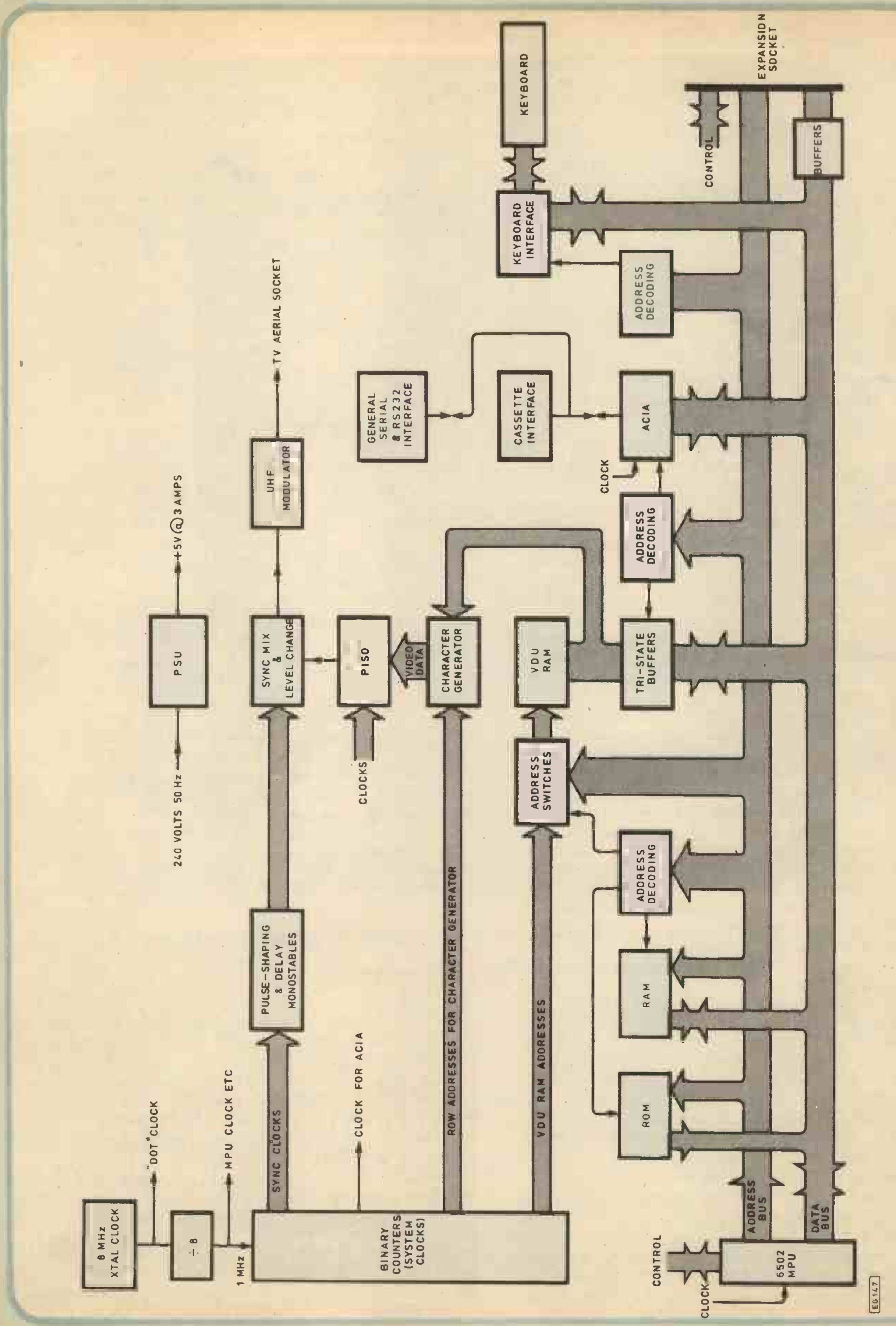
The VDU *Dot* clock on the COMPUKIT oscillates at 8MHz, which is fast enough to display about 48 characters per line on a normal TV. 768 characters are thus displayed on the 16 lines. The rest of the 1024 remain "hidden" off the screen but are perfectly valid Read/Write memory locations. This number of characters keeps the bandwidth down to a value acceptable by the I.F. stages of all domestic sets, and straight video need never be used due to the resulting excellence of definition in the characters displayed by the COMPUKIT.

The "hidden" characters of the VDU are never used by the BASIC interpreter, of course, as the software is carefully modified to use just the 49 characters per line which appear. The number of characters thus used per line is also selectable by the user for those TVs which will only comfortably display 48 or less characters across their screens.

The other sections of the COMPUKIT are shown connected to the Address and Data buses as well as to Address Decoding logic which selects each block as its address comes up on the Address Bus. The various control lines are omitted for simplicity.

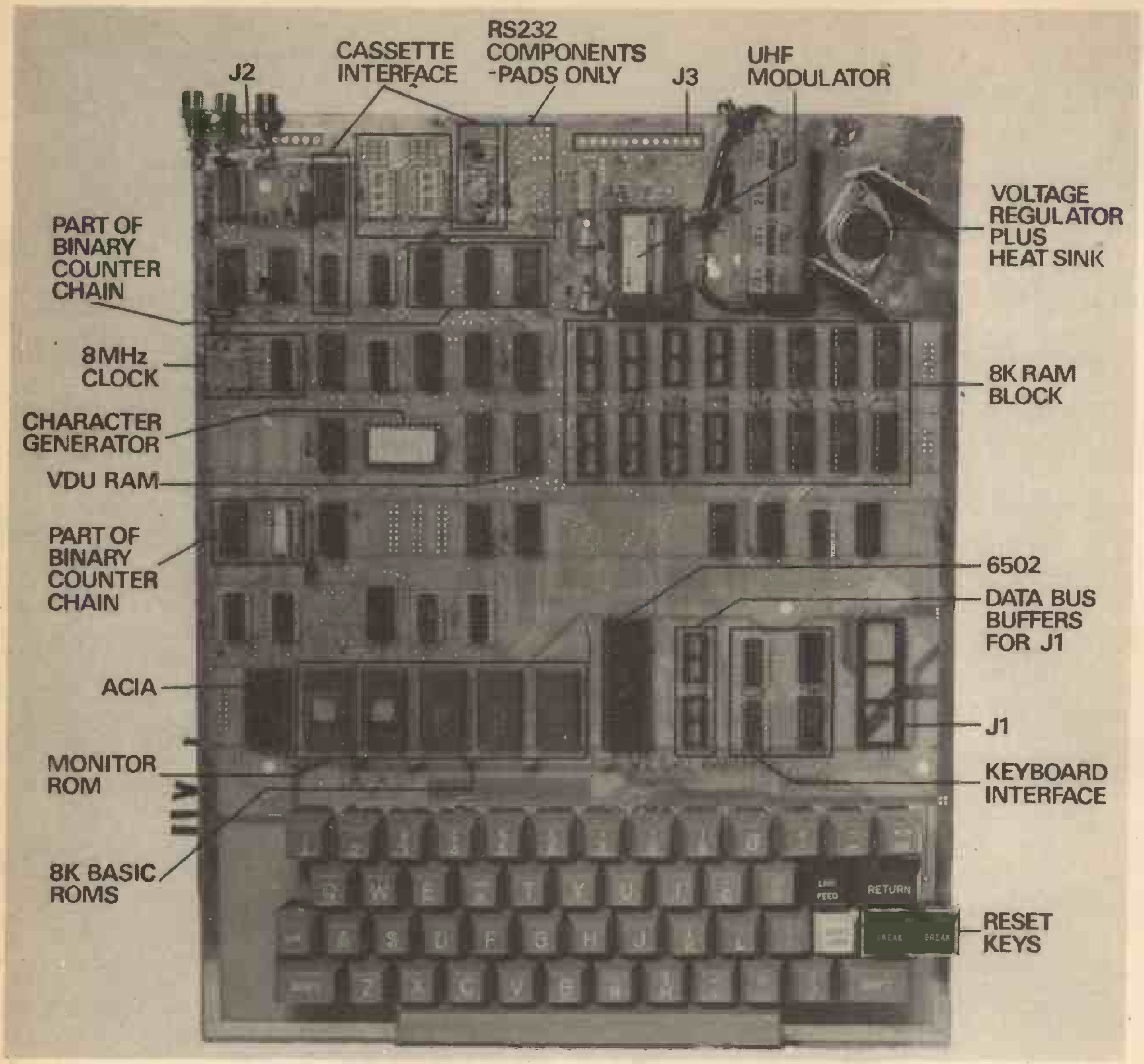


The full character set. Note that alpha-numeric characters are vertically spaced to give uncluttered lines of text, but graphics characters join together to allow pictures to be formed.



UK-101 COMPUTER

Fig. 2. Block diagram



The COMPUKIT UK-101 board. A transformer is supplied but does not mount on the p.c.b.

(Note that this is the prototype board)

The Bus lines are controlled and operated by the 6502 MPU which derives its instructions from the ROM and RAM blocks which take up between them 18K of memory. 2K of this is a Monitor (operating system) with BASIC support, keyboard handling, machine-code monitor, floppy-disc bootstrap, etc. 8K is the BASIC interpreter and 8K is for the RAM block, of which around ¾K bytes are used as a scratchpad by the various ROM-based programs.

Another important block is the Asynchronous Serial Communications section—including the cassette interface. This is driven by an ACIA (Asynchronous Communications Interface Adapter—the 6850 chip). The clocking comes, of course, from the binary counter chain and may be fed from higher up the chain to effect faster transfer speeds than the 300 BAUD for which the system is set up. In addition, there is provision, on board, for a RS232 interface run by the same software as the Cassette. This allows connection of the system to any standard serial device from teletypes to modems and extra VDUs.

The keyboard section is also shown connected to the Data Bus and Address decoding, and this is run by software scanning for speed and efficiency. The software scans the keyboard for a key-closure and identifies the character being accessed from ROM.

Finally, and of great importance, is an expansion socket (40-pin d.i.l.) for the Address, Data and Control lines to allow expansion to a separate Motherboard. This could easily be extended to the S100 Bus, but is plug-compatable with the Ohio Scientific OSI-48 Bus and Floppy-Disc interface. Anyone wishing to use the COMPUKIT for control purposes will find the expandability via this socket of great assistance.

The 5V Power Supply Unit (PSU) gives 3 amps.

COMPONENTS . . .

Resistors

R1–R12, R68, R80, R81	4k7 (15 off)
R33	6k8
R34, R50	15k (2 off)
R37, R55, R63, R64	10k (4 off)
R35	560
R36, R60, R61, R65	470 (4 off)
R51, R74	270 (2 off)
R52, R54, R59, R72, R82	1k (5 off)
R53	22k
R56	100k
R58	560
R62	100
R67	27k

All $\frac{1}{4}$W 5% carbon film

Capacitors

C6	150p ceramic
C7, C12, C55	1n mylar (3 off)
C8	100n mylar
C9	68p ceramic
C10, C13	10n mylar (2 off)
C11	1µ mylar
C48	220n ceramic
C57	27p ceramic
C58	47µ electrolytic
C59	3,300µ electrolytic
C60	100p ceramic
remainder	100n disc ceramic (31 off) (These are all supply decoupling capacitors)

Diodes

D1–D10	1N914 (10 off)
D15	1N4001
D17, D18	Any 3A rectifier diode (2 off) (1N5401 will do)

Integrated Circuits

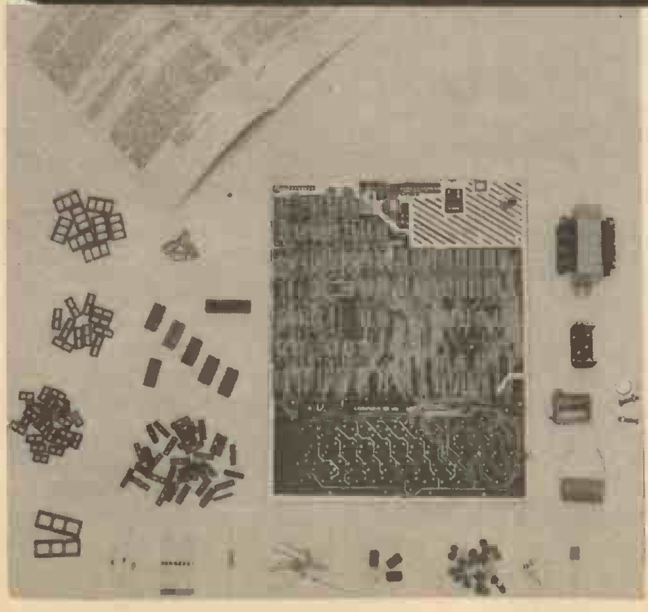
IC1	Any 5V, 3A TO3 type regulator
IC2, IC3	74LS75 (2 off)
IC4, IC5	74LS125 (2 off)
IC6, IC7	8T28 (used only for expansion)
IC8	6502 microprocessor
IC9–IC12	ROMs for BASIC (4 off)
IC13	ROM for monitor
IC14	6850
IC15	7402
IC16, IC18, IC21, IC62	7404 (4 off)
IC17	74LS139
IC19	74LS20
IC20, IC22, IC23	74LS138 (3 off)
IC24, IC25	8T28 (2 off)
IC28, IC65, IC69	74LS123 (3 off)
IC29	7493
IC30, IC59–IC61	74163 or 74161 (4 off)
IC31–IC40, IC45–IC52	2114 (18 off)
IC41	00000 Character Generator
IC42	74165
IC53–IC55	74LS157 (3 off)
IC56	7420
IC57	74163
IC58	7400
IC63	7474
IC64	7476
IC66	CA3130
IC70	7403

Miscellaneous

d.i.l. sockets

40-pin	2 off
24-pin	7 off
18-pin	18 off
16-pin	21 off
14-pin	13 off
8-pin	1 off
FS1	3 Amp fuse plus holder
X1	8MHz crystal
UHF modulator	Astec 8MHz bandwidth
Double-sided plated-through p.c.b.	
Set of keyboard switches and key tops	
Regulator heatsink plus fixing screws	
Transformer—240V/50HZ: 9-0-9V 3A	

Please note that component numbers do not run contiguously



CONSTRUCTORS' NOTE

The *Compukit UK–101* is being produced by **Comp Components** (see advertisers' index), for £219 + VAT. This will include a full power supply on-board (including power transformer), and a UHF modulator. The graphic character set also includes such symbols as £ and π.

The p.c.b. is of a professional standard with plated-through holes and silk-screened component legends, and a full set of i.c. sockets is included in the kit price as is—with 4K of user RAM (a further 4K may be purchased to upgrade the board to its full capacity).

The Compukit comes with full manual (written by the author), but the beginner would be advised to obtain a book on BASIC, and perhaps even on 6502 machine code programming, as the Compukit manual is not intended to be a primer on either subject.

The computer is available for demonstration at Comp Components.

SOFTWARE

The machine accepts its instructions in the programming language called BASIC as well as 6502 machine-code. It is the use of BASIC which will be paramount and its specifications are given below.

There are many versions of BASIC (Beginner's All Purpose Instruction Code) for many different machines. There are Tiny BASICS, Integer BASICS, Double Precision BASICS, etc., etc. Minis and Main Frames usually offer a version of BASIC in Compiler form which includes all the Scientific and other functions plus the ability to manipulate matrices and Disc files. Few if any of these versions, however, allow direct manipulation of memory locations within the computer when programming or debugging. Access to machine-code routines is also a rather complex operation and use of the machine to control even such simple things as a bank of lights is usually impossible. It was not until the advent of the MPU-based computer with its feet firmly embedded in memory address decoding, machine-code programming and control applications that such interplay became common. BASIC has become the high-level language of the micro-computer, and interpreters rather than compilers are the normal implementation method. The interpreter's ease of use made it the order of the day and Microsoft's BASIC interpreter was born. This is a very powerful package and exists in many versions of which the COMPUKIT's is one of the very fastest.

It is quite different from the 1K and 2K BASICS with their incredibly restricted instruction sets. The COMPUKIT's version, as its name implies, occupies 8K (8192) bytes of the machine's memory and is stored in Read Only Memory (ROM). This type of memory has two advantages:

(1) The BASIC interpreter is not lost when the machine is switched off—indeed it is almost impossible to lose it short of crushing the chips in a vice.

(2) The language is available instantly upon switch-on and does not need to be loaded from some external medium into the machine's memory.

Other methods of offering BASIC include storage on disc. The COMPUKIT can be expanded (by a direct plug-in option) to run the Ohio Scientific's Disc System which comes complete with a powerful disc BASIC, as well as 24K of extra memory to run it in.

Despite the fact that the resident BASIC (in ROM) is at the top end of the scale for speed and sophistication, this does not mean that it is difficult to program. On the contrary, BASIC's use has blossomed for one paramount reason—it is sophisticated enough to satisfy the most technical user in industry, business and research while being remarkably easy even for total beginners to learn and use. The reader will recognise that most of the language is written in a kind of formalised logical English.

SUMMARY OF BASIC SPECIFICATIONS

There are three modes of use of BASIC on the COMPUKIT:

(a) Command mode
(b) Immediate-mode execution
(c) File-mode execution

The computer is said to be in the Command Mode whenever the message:

OK
—

appears. This is usually after a system Reset following initial power-up, or at the end of a program. The "—" is a cursor which moves around the VDU screen and keeps the user updated as to his/her position. In this mode, the following commands are allowed:

Software has unexplored dimensions awaiting the adventurous, and sophisticated games are possible which can be as much fun to devise as to play.

CONT (short for CONTINUE), LIST, NEW, NULL, RUN, SAVE, LOAD. These include editing, running programs, continuing after a Breakpoint and Cassette handling. Most of these commands may also form statements within a program.

Immediate mode of execution is similar to Command mode but involves normal BASIC statements which may be ganged together to form complete programs executed when the RETURN key is pressed. In this mode, for instance, the machine is available as a super calculator with Scientific calculations of great complexity able to be executed *immediately*.

To file program statements *for later execution,* and to build up complete programs, statements are given line numbers to distinguish them uniquely and place them in instruction sequence in the computer's memory. The finished program may be started by using the command RUN and this is termed File-mode execution.

STATEMENTS AVAILABLE

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

RELATIONS, OPERATION AND FUNCTIONS

−	**SUBTRACT (OR NEGATION)**	**NOT**	**Bolean operations from which complex logical functions may be constructed, e.g. IF . . . THEN**
+	**ADD**	**AND**	
•	**MULTIPLY**	**OR**	
/	**DIVIDE**		
↑	**RAISE TO THE POWER OF**		

>	**GREATER THAN**	>=	**EQUAL TO OR GREATER THAN**
<	**LESS THAN**	<=	**EQUAL TO OR LESS THAN**
<> (OR ><)	**NOT EQUAL TO**	=	**EQUAL TO**

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

The variables I and J denote integers and X denotes any number. This is a collection of scientific and other functions which includes calculation of the number of bytes left free for program storage, manipulations of address locations directly, and calls to machine code subroutines.

STRING FUNCTIONS

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

These functions allow a string of alphanumeric and graphic characters to be stored, manipulated, sorted, etc. to a very sophisticated degree. A numeric string may, for example, be converted to its numeric equivalent and back again. The use of all these BASIC statements will be clearly explained in subsequent issues of PE, for the benefit of the beginner.

VARIABLES, TYPES, ACCURACY

Numeric variable names may be any alphanumeric string starting with a letter and containing no special BASIC words. Only the first two characters define the variable. The number of variable names thus available is of the order of 900. String variables are similar but their names must end with a $. For example A1 is numeric and A1$ is a string. Numeric and string arrays are also allowed, and increase the already large number of variables available by a considerable factor.

An accuracy of $6\frac{1}{2}$ digits is used for Scientific calculations, and numbers from 10^{-38} to 10^{+38} are allowed. The computer automatically shifts into exponent form (Scientific representation) as necessary. String variables are from 0 to 255 characters in length. Both string and numeric arrays of several dimensions are allowed.

ABBREVIATIONS AND SPECIAL CHARACTERS

The character ? may be used instead of the word PRINT, and LET and END are optional, as is the variable in a NEXT statement under certain conditions. Spaces are irrelevant to the BASIC and colons may be used to separate statements on the same program line.

The above features allow fast programming with improved use of memory space, in addition, errors in typing may be deleted by use of the DEL key.

This completes the general overview of the system, and next month the details are given in full. Some details of programming in BASIC will be given and will be selected to "tie in" with the introduction to BASIC to be published in *P.E.* in the near future. 6502 machine-code is of a more specialised nature and the reader is well advised to buy a good primer on this subject along with a technical description of the 6502 if it is intended to use the machine at this level. Those with any expertise in machine-code programming on another machine will find that learning the 6502 code is quite simple however, and a 6502 data sheet will probably suffice.

HARDWARE AND SOFTWARE INGENUITY

In this series of articles, applications for the UK 101 will be suggested, and it is hoped that software houses will be interested in providing cassette packages for as many uses as can be dreamed up.

The hardware will also be described in such detail as to allow maximum freedom to modify or add to the basic design, and readers are welcomed to let us know of any software/hardware accomplishments or suggestions they may have.

KEYBOARD HARDWARE

The photograph shows the positioning of the keys on the keyboard; while Fig. 3 shows the arrangement of the keyboard switches and interface logic.

The keyboard looks like a matrix of 8 rows and 8 columns to the computer; the Rows being one *Write-Only* memory location, and Columns being *Read-Only*. These two occupy the same memory location (DFOO in HEX) and the computer distinguishes between Rows and Columns by writing to or reading from DFOO.

The MPUs R/$\overline{W}$ line is used to control WKB and $\overline{RKB}$ accordingly by some logic to be described next month.

Essentially, the software is designed to send a "walking bit" to R0–R7. Thus, the R0 line is set to a "1", then back to "0", followed by the same on the R1 line, and so on, up to R7 and back to R0 again. The "1" scans along the Rows waiting for a key closure to transmit it to a Column (one of the C0 to C7 lines). If character A on the keyboard is pressed, the contact time must be long enough for the "1" to reach R1 (a very short time at worst). The A key then transmits it to C6, and the Computer receives and processes an A character. The fact that the walking 1 was being sent to R1 and immediately received along C6 makes the A key unique. R0 is used to decode the control keys at the same time; thus, if R0 and C1 followed immediately by R1 and C6 is decoded, the computer receives a SHIFT A character. The encoding for the keyboard is thus stored in the Monitor ROM.

When the computer has written to a Row, the Data Bus switches to *Reading* from the Columns. Normally, therefore, the Row information would thus be lost and the 1 would never reach any of the Columns. Hence the reason for the latches IC2 and IC3 which store the walking bit long enough to be read from the Columns as necessary. The diodes on IC2 and IC3's O/Ps protect against multiple key closures shorting two or more O/Ps together. IC4 and IC5 are tri-state buffers which ensure that the keyboard information is presented to the Data Bus only when the computer is reading the Columns, otherwise the keyboard would present its information at a time when the Bus was being used elsewhere, thus causing an electrical conflict. Pull-up resistors are included on the inputs of IC4 and IC5, as C0–C7 are open circuit most of the time.

The keyboard decoding is thus dependent upon a particular program in the Operating System, and whenever that routine is inoperative, for instance while certain parts of a user's program are under way, the keyboard is unusable. However, the INPUT statement in BASIC allows the operator to input data via the keyboard during a program. In addition, the address of the keyboard routine itself is available for use via the USR function within a BASIC program.

The only two keys not mentioned in the diagram are the two BREAK (or RESET) keys. These connect directly to the RESET line of the MPU and must *both* be pressed to reset. This prevents accidental breaking in most circumstances.

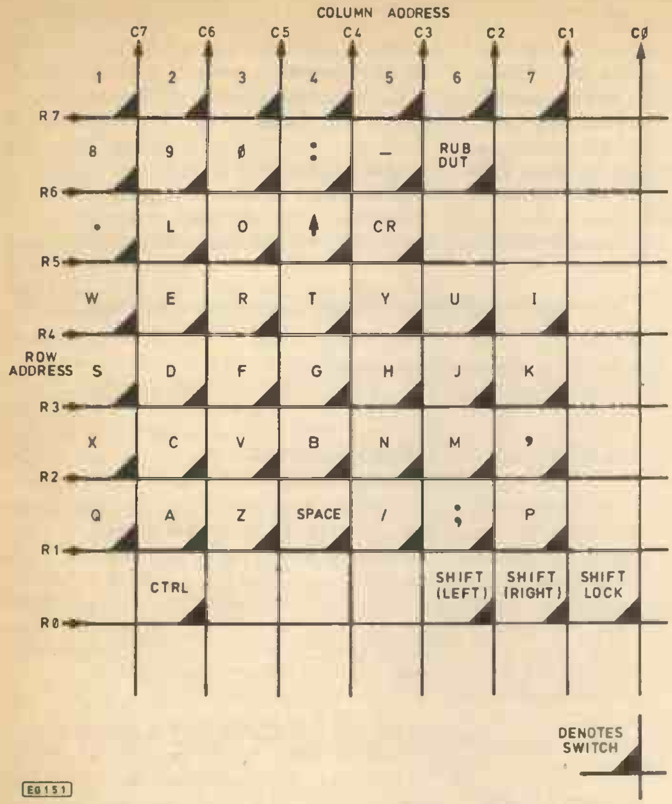
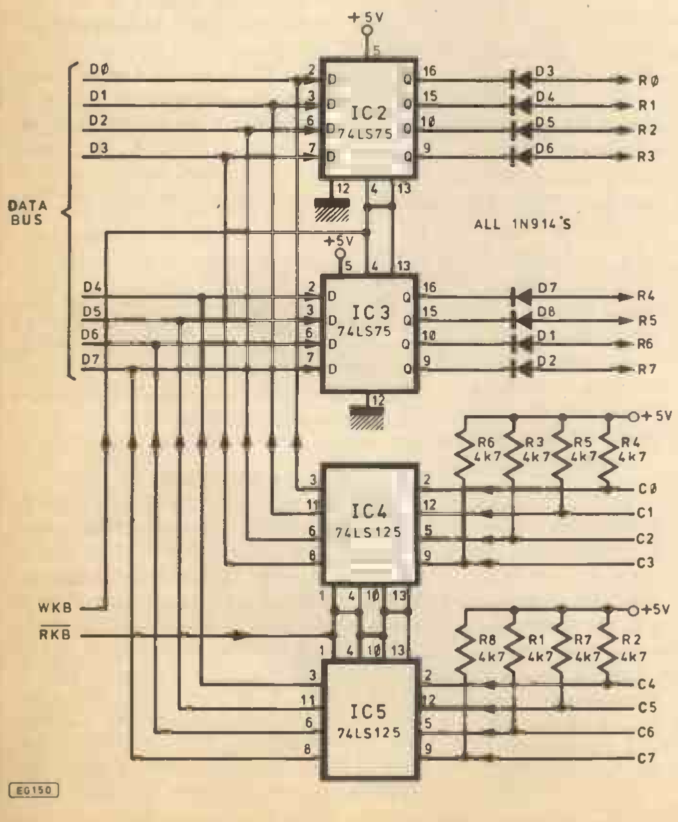


Fig. 3. Above: Keyboard switching matrix
Below: Keyboard interface circuit



POWER SUPPLY UNIT

The power supply is very straightforward since the Compukit is a single supply device with distributed capacitive decoupling on the board. All but the transformer are mounted on the p.c.b. and a heat sink is provided for the 5V regulator. The photograph shows the extent to which supply noise decoupling is allowed for on the p.c.b. 100n capacitors appear at the most important places to prevent spikes and crosstalk being transmitted along the power lines.

The PSU also has a 3A fuse and a polarity compliance diode to give some protection against accidentally reversing the +5V and 0V lines by those using an external PSU for any reason.

The UHF Modulator used on the board is the 8 MHz Astec device which gives an excellent output when supplied with five volts. This device was chosen to ensure that the p.c.b. remained a single-supply system.

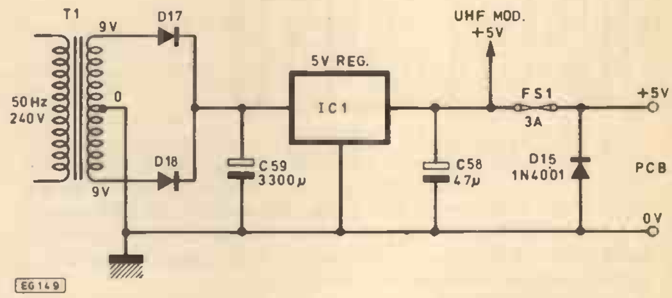
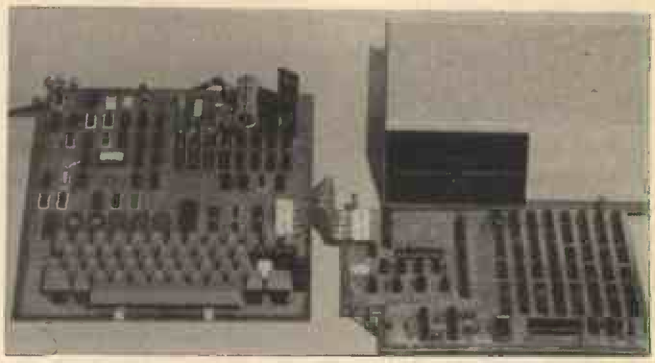


Fig. 4. Power supply circuit diagram



The UK-101 working happily with a floppy disk.

NEXT MONTH: Constructional details of this powerful computer are given, so learn computing the comprehensive way, using a high level language and working down to hex code programming. The UK-101 is capable of both!

FRANK W. HYDE

END OF TASK

The third small astronomy satellite launched by NASA ended its task and life by burning up over the Pacific Ocean in April. During its lifetime it made important discoveries which are being studied at the Massachusetts Institute of Technology and the Smithsonian Astrophysical Observatory.

The satellite was launched in 1975 and placed in a 500km circular orbit. It was designed for a life of one year but in fact lasted three times that period. Data was continuously returned up to the time when atmospheric drag (accentuated by the rise in sun-spot activity) ended in the decay of the orbit to burn-up destruction of the satellite.

Several X-ray sources were discovered and also two quasars. The most interesting objects discovered were the X-ray 'bursters'. These objects have the characteristic of giving short intense bursts of X-rays. Such is the intensity that in some cases bursts appear, at intervals of a few hours, at a level of 100,000 times the intensity of the Sun in a fraction of a second, and then fade away over a period very much greater. A theory offered in explanation of these events, and this is supported by other satellite observations, is that the bursts of energy derive from thermo-nuclear reactions. About 35 such 'bursters' are now known; more than half of them were discovered by the satellite.

The astronomy satellite also discovered an X-ray burster which emitted bursts several times a minute. The nearest of this type of object is about 15 light years distant.

INTERNATIONAL ULTRA-VIOLET EXPLORER

This spacecraft is an astronomical telescope in a geostationary orbit which has been used recently by the European Space Agency to look at a new supernova. The supernova was observed by an American amateur astronomer Gus E. Johnson of Swanton, Maryland. He has the distinction of being only the third person in history to have made a direct observational discovery of a nova in another galaxy. Gus Johnson was observing NGC 4321, number M100 in the Messier catalogue. Using his eight inch telescope he saw a 12th magnitude star southeast of the nucleus of the galaxy. It is not possible to see the nova with the naked eye. Its distance is about 100 million light years; what is being seen now happened 100 million years ago.

The European Space Agency, ESA, have observed rapid changes in the ejected material of the nova and modified spectral features similar to those found in earlier examples. Also there was shown the absorption of ultra-violet emission lines. These lines are similar also to that found in the interstellar gas in our own galaxy.

The satellite is controlled through the tracking station at Villafranca near Madrid. The US contribute the major share of the cost, other funding coming from the ESA and British Science Research Council. Access to the International Ultra-Violet Explorer is divided between NASA at the Goddard Spaceflight Centre in Maryland and the ESA's station at Villafranca. This spacecraft was launched last year.

THE SHUTTLE—TOWARDS THE LAUNCH

The Orbiter named Enterprise was moved from the assembly pad to launch pad 39A at Cape Canaveral at the beginning of May. It consisted of the Enterprise assembled on the external tank and a pair of Solid Rocket Boosters, SRBs. It is proposed to use the Enterprise to prepare the way for Orbiter Columbia which will make the first flight. The gross lift-off weight of the shuttle is a little over 2,000 tonnes. The shuttle is fixed to the launch platform at four hard points at the base of each SRB.

The purpose of the launch pad trials with the Enterprise are to check procedures and mechanical clearances. One important part of the tests will be that of opening and closing the payload bay doors while the shuttle is in the vertical launch position. This appears to be a vital stage because in the procedure of the first launch the payload will be loaded at a late stage. It is expected that a number of launches will take place in this position. Though some launches may be requested in this manner it is thought that it may be a procedure to save time between successive launches. It is probable that after the tests have been carried out Enterprise will be refurbished for a mission later.

The last date for the first launch was scheduled for September 1979 and the success of the tests will determine the exact date for the first mission, which is now thought to be for November. The completion for the work on Columbia will naturally be the determining factor. Columbia left the Rockwell plant in March but there remained a number of things to be done and some of the temporary work has led to certain difficulties. A very considerable number of man hours are required to bring matters to the right timetable, something of the order of 70,000.

The attitude control system used in orbit is erected below the cockpit windows and had to be removed in order that the propellant could be loaded. Columbia is fuelled by hypergolic propellants. These are mono-methyl, hydrazine and nitrogen tetroxide. These are subject to ignition on contact.

Other work involved in preparation was the powering of the electrical system and connecting up the automatic test systems. There were no problems. The data processing and warning systems were also tested. The test instrumentation has a very extensive task, for this is to give vital information as to stresses, acoustic levels of vibration and temperatures. Installation of the fuel cells for electrical power has yet to be accomplished. An auxiliary power unit is an important item for installation since this is to be used for the operation of the control surfaces during ascent and descent. All this could mean that the final date for the first launch will be delayed until 1980.

Meanwhile the two astronauts John Young and Robert Crippen, the first pilots of the Space Shuttle Age, continue to prepare. Many programmes have already occupied their time in the simulator and the remaining programmes are now being studied and practised.

THE SECOND FLEET SATCOM

The United States Navy's new fleet Satcom was launched from Cape Canaveral on May 4th 1979. This was one day later than set because of certain last minute confirmation checks. Two days after launch the apogee 'kick' motor boosted the satellite from its transfer position to the geostationary orbit.

The satellite will provide radio links between ground stations, ships, submarines and aircraft. It will be controlled by the USAF at its own centre at Sunnyvale, California. The USAF will use the facility for ground to air communications but the Navy has independent access.

The coverage is the eastern United States, the Atlantic Ocean, Europe and a part of Africa. The position of the satellite is at the geostationary longitude 23°West. Three more such satellites will be added at the rate of one a year. The average life of each one is of the order of five years.

VENUS

The first full disc view of Venus has been provided by the Pioneer Venus Orbiter. The direction of the clouds clearly indicate to east-west rotation of the planet, that is retrograde. It was taken from a distance of 65,000km from the planet.

THE FALL OF SKYLAB

By the time this is in print Skylab might be down. British and American satellite experts forecast Skylab's re-entry at 1st, 2nd, 10th or 20th July. Of the 20 tonnes of fragments falling at 320km/h the largest pieces likely to pass through our atmosphere are: a lead film vault weighing 1,800kg, an aluminium airlock shroud of 2,250kg and six oxygen tanks at 1,215kg each. A total of about 500 pieces are expected to fall over an area 6,400km long by 160km wide, between latitudes 50° north and 50° south. Most of the pieces will vaporise.

Market Place

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

by Alan Turpin and David Shortland

IC TEST CLIPS

This new Lektrokit i.c. test clip offers a simple and inexpensive means of assessing any i.c. pin or lead. Test probe attachment is made simple and the chance of damaging i.c. pins is avoided. The test clip simply clips over the i.c. bringing its individual lead connections out to a set of easily accessible contacts at the top of the clip.

8, 14 and 16 pin sizes are available. The 14 pin version costs £2·95p, (pre-budget).

A contact "comb" separating individual contacts gives positive positioning and prevents accidental shorting of adjacent leads.

Lektrokit Limited, Sutton Industrial Park, London Road, Earley, Reading, Berks RG6 1AZ (0734 669116/7).

D.I.L. SWITCH BROCHURE

A new, six page, four colour brochure is available free from Erg Components. It contains full technical specifications and switching configuration diagrams for all types of Erg d.i.l. switches. Prices are given and there is no minimum order charge for items held in a maintained stock.

Erg Industrial Corporation Ltd., Luton Road, Dunstable, Bedfordshire, LU5 4LJ. (0582 62241).

LOW PROFILE KEYBOARD CONSOLES

A new range of keyboard enclosures has recently been introduced by BOSS Industrial Mouldings. They are available in three sizes, are all aluminium and have a textured black base which contrasts with either the semi-gloss sand or charcoal grey top panels. The top panels slope at approximately 20°.

Prices from £16·05 to £21·83, plus VAT and carriage.

BOSS Industrial Mouldings, Higgs Industrial Estate, 2 Herne Hill Road, London, SE24 0AU (01-737 2383).

CHEAP CHIPS

A special price is being offered by Chromasonic Electronics this month on ZN414 i.c.s. Two chips will cost £1·25 including VAT, p.&p. If you check the normal price and include VAT, etc. we think you will find this is a saving of almost 50 per cent!

BECKMAN DMM

A new $3\frac{1}{2}$ digit l.c.d. multimeter has been introduced by Beckman Instruments. Measurements can be made on five d.c. voltage ranges from 200mV to 1,500V; five a.c. voltage ranges from 200mV to 1,000V and five a.c. and d.c. current ranges of 200µA to 2A which can be extended to 10A through a separate input. The six resistance ranges have f.s.d. values from 200Ω to 2MΩ.

The low power resistance ranges permit in-circuit resistance measurements to be made without turning on semiconductors, which would affect the measurements. For applications that require diodes and semiconductors to be tested, a separate semiconductor test function provides a 5mA test current, enough to check the operation of most semiconductor junctions, even circuits with as low as 200 ohms of equivalent parallel resistance.

An Insta-Ohms continuity test indicator allows continuity to be checked. When an in-range resistance is measured an ohms symbol is displayed in less than a millisecond.

The meter has an input impedance of 22MΩ. Accuracy is to within 0·1 per cent + 1 digit on all d.c. voltage ranges. Both a.c. voltage and current are average r.m.s. measurements.

The inputs are protected against overload conditions that may arise from measuring unknown signals or from operator error. Voltage ranges are protected from inputs in excess of 1,500V r.m.s. a.c. Resistance ranges are protected to 300V d.c. or r.m.s. a.c. The current inputs are protected with a 2A fuse, a replacement fuse being included inside the instrument's case. The 10A range is rated for 20A for 30 sec.

A 9V battery provides up to 2,000 hours of continuous instrument operation, giving up to two years typical use. During the final 200 hours of battery life a decimal point blinks on the display to warn the user to change the battery. Calibration, guaranteed for one year, requires only the simple adjustment of an internal trimming potentiometer.

Accessories include two carrying cases, a radio-frequency probe for voltage measurements up to frequencies of 200MHz, a current clamp for measurements up to 200A, and a de-luxe test-lead kit with test leads and ten screw-in probe tips.

The price of the 3020 is £115, plus VAT and p.&p. For further details contact **Beckman Instruments Ltd., Queensway, Glenrothes, Fife KY7 5PU (0592 753811).**

MULTIRANGE CAPACITANCE METER

This simple-to-use instrument is now available on the UK market from Alcon Instruments. Known as the Varicaptester, it is a pocket-sized multirange capacitance meter with abilities extending from pF to thousands of μF.

It is constructed in tough ABS plastic with simple range selection, full-view cover, and can cope with all types of capacitor. Component values up to 3μ are read in conjunction with a green illuminated indicator (overflow) which clearly shows when the value of the component under test is too high and it requires a higher range.

For values above 3μ a system of timing the interval between flashes of an l.e.d. provides direct indication of capacitance value. On two selected ranges, capacitance can be indicated as 1μ per second or 100μ per second, thus extending the range to several thousand μF.

Maximum sensitivity is 1pF × division, accuracy is 2·5 per cent. Power for all normal uses is supplied using internal batteries. The user may apply an external voltage.

The Varicaptester comes complete with instructions, leads, case and batteries. Price is £82·50 (pre-budget) and delivery is at this time 'off the shelf'.

Alcon Instruments, 19 Mulberry Walk, London, SW3 6DZ. (01-352 1897).

100W MOSFET

The PA100 from Ambit is a power amplifier module which uses Hitachi power MOSFETs and is suitable for audio applications at power levels up to 100W r.m.s.

The drive circuitry is greatly simplified with MOSFETs while bandwidth is up to 300kHz and the harmonic distortion less than 0·01 per cent in the audio range.

The use of MOSFETs increases the reliability of the amplifier because of their inherent freedom from thermal runaway and secondary breakdown as well as loads that are potentially hazardous for bipolar amplifiers (i.e. reactive loads).

The price of the PA100 is to be announced in the near future.

Ambit International, 2 Gresham Road, Brentwood, Essex (0277 216029).

NANO TRAINER

The Nanocomputer training system has been specifically designed by SGS-ATES for the educational environment. The system which is based on the Z80 microprocessor includes a solderless experiment section, specially written user software, many optional peripherals and a three volume series of training books.

The modular construction of the system allows the student to enter the course at a level to suit his ability.

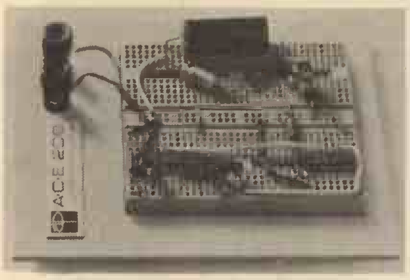
The three main levels in the course cater for: students with no knowledge of computers or digital electronics—book one with the basic micro-computer; students with a knowledge of digital electronics—book two and the experiment station; students with a more advanced knowledge—book three plus the microcomputer, the experiment station, and additional software. At the very highest level of education it is possible to upgrade the Nanocomputer to a full industrial microcomputer, thus allowing individual research programs to be carried out.

The price of the Nano trainer is between £250 and £450 depending on the model.

SGS-ATES (UK) Ltd, Planer House, Walton Street, Aylesbury, Bucks. (0296 5977)

ACE 200

Lektrokit have introduced an evaluation breadboard kit called the ACE 200. The unit has a universal matrix of 728 plug in tie points which include 136 separate tie points in lines of 5, and has two distribution buses each consisting of 24 tie points.



Measuring 11·5 × 14mm the unit is mounted on a baseboard which enables two power terminal connections to be fitted.

The cost of the ACE 200 is £11·48 plus VAT and p&p.

Lektrokit Ltd., Sutton Industrial Park, London Road, Earley, Reading RG6 1AZ. (0734 669116).

MICRO TRAINER

The Signetics Instructor 50 has been designed as a microprocessor training aid suitable for teaching CPU operation, programming and applications. The self contained unit can be interfaced with a conventional audio cassette recorder for program storage.

The Instructor 50 incorporates a single-line l.e.d. prompting display together with a 16-key hexadecimal keyboard for entering data values and a 12-key command keyboard for issuing instructions and selecting operating modes. The system uses a monitor known as USE (User System Executive) which eliminates the need for complicated start-up routines and allows a variety of operations to be carried out on programs and stored data.

The unit, which is based on the Signetics 2650 microprocessor, is equipped with an S-100 expansion interface which allows it to be used as a small computer limited only by the peripheral boards used. In addition, the program/data-entry and debug facilities of the basic Instructor 50 can be extended to any device connected to the interface.

The Instructor 50, which is supplied complete with a user's guide, introductory manual and leads for audio-cassette interfacing, is priced at £300 plus VAT.

SASCO, PO Box 2000, Crawley, Sussex RH10 2RO.

ONE MEGABIT BUBBLE FROM ROCKWELL

The latest addition to the AIM65 microcomputer system from Rockwell is a fully addressable add-on one megabit bubble memory system.

This external memory is interfaced to the AIM65 via a buffered expansion motherboard which has five connector slots that can accommodate any of the other types of Rockwell or Motorola Exorcisor modules as well as those from other manufacturers.

The motherboard extends the 6502 bus. The bus lines (address, data and control) are buffered to provide drive capability. Address decode logic for mapping internal and external addresses in 4K byte increments is also provided. Sixteen switches enable the user to define whether each 4K byte portion of the 6502 address space of 65K bytes is internal or external to the AIM65. Thus under software control the megabit bubble memory module can provide 128K bytes of memory expansion.

The price of the motherboard is £136·50 plus VAT and p&p. Pricing of the various options allowed by the motherboard can also be obtained from **Pelco (Electronics) Ltd., Enterprize House, 83-85 Western Road, Hove, Sussex, BN3 1JB. (0273 722155).**

VAT PRICES.
Printed before Budget

Market Place

SPRING TRADE SHOWS

Every year the TV, Radio and Hi-fi manufacturers gather in London for the Spring Trade Shows. However instead of gathering under one roof, they spread themselves out over 26 hotels with anything from one to nine exhibitors at each. For those with the stamina it was a chance to see the very latest products before they reach the high street retailers, or blister in the attempt.

On the TV scene, Ferguson and Ultra were showing their new television ranges, featuring the latest TX9 single board chassis from Thorn featured in a News Brief last month. Philips were also launching a range of TVs with their new chassis the KT3 which is also used in the latest Pye range of colour sets. The KT3 chassis was especially developed for use with the smaller (14in to 20in) picture tubes.

Many of the larger manufacturers had sets suitable for both teletext and Prestel on view, and Hitachi had their "Instaview" TV on display which provides sound and picture one second after switch on by eliminating the need for preheating the tube.

One area of the market which seems to have really expanded is the small screen TVs

The Plustron CTV55D from Plustronics, a 5½in. colour model priced at £299.

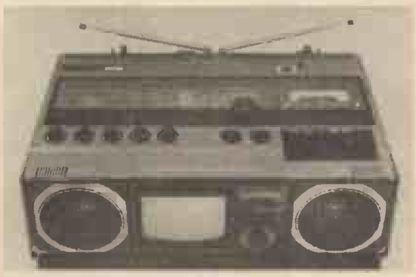
with Plustronics, JVC, Hitachi and Toshiba all showing 4½ to 6in colour sets. Many more were showing 4 to 5in monochrome sets with JVC and Sinclair taking screen size to what

The P100 TV from JVC with a 2in. screen which retails for around £165.

must be its realistic limit with their 2in sets. These miniature TVs vary considerably with many having radios and/or cassette recorders, some of which are stereo.

Crown's 5TV priced at £125 and supplied complete with rechargeable battery pack.

Crown launched their 5TV, a 5in set wit a 3 band radio and a totally flat screen whic is said to give a larger viewing area than conventional tube. Crown hope the 5TV wi increase their share of the small screen marke (currently claimed to be 48 per cent) but the competition will be intense.

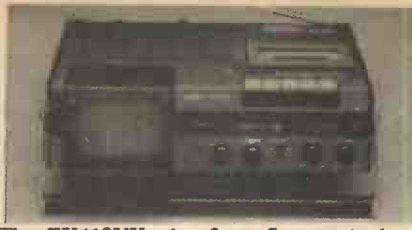


The K50 and K62 TVs from Hitachi retail for £220 and £249 respectively.

Hitachi had two 5in monochrome sets on display, the K50 and K62, both of which have cassettes and radios with the radio in the K62 being stereo. The small screen offerings from Sony were two very different models. The TV

The TV511UK from Sony is priced at £127.

511UK is a robust looking set with a screen angle adjustment ring to enable the picture to be moved through 90° for horizontal or vertical viewing, whilst the FX412UK is a



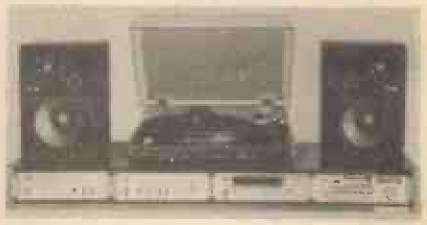
The FX412UK also from Sony, priced at £209.

smart lightweight unit with a 4in screen, 3 band radio and a cassette recorder.

The latest innovation in the hi-fi field is a continuation of the micro TV trend with micro hi-fi separates being exhibited by Aiwa and

The complete Amstrad system includes the pre amp, power amp and tuner, priced at £185.

Amstrad. The Amstrad system includes a P101 preamplifier, A101 power amplifier and T101 tuner which has a digital frequency display, l.e.d. signal strength indicator and centre zero tuning.



The Aiwa system is priced at around £500 excluding speakers (SCEII) and record deck.

The Aiwa micro system on show consisted of a pre amp (SAC22), power amp (SAP22), tuner (STR22) and cassette deck (STL22).

Toshiba's latest music centre, the SM4750 has microprocessor memory tuning which can store preset information of eight stations on each of the four wavebands. Long, medium, shortwave and VHF are available with auto tuning on VHF and medium. The 4750 has a direct drive turntable with a strobe, Dolby stereo cassette deck and built in clock timer.

The SM4750 has a retail price of £664·50 excluding speakers. British made SS45GB speakers are recommended for the 4750, priced at £109·50 a pair.

TV, Radio and Hi-fi were the main categories of the shows but other small and interesting products were on view. Here are a few examples of the way developments in technology and changing consumer interest are being responded to by manufacturers and marketeers.

DESTROY—DESTROY

You control the destroyer to protect your convoy against enemy torpedo attack. Direct your destroyer to intercept and destroy the enemy torpedoes. Play against the clock.

Approx. size–$6\frac{1}{2} \times 3\frac{1}{2} \times 1$in.

Priced at around £16.

Other hand held games from Adam Imports: **SOCCER.** The computer defends the goal with its six defenders. You attack using the keys provided. Shoot for goal and score as many goals as you can in the time allotted.

Full timing for first and second halves, scoring for Team A and Team B. Change side indicators. You change sides when you have scored and when you have played for a set period of time without scoring.

The game can be played in amateur or professional status and operates off a heavy duty PP3 battery or equivalent (supplied), or an alternative Grandstand mains adaptor (extra). Game priced at around £20.

4-IN-1. *Speedway:* Red l.e.d.s travel along the display being controlled by the gas and brake pedals. Steering is done by the two steering keys. Play against the clock.

Blackjack/Pontoon: Play this card game to Las Vegas rules. The bank will automatically take your losses or add your winnings.

Brain Drain: The computer generates four hidden numbers. Guess the numbers in the least number of tries.

Calculator: A full 4-key memory calculator is incorporated with all major functions: dividing, multiplying, adding and subtracting.

Power source–5 × HP7 batteries or equivalent (not included). Grandstand mains adaptor (extra). Game priced at around £20.

The complete range of products in the Adam Collection comprises: Video Sports Centres, Video Entertainment Centres, Video Entertainment Computer, Hand-Held Electronic Games, Electronic Calculators, Quartz Watches, Clock and Portable Radios, Digital Clock, Clock Radio Cassette Recorder, Stereo Clock Radio, Mains Adaptors, Audio Whistle Switch.

See the range at an Adam stockist or write for leaflets to **Adam Imports Ltd., Unit 2a, Ripon Way, Ripon Rd. Ind. Est., Harrogate, Yorks. (0423 501151).**

HYPERSPACEWARPWIPEOUT

Star Chess is a TV game for two players which combines sophisticated technology with skill and luck.

Both players are Admirals of a fleet of spaceships. Using all your resources, your mission is to annihilate your opponent's flagship, the Commander, and at all times protect your own Commander from destruction.

To help you in your task, you have Starfighters, Supercruisers, Superfighters, Starcruisers and an extremely powerful Destroyer. Each of these spaceships has an armoury of missiles to blast your enemy's forces off the screen.

When one of your spacecraft is in danger and has no apparent means of escape—all is not lost, it can be warped into hyperspace and out of immediate danger. But beware, for that ship will re-materialise in almost any square on screen, wiping out any spaceship occupying that square—even your own Commander. When one of the Commanders has been destroyed—cosmic pandemonium breaks out on your TV screen. R.R.P. is £64·95.

Literature on other games from **Waddingtons Videomaster Ltd., 36-44 Tabernacle Street, London EC2A 4DT.**

BE YOUR OWN VIDEO CAMERAMAN/DIRECTOR

Do your own video thing with a portable video cassette recorder and zoom camera.

Video cameras from Ferguson can be powered from their Videostar portable cassette recorder as well as mains. The monochrome camera has a 2 to 1 zoom lens, automatic iris, and a built-in directional microphone in case you don't have a sound assistant. The colour camera has a 6 to 1 zoom. Likely prices, monochrome camera—£214; colour camera—£856; portable recorder—£856; mains adaptor—£20; tuner/timer—£214.

MULTI-INTERFACE SCENARIO

What to do with a Cassette/Clock/Radio.

Listen to the radio.
Listen to cassettes.
Note the time.
Record speech onto cassette.
Record from radio onto cassette.

Auto-record at a preset time.
Be lulled to sleep with auto-stop.
Sleep-learn from cassette.
Have the radio wake you up.
Have cassette music wake you up.

All this seems to be possible with the Nova 309 which has a R.R.P. of £57·50.

If a microwave oven and a home computer were incorporated what couldn't you do?

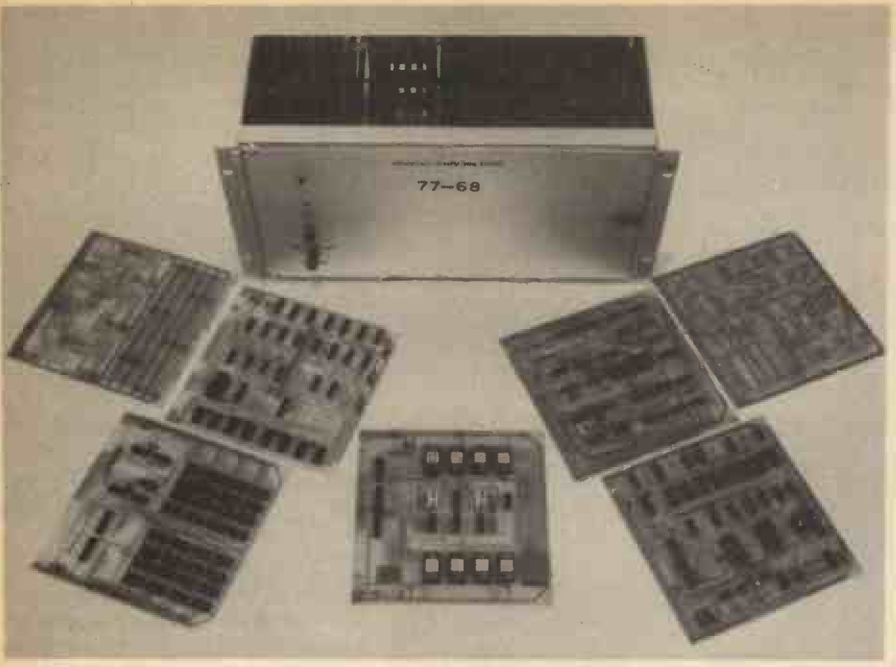
Novaline Ltd., 14-20 Headfort Place, London SW1X 7HN (01-235 5444).

UHF VROOM

If a second TV set is a portable it is likely that its integral aerial will not provide as good reception as an outdoor array. There may be sufficient signal strength from the outdoor aerial to feed both sets but parallel fed sets are almost certain to cause each other interference. So a properly designed splitter must be used. Then there is still the possibility that there is insufficient signal strength to feed both sets.

A solution to both problems is offered by a Second Set Amplifier by Labgear. It is expressly designed to operate two UHF TV sets from one aerial. The device is mains powered and provides a modest boost to the signal on each outlet. R.R.P. £7·30.

A leaflet on Labgear's—Signal Amps., Splitter/Combiner, and Log-periodic room aerial, is available from **Labgear Ltd., Abbey Walk, Cambridge CB1 2RQ, England (0223 66521).**



77-68 review

P. BIRNIE

Would-be microprocessor system constructors are today faced with a bewildering variety of systems to choose from. These range from cheap systems which are relatively easy to build, but may be difficult or impossible to extend beyond the 'keys and lamps' stage, to the expensive systems aimed more at the professional market which require the purchase of many hundreds of pounds worth of equipment before any results can be seen. When Tim Moore of Newbear Computing Store designed his 77-68, he was clearly aiming at a minimum cost system capable of expansion to a 'full house' system without the necessity for spending a large amount of money before results were seen. His claim in 1977 that 77-68 only cost £50 to get going was proven by many members of the Amateur Computer Club and even today the kit of parts for the basic system costs less than £50.

This review looks at the 77-68 CPU board, which utilises the Motorola 6800 processor, and goes on to examine in detail the VDU and monitor boards presently available. Brief mention will also be made of the boards currently under development—these include a dynamic RAM board and floppy disc controller. It is worth noting at this point that in common with all systems employing complex logic devices of the TTL and MOS families, 77-68 should be regarded as a project for the constructor with at least limited experience of assembling projects utilising these devices. The complete beginner would be well advised to make several of the simpler projects offered in *Practical Electronics* before tackling an ambitious project such as this—when later on the construction is referred to as 'simple', this should be taken strictly as a relative term.

THE SYSTEM

76-68 uses the Motorola 6800 8 bit microprocessor. This device is a firm favourite with both the amateur constructor and the professional user and although the device has in its basic form some software 'nasties', these can be overcome by a bit of thoughtful programming (new software compatible versions of the 6800 such as the 6809 overcome these problems, but will not be considered here).

The basic CPU board is designed to operate as a 'stand-alone' unit interfacing with keys and lamps to allow simple programs to be written and executed without the necessity for a VDU or teletype. This same board, when plugged into the 77-68 bus, will operate as the CPU card for a system with RAM, ROM, I/O etc., in other words the constructor can start at the simplest and cheapest end of home computing and grow his system as time and money allows into a powerful computer capable, for instance, of running BASIC or performing complex computing tasks.

A block diagram of the CPU card is shown in Fig. 1 and those with knowledge of microprocesors will recognise the familiar blocks of circuitry needed around the 6800 to turn it into the heart of a computer system. For those who may be new to the subject—the blocks shown are essential to allow the microprocessor to communicate with the address and data busses and the keys and lamps are used to allow the user to input programs and read data bus contents.

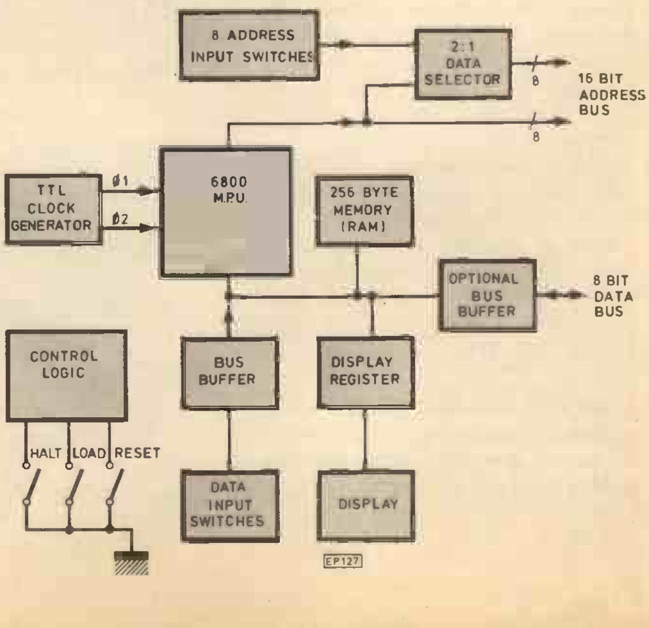
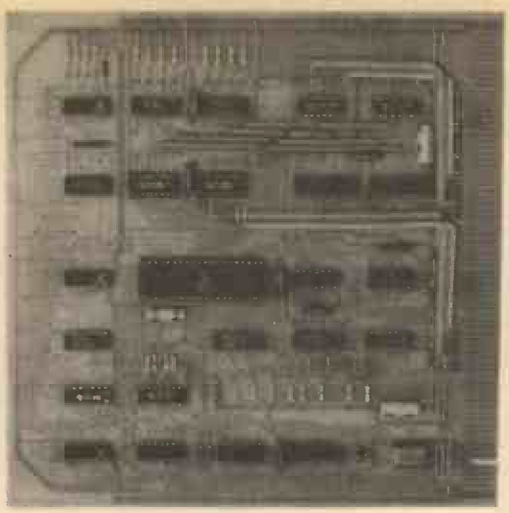


Fig. 1. Block diagram of CPU board



CPU board

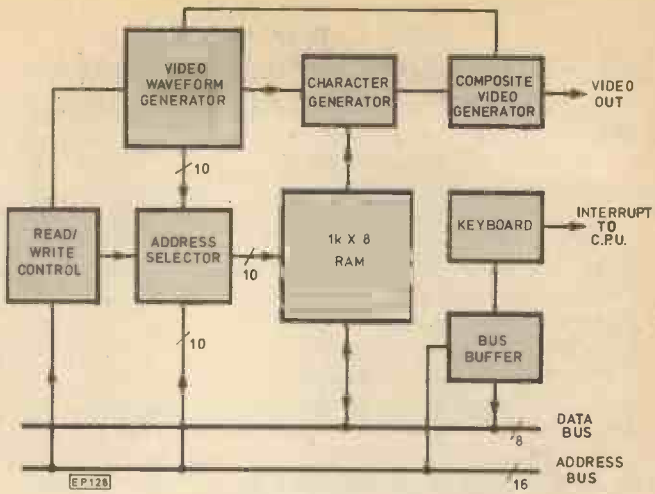


Fig. 2. VDU block diagram

The data input switches are buffered from the data bus by a tri-state buffer allowing the processor bus to be freed from the keys except when data is actually being entered from them.

The data display register latches the data bus information at the appropriate instant and displays this information on an array of l.e.d.s. As the 6800 is a dynamic device, this latch is necessary since data bus information only 'appears' for part of the microprocessor clock cycle and must be 'caught' by appropriately gated signals in an 8-bit latch. The 77-68 CPU board allows bus buffers to be fitted to the data bus and this should be considered essential if a system with other 77-68 cards is being constructed. The address bus from the microprocessor has its lower order eight bits passed through a 2:1 data selector to allow either a microprocessor generated or switch generated address to be output from the card.

These address switches, data switches and lamps are the users input/output path, allowing memory to be written with programs or data (256 bytes of RAM are provided as shown in Fig. 1), and when programs are being run or debugged, data from memory or the processor to be output onto the l.e.d. display.

The 77-68 CPU card also contains a TTL clock generator which is crystal controlled, allowing accurate software timing should this be required by the user—and finally control logic which interlocks the keys and lamps described above with three switches, halt, load and reset, which will be described later.

CARD CONSTRUCTION

Construction of the CPU is facilitated by the use of an 8in square printed circuit card with a 78 way, 0·1in gold plated edge connector etched along one edge. The instruction manual *'The construction of a simple microcomputer'*, which can be obtained separately from Newbear, contains full and detailed descriptions of the 77-68 system and the construction of the CPU.

The card assembled as part of this review was completed in a couple of evenings and worked first time when connected to a 'keys and lamps' interface.

The card being single sided for reasons of economy, requires a large number of insulated links and two pieces of ribbon cable to complete the interwiring pattern of the integrated circuits. This part of the assembly takes more than half of the total assembly time and requires care since any errors in linking holes, or faulty insulation, solder bridges, etc., can prove difficult to track down later. The considerable economy affected by using a single sided board is probably worth while since a double sided plated through hole board of this size would almost certainly add £15-£20 to the overall cost of the system; to an amateur constructor with 'free' time at his disposal this additional cost will in most cases be undesirable. The remainder of the construction simply involves 'plugging in' the i.c.s and the discrete components and carefully soldering them in place with the usual earthed soldering iron.

RUNNING A PROGRAM

Having completed the CPU card and made up a simple keys and lamps interface as described in the manual, a 5 volt 1 amp power supply must be used to power it, this being supplied by the constructor.

Having followed the Newbear instructions for testing what can be achieved with this basic CPU system? The manual briefly describes the 6800 instruction set in terms of its addressing modes and then gives a number of small programs which allow the user to immediately see and hear the processor at work. Several lamp flasher programs can be run which cause varying lamp patterns to flash on the data l.e.d.s. In addition, if a simple add-on amplifier interface is built then a tone generator program and even a program to play tunes can be run.

These programs, whilst showing in no uncertain terms that the CPU is operational also allow the user an opportunity to study the mode of operation of the 6800 software since clear notes are included in the manual of the changes which can be made to the software, for instance the lamp flasher programs, and the user can see for himself just what effect such changes have on program operation.

A couple of evenings spent loading programs from keys in pure binary form and reading back program and data in binary will convince most constructors of the transitory nature of any 'keys and lamps' system—in simple terms the possibility of error is so great in entering and retrieving data in binary form, that such a simple system can only be considered as suitable for educational purposes. This is not to say that relatively sophisticated programs cannot and have not been run using only keys and lamps, but that operation of such a system in conjunction with lengthy software *is* a painfully slow process.

VDU AND MONITOR BOARDS

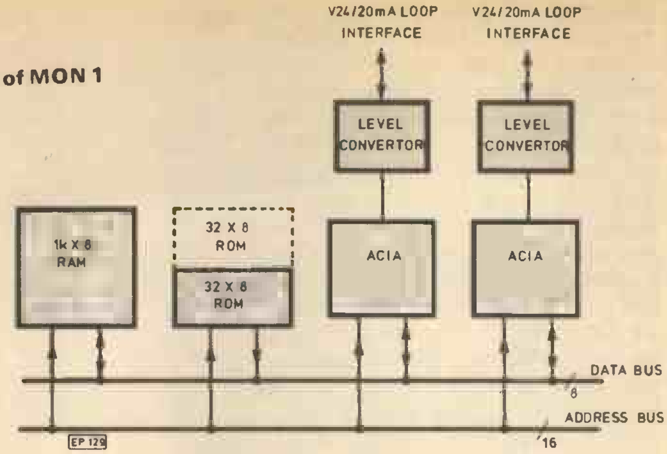
Confronted with the above dilemma, one can either purchase a teletype or consider the construction of a VDU, and it is the latter approach which is greatly favoured by the reviewer. The inconvenience of a VDU in terms of the lack of hard copy, is countered by its silent operation and the convenience of a 'screen' when it comes to playing most computer games and displaying data as program output in many cases. In addition a VDU, if constructed round a domestic TV set, will almost without exception cost less to construct than a teletype would cost to buy.

Newbear have a 77-68 VDU board which offers a bus compatible interface between a keyboard and a video monitor or with the addition of one of the cheap readily available video modulators—a domestic TV set. The resulting VDU has a 24 line display with 40 characters per line, upper and lower characters being displayed in a 7 × 10 dot matrix. As is becoming virtually standard in 6800 base systems, the video memory (constructed from eight 2102 devices) is memory mapped as far as the CPU is concerned, giving a vector driven display. This means in simple terms that if a single character on the screen is to be modified then by generating the address of the character to be modified, and sending that to the VDU, that character can be modified on its own, rather than in a serial VDU system where to modify a single character, then the whole screen must be re-written.

The VDU board is the Newbear standard 8in square unit with a 78 way 0·1in pitch edge connector etched along one side. Rather than use one of the many CRT Controller (CRTC) chips now available, Newbear implement their VDU using LS-TTL and this allows the use of a good character generator with upper and lower case alpha characters and a variety of semi-graphics characters.

The use of this device, the Texas Instruments 74S262, turns any home-built VDU from the familiar upper case only device into a truly professional unit which is easy to read and offers scope for limited graphics. In addition to the devices necessary to generate the line and frame waveforms, and form characters, this board also contains 1K × 8 of static RAM—seven bits in each type being used to store a ASCII code for that character, the eighth bit being used to over video invert/normal on a character by character basis.

Fig. 3. Block diagram of MON 1



This facility allows highlighting of text and considerably extends the scope for graphics production. As with the 77-68 CPU board, and others in the 77-68 family, the VDU board is a high quality single sided fibre glass printed circuit board and as with the CPU board, more than half the construction time is taken up in linking points on the circuit using single cored insulating wire. The remainder of the time is taken up in soldering in place the thirty-four integrated circuits used in the system, and an experienced constructor should have no problems in completing the assembly in two or three evenings.

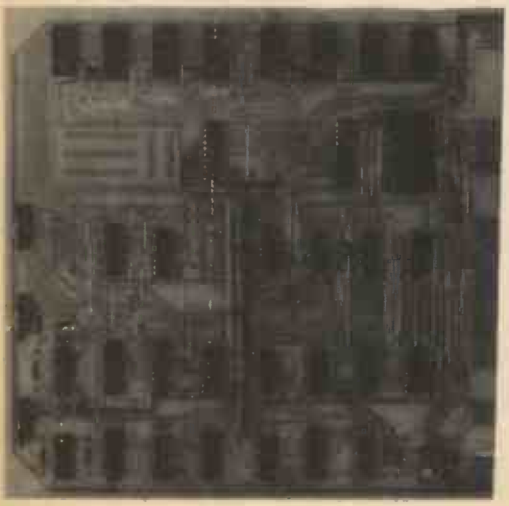
The VDU card has a video output which will direct drive any standard video monitor, or by means of one of the cheap modulators now available feed into the aerial socket of any TV receiver. The card provides an 8-bit port for a keyboard which of course must be provided by the constructor.

Any ASCII keyboard will be suitable provided that it has a positive going strobe in addition to the eight data lines—this strobe being used to cause a 'Non Maskable Interrupt' to the processor when a key is depressed. Newbear have thoughtfully provided a breadboard area on the VDU board which could be used to interface a non-standard keyboard to the VDU card if required.

It was during testing on this board that the only design fault was found in 77-68; one of the fixed resistors used to determine the range over which the line and frame pulse generator may be adjusted, was too large a value and only by changing this resistor could a stable locked display be obtained. This minor fault, whilst being easy to trace with an oscilloscope, could prove tricky for the constructor with only a multimeter to hand.

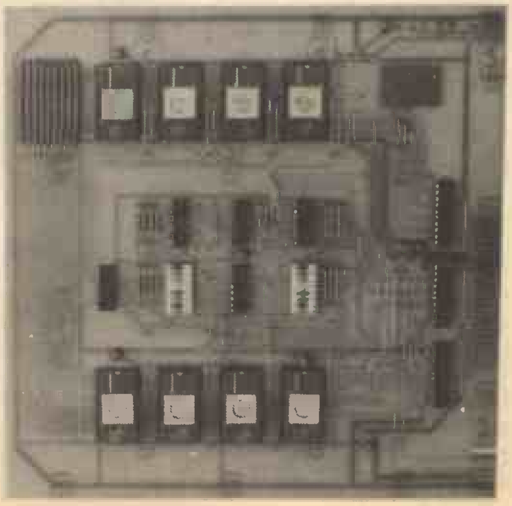
EXCELLENT DISPLAY

The complete VDU offers a really excellent professional quality display and the keyboard quality is obviously determined by whatever is connected to the



(Left) VDU board

(Right) ROM A—the 16K byte EPROM card



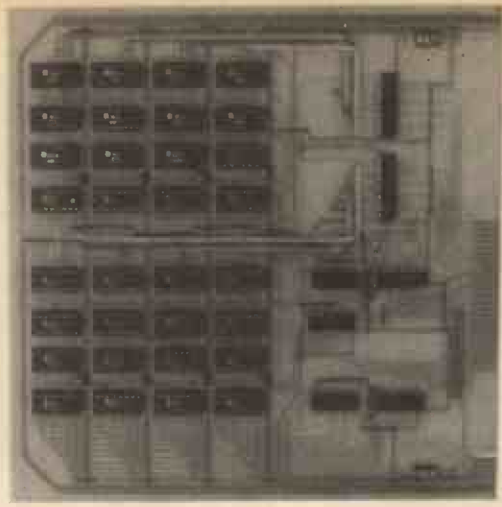
interface provided by Newbear. As has been said before, there are significant advantages in using a good (if expensive) character generator and these advantages clearly show up when even simple video graphics are displayed, let alone when text is being viewed. The video is absolutely rock steady (which is more than can be said of some commercial units) even although the 'timebase' of the VDU is centred round a 556 dual timer chip. This is undoubtedly due to the digital circuitry used to generate all timing waveforms, rather than the inaccurate monostable approach adopted by some designers.

BUG 2 MONITOR

Completion of the CPU and VDU boards results in a processor capable of operating (via the keyboard and VDU) only when a monitor program is loaded into the system and set running. The best known 6800 monitor is of course the Motorola MIKBUG software familiar to most 6800 users. This software allows the user to communicate at machine-code level with the processor via a teletype or serial port VDU. Since 77-68 uses a parallel port VDU and keyboard, MIKBUG would not be a suitable piece of software and thus Newbear supply their BUG 2 monitor listing along with the VDU hardware. This monitor must be toggled in using the keys and lamps of the basic control panel and when set running, allows VDU access to the system—fine while power is applied to the system, but the software is of course lost on power-down, resulting in a lengthy 'toggling in' procedure before each session. This could be overcome by Newbear providing BUG 2 in a ROM and the reviewer feels that this expense would be justified (perhaps as a plug-in option). The Newbear view is that due to the simplicity of BUG 2, most users will go on to develop their own monitor software and though this may well be true, for many this omission will be a great nuisance.

THE SYSTEM IN USE

With BUG 2 installed in the system, what can be achieved? The VDU will produce a 16 line by 32 character display and on depression of the reset button will display an '*' on the screen. Five 'commands' allow memory locations to be examined and altered, MPU registers to be displayed, user programs to be run and also allow the running of a program to be continued following software interrupt. The software should prove adequate for most experimenters in their early work and will of course allow the user to develop a more advanced monitor should this be felt necessary.



4K RAM board

Newbear users will almost certainly want to extend their system by adding RAM and an interface port of some sort and this is conveniently provided by the 77-68, MON1 board. Constructed as before on an 8in square single sided printed circuit board, this unit gives access to bulk storage media such as paper tape and cassette units and also provides 1K × 8 of RAM. The board also allows a 'bootstrap' ROM to be used to load a monitor from, for example, cassette tape, into the system. In practice this allows the user to develop his own monitor or monitors which he can save on tape for subsequent easy reloading into the system. Serial communication is by means of the Motorola ACIA, the 6850, and provision is made for two such devices on this one board, in addition to a variable baud-rate generator (crystal controlled). Both V24 and current loop interfaces are provided, offering interfaces to most serial driven peripherals such as cassette recorder interfaces, teletypes etc.

In practice the 77-68 MON1 board might be used in the following fashion. With the Newbear 'BOOT' ROM installed in its socket on the board, a previously punched monitor is boot-strapped into RAM from a paper tape reader. The monitor could contain 'CUTS' input-output software allowing access to recorded software via an ACIA port and a 'CUTS' interface, and with this software loaded into the system, it may be modified, run etc., using the VDU as a man/machine interface. Newbear provides a listing of 'DUMP', allowing the user to off-load software to, say, a paper tape punch for subsequent re-use. Clearly this board turns the 77-68 system into a very versatile and powerful processor capable of supporting a variety of hardware peripherals and of running relatively large programs.

Most constructors will aim for a basic system comprising the CPU, VDU and MON boards and when they have gained experience of machine code programming, look for a way of operating in BASIC or some other high level language. This will require the use of more memory than is offered by the basic system and Newbear offer a 4K byte static RAM card (which many would consider as part of the basic system in any case), a 32K byte dynamic RAM card and a 16K byte EPROM card using 2708s. This range of memory cards is bus-compatible with the other 77-68 of course and will shortly be joined by a floppy disc interface board, offering a good range of memory types to suit all tastes.

IMPRESSIONS

The 77-68 system has been thought out to allow low price 'start-up' costs while at the same time offering a wide range of bus-compatible boards which build into a comprehensive processor system. The quality of the hardware supplied is excellent. The only constructional problems encountered were very minor in nature—under-size p.c.b. drillings for instance were encountered on a number of occasions. The documentation supplied is clearly written although it would be helpful if a description of the overall system existed which could be studied before boards were bought to allow each user to determine exactly which way his system was going to grow.

Purchasers of 77-68 VDU systems automatically become members of the '77-68 User Group' which circulates a quarterly Newsletter which allows users to share software and hardware information. In addition lists of members are circulated and the formation of local groups is encouraged—activities designed to assist newcomers, in particular to microprocessors, to get their first system 'up and running'.

To summarise the above points, Newbear have put together a thoroughly practical system suitable for amateur or professional for a first system.

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas often come from readers working on their own systems, and payment will be made for any contribution featured.

EIGHT EIGHTS PROBLEM

THIS MONTH'S Micro-Bus begins with a challenge for all owners of the Science of Cambridge MK14 microprocessor system, and a chance to win a kit. A program for the MK14 is given in Fig. 1 and with this program running it is possible, by pressing the keys on the keyboard in a certain order, to get eight '8's lit up on the display. Only the correct sequence of key presses will give this result. Alternatively you may like to try to solve the problem from the program listing (Fig. 1). Either way, the problem is extremely tantalising until you discover the rule governing the operation of the keys.

The *Eight Eights* program occupies locations OF18 to OF47 in the MK14's memory. Enter it as usual, either from the listing or from the hexadecimal dump in Fig. 2, and then execute it at OF18. The display should then go blank except for one '8' in the rightmost digit position; you can then use any of the number keys O–F to try to solve the problem. Do not press ABORT or you will have to re-enter the last eight bytes before running the program again.

```
                ; EIGHT EIGHTS PROBLEM
                ;
OF18 C484   BEGIN:  LDI    X'84
OF1A 33             XPAL   3
OF1B C40F           LDI    X'OF
OF1D 36             XPAH   2
OF1E C401   BACK:   LDI    1
OF20 37             XPAH   3
OF21 01             XAE
OF22 C440   RIGHT:  LDI    X'40
OF24 32             XPAL   2
OF25 C47F           LDI    X'7F
OF27 E280           XOR    -128(2)
OF29 CA80           ST     -128(2)
OF2B 3F     SHOW:   XPPC   3
OF2C 90FD           JMP    SHOW
OF2E 03             SCL
OF2F C402           LDI    2
OF31 78             CAE
OF32 94EE           JP     RIGHT
OF34 C601   LOOP:   LD     @1(2)
OF36 98FC           JZ     LOOP
OF38 32             XPAL   2
OF39 60             XRE
OF3A D40F           ANI    X'OF
OF3C 98E4           JZ     RIGHT
OF3E 90DE           JMP    BACK

OF40 0000           .BYTE  0,0,0,0,0,0,0,0

     0000           .END
```

Fig. 1. Program for the SC/MP micro which sets up the Eight Eights problem described in the text

```
HEX DUMP

OF18 C4 84 33 C4 OF 36 C4 01
OF20 37 01 C4 40 32 C4 7F E2
OF28 80 CA 80 3F 90 FD 03 C4
OF30 02 78 94 EE C6 01 98 FC
OF38 32 60 D4 OF 98 E4 90 DE
OF40 00 00 00 00 00 00 00 00
```

Fig. 2. Listing of the bytes to be entered to run the Eight Eights program

WIN A KIT

Readers sending in the shortest sequence of key presses that will light up eight '8's on the display can win one of the MK14 VDU interfaces that have been kindly donated as prizes by Science of Cambridge. The first three correct entries opened on the 31st August will each receive a kit, and entries should be posted to: **Micro-Bus Problem, Practical Electronics, Westover House, West Quay Road, Poole, Dorset BH15 1JG.** The next Micro-Bus will reveal the solution to this problem, and give a full explanation of how the program works.

MICRO DRIVES A TRAIN

The speed and direction of an electric motor can be controlled by a microprocessor, and by way of illustration a simple program is presented here which can vary the speed and direction of movement of an electric model train. As it stands, the train can be set to one of eight forward or reverse speeds, but the program could form the heart of a more complex system which incorporated the switching of signals and points, and the use of sensors to detect the train's position on the track.

The program was developed and run on an Acorn microprocessor system which makes an ideal controller for such applications. Control of the train is from the Acorn's keyboard; the keys 0–7 give forward motion, and 8–F give reverse. The number pressed determines the speed: 7 and F give maximum speed in forward and reverse respectively, and 0 or 8 stops the train.

OPERATION

The polarity of the power applied to the motor is controlled by a bridge circuit of power transistors; see Fig. 3. The transistors are not critical, and the ones shown, chosen for economy, will drive several amps. Two

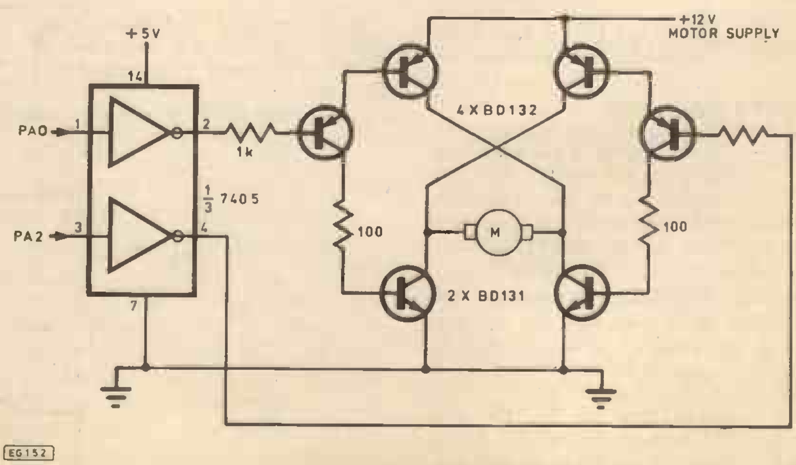


Fig. 3. Circuit which provides control of an electric motor from two logic-level lines

gates in a 7405 package (a hex inverter with open-collector outputs) act as buffers between the bridge circuit and two lines from the Acorn's RAM I/O device, PAO and PA2. With both lines high, or both lines low, the voltage across the motor is zero. If one line is taken high the motor is connected between the power rails, and the polarity depends on which line is high.

Control of the motor's speed is achieved by pulsing the power to the motor rapidly on and off, and varying the ratio of on-time to off-time. This control is performed by software timing.

MOTOR CONTROL PROGRAM

The motor controller program, shown in Fig. 4, requires some understanding of how the Acorn's keyboard is connected. The keyboard uses six bits of port A in the RAM I/O chip addressed at $OEOO. The lower three bits, PAO–PA2, are decoded to enable one of the eight keyboard columns. The next three bits, PA3–PA5, are inputs from the keyboard rows. Each key, when pressed, makes a connection between a row and a column; keys 0–7 correspond to PA5 low, and keys 8–F correspond to PA3 low. When no key is pressed all three rows are high.

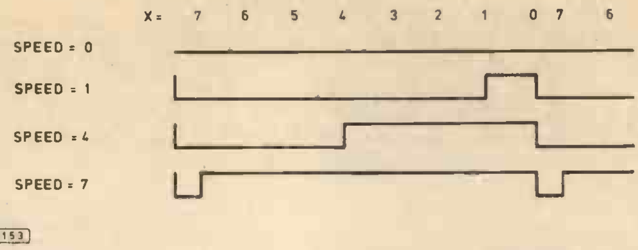
```
                ;       MODEL TRAIN CONTROLLER
                WAIT    =$FECD              DELAY ROUTINE
                USERIO  =$0920              SPARE RAM I/O CHIP
                KYBDIO  =$0E20              KEYBOARD/DISPLAY I/O
                DIRN    =$000D              FOR DIRECTION CODE
                SPEED   =$0020              FOR SPEED CODE 0 - 7
                ;
0000                    *=$0210
0210 A9 07      SETUP   LDA    £7           PAO-PA2 AS OUTPUTS
0212 8D 22 OE           STA    KYBDIO+2     DATA DIRECTION
0215 8D 22 09           STA    USERIO+2       REGISTERS.
0218 A4 20      RESET   LDY    SPEED
021A A9 00              LDA    £0
021C 8D 20 09           STA    USERIO       TURN MOTOR OFF
021F A2 07              LDX    £7           COUNTER
0221 8E 20 OE   SCAN    STX    KYBDIO       SELECT KEYBOARD COLUMN
0224 AD 20 OE           LDA    KYBDIO       READ FOR ROWS
0227 29 3F              AND    £$3F         MASK TOP BITS
0229 C9 38              CMP    £$38         KEY PRESSED?
022B BO 07              BCS    NOKEY
022D 4A                 LSR                 MOVE ROW
022E 4A                 LSR                   BITS
022F 4A                 LSR                   DOWN.
0230 85 OD              STA    DIRN         SAVE AS DIRECTION
0232 86 20              STX    SPEED          AND UPDATE SPEED
0234 CA         NOKEY   DEX                 SCAN 8 TIMES
0235 30 E1              BMI    RESET
0237 C8                 INY
0238 CO 08              CPY    £8           ENABLE MOTOR?
023A DO 05              BNE    MISS         NOT YET.
023C A5 OD              LDA    DIRN
023E 8D 20 09           STA    USERIO       SWITCH MOTOR ON
0241 20 CD FE   MISS    JSR    WAIT         DELAY
0244 4C 21 02           JMP    SCAN         LOOP.

                        .END
```

Fig. 4. Program for the 6502 micro which, with the circuit of Fig. 3, varies the speed and direction of rotation of an electric motor

Bits PAO and PA2 of the spare RAM I/O chip, which is addressed at $0900, are used to control the motor. When run, the program first configures bits PAO–PA2 of both RAM I/O chips as outputs. It then performs the SCAN routine eight times, for values in the X register of from 7 down to 0. The SCAN routine selects a keyboard column and checks for keypress in that column. If a key has been pressed it shifts down the row bits PA5 and PA3, one of which will be low, to coincide with the lines PA2 and PAO, and saves them at DIRN. It also updates SPEED with the current value of X.

The value of SPEED determines for how many of the seven time slots the motor is turned on, see Fig. 5. A delay, provided by the WAIT routine in the Acorn monitor, is inserted at the end of the SCAN loop. The program works without this, but the train motor acts as a loudspeaker coil and, due to the high frequency of the pulses applied to it, emits an audible whistle which is rather disturbing!

Fig. 5. Timing diagrams showing how the speed of the motor is varied by altering the point in each cycle at which power is applied



AN INSIGHT INTO MICROPROCESSORS

Many people seek to gain an introduction to microprocessors by building one of the excellent kits currently available; but running programs on a kit still leaves one fairly mystified about the internal operation of the micro. The problem is that the microprocessor executes many thousands of instructions every second, and a whole program can be executed in an instant.

The circuit to be described provides one solution. Designed for use with SC/MP microprocessors (the INS8060), it makes it possible to execute programs one cycle at a time, suspending execution between cycles so that the status of the micro can be examined. In addition to giving an insight into the operation of a micro that is not gained by simply running programs on it, the single-cycler also make it a simple matter to fault-find microprocessor kits.

SINGLE-CYCLER DESIGN

The single-cycler was designed by Nick Toop, whose cassette interface appeared in the October 1978 Micro-Bus, and though intended for use with a Science of Cambridge MK14, it should work with any SC/MP-based system. The circuit, shown in Fig. 6, uses two TTL integrated circuits and its operation is controlled by two push buttons, of which one should have changeover contacts and can be a biased toggle-switch. The single-cycler is connected to the MK14 by five wires, and there is no need to make any changes to the MK14 itself. The connection points are as follows:

Wire	SC/MP pin no.
+5V	40
NWDS	1
NRDS	2
NHOLD	6
OV	20

There are more convenient points on the upper side of the MK14 where connection can be made, and the photograph of the prototype shows these.

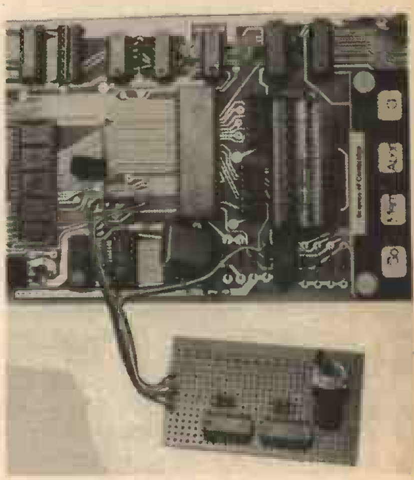
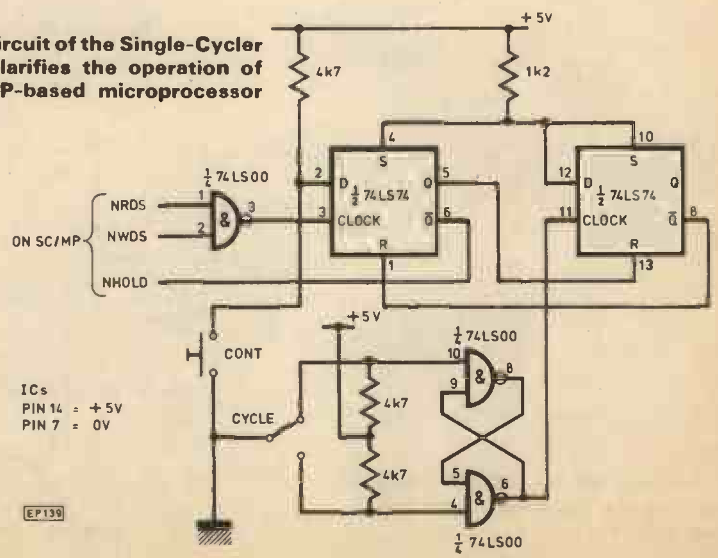


Fig. 7. The Single-Cycler circuit described in the text attached to an MK14 microprocessor kit

Fig. 6. Circuit of the Single-Cycler which clarifies the operation of a SC/MP-based microprocessor system



OPERATION

Instructions executed by a microprocessor consist of a number of read and write cycles, during each of which the micro accesses the memory (or I/O devices). Every instruction must have at least one cycle—the *instruction fetch*—during which the micro reads the instruction op-code from memory. During this cycle the address of the instruction appears on the address bus, and the instruction itself appears on the data bus. Some SC/MP instructions have as many as four read/write cycles; for example, *increment-and-load* (ILD) has three read cycles (instruction fetch, operand fetch, and read data) and one write cycle (write incremented data). The number of read and write cycles for any particular instruction is fairly obvious from what it does, and a full list can be found on pages 30-31 of the MK14 manual (page 42 in the new manual).

The SC/MP micro signals a read cycle by taking NRDS low, and a write cycle by taking NWDS low. The single-cycler circuit of Fig. 6 works by taking NHOLD low whenever either of these lines goes low; this halts the micro in the middle of the cycle, leaving the address and data for that cycle on the buses so their state can be interrogated. Pressing the CYCLE switch releases NHOLD, and the micro runs until the next read/write cycle is reached. For continuous operation the CONT switch is held down, and the CYCLE switch pressed once to start execution; releasing the CONT switch at any time will halt the micro in the next read/write cycle.

Note that the operation of this single-cycler circuit is quite different from the operation of the single-step facility described in the MK14 manual. Whereas the single-step circuit just generates an interrupt so that control is transferred to the monitor program after each instruction is executed, the single-cycler actually stops the micro between cycles.

Old Monitor (SCMPKB)

Address lines	Data lines	NRDS	NWDS	Comments
001	CF	low	high	Instruction fetch ST @(3)
002	FF	low	high	Disp. for instruction
FFF	00	high	low	Store data to RAM
003	90	low	high	Instruction fetch JMP
004	1E	low	high	Disp. for jump
023	C8	low	high	Address jumped to.

Revised Monitor (SCIOS)

Address lines	Data lines	NRDS	NWDS	Comments
001	90	low	high	Instruction fetch JMP
002	1D	low	high	Disp. for jump
020	C8	low	high	Instruction fetch ST
021	DC	low	high	Disp. for instruction
FFD	00	high	low	Store data to RAM
022	40	low	high	Instruction fetch LDE.

Table 1. The results expected when single-cycling through the first few instructions of the old and revised MK14 monitors

FAULT-FINDING WITH THE SINGLE-CYCLER

The Single-Cycler should be used in conjunction with some means of reading the state of the address, data, and NRDS/NWDS lines, such as logic probe, oscilloscope, or voltmeter. The following steps illustrate how to fault-find a non-functional MK14:

(a) Attach the Single-Cycler circuit as described above, and press the RESET button on the MK14. This should cause pin 7 of the SC/MP, NRST, to go low.

(b) Release RESET and check that the clock, pin 38, is working. Verify that all the address lines are tri-stated (neither high or low). Data lines D4–D7 should also be tri-stated, but D0–D3 will be pulled high by the resistors R12–R15. NWDS and NRDS should also be tri-stated. Any departure from this indicates a fault, probably a short between two adjacent tracks on the printed-circuit board.

(c) Now press the CYCLE switch once. The SC/MP should then be outputting the address X'001; in other words A11 to A1 should be low and A0 high. The cycle is a read cycle so NRDS should be low, and the data lines should be reading the first instruction in the monitor, which is X'90 for the old monitor X'CF for the revised monitor.

(d) By repeatedly pressing CYCLE one can single-cycle through the monitor program, at each stage comparing the observed states of the address, data, and NWDS/NRDS lines with the results expected from the monitor listing. Table 1 shows the first five cycles for the old and revised MK14 monitors. Departures from this table will point to shorts, faulty components, or incorrect PROMs.

(e) To get into the keyboard and display routine, KYBD, continuous run for a while by holding down CONT, pressing CYCLE, and releasing CONT. One can then single-cycle through the KYBD routine to check the display circuitry. One display digit should be enabled at a time, and every 26 operations of the CYCLE switch should move to the next display digit.

IMPROVEMENTS

It is possible to incorporate this circuit into a more sophisticated device that will give a continuous display of the state of the address, data, and NWDS/NRDS lines, thus making it unnecessary to test each line in turn. It is also possible to make the circuit single-cycle within limited address ranges, such as only in the user RAM so that it is possible to cycle through one's own programs. But even the simpler circuit just described, whether it is used to examine the operation of a working microprocessor system or to repair a faulty one, should prove a valuable addition to a micro.

Semiconductor UPDATE...

FEATURING INS 8295 MK 4816 μA78MGU1C

R. W. Coles

NIBL ROM

Devotees of the SC/MP microprocessor (used in the MK 14 and Scrumpi micro kits) may already have heard of NIBL.

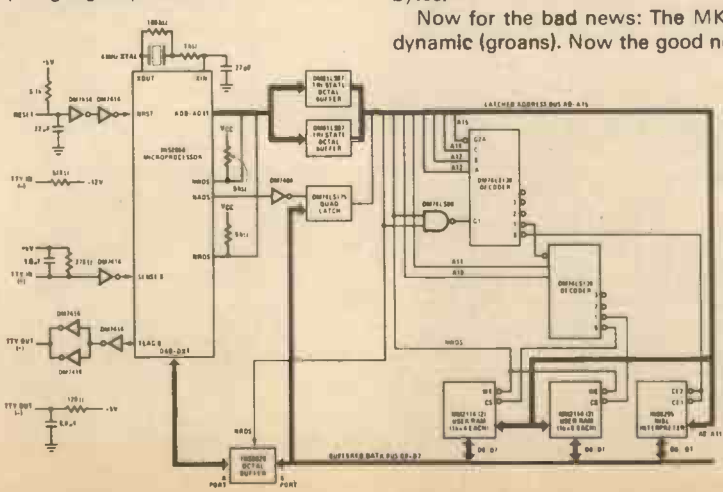
NIBL stands for National Industrial BASIC Language, and it started life as an adaptation of the original Tiny BASIC as described in the first issue of the now famous "Dr. Dobb's Journal of Computer Calisthenics & Orthodontia." This version of BASIC, like most other Tiny BASICs, has *integer only* arithmetic with an effective 16-bit precision, but it also sports a few features not found on the others, including a DO-UNTIL statement in addition to the usual FOR-NEXT.

The "Industrial" part of NIBL refers to the SC/MP manufacturer's conviction that many control programs used in industrial situations could be written in a high level language such as BASIC, rather than in the more usual machine code or assembly language form.

The advantages of this sort of approach are obvious. Programs to control a central heating system or a machine tool become lists of easy to write English-like statements which can be readily understood by almost anyone, and programs also become more portable, since one BASIC is very much like any other.

The disadvantages stem mainly from the fact that NIBL is an interpretive language which requires a large "Interpreter" program to be resident in the system as well as the user program itself.

Each of the concise NIBL statements has the effect of calling a large machine language subroutine in the Interpreter at run time, leading to inefficiencies and a drastic reduction in speed compared with an assembly language equivalent.



The resulting choice is simple. Either you stick to assembly language and get compact code which runs fast but takes a great deal of time to write and debug, *or* you use a language like NIBL which means your programs run slower but are much easier and quicker to write.

So much for using NIBL for control applications, but what about hobby use? Well, you can use NIBL anywhere you would use a standard Tiny BASIC, for games and other purposes, and it would certainly add a great deal to any existing machine code system.

The best news of all is that National have now put the NIBL interpreter into a single, cheap, 4K by 8 masked ROM which will go into a 24-pin socket. The new ROM is coded **INS 8295** and is intended for use in an 8060 SC/MP system with at least 2K of RAM available.

Being a high level language, NIBL requires an alphanumeric communication channel, and the interpreter in the 8295 contains a software driver for a 110 baud ASCII terminal connected to the SC/MP SENSE B and FLAG 0 lines.

I should think that an SC/MP system equipped with NIBL is one of the cheapest ways possible into the world of the Home Computer, so why don't you try it, all you SC/MP fans?

BYTE RAM

One nifty way to get the 2K bytes of RAM you need for an SC/MP based system using NIBL could be to buy a *single* **MK 4816.**

The MK 4816 from Mostek is a wonderous new RAM chip which eats and spits out data, not in mere *bits* but in whole *bytes.*

Now for the bad news: The MK 4816 is dynamic (groans). Now the good news: The MK 4816 has on-chip refresh! (Cheers). Yes folks, someone has finally done away with all that horrible address multiplexing circuitry and those nasty RAS and CAS strobes and refresh clocks by organising a 16K bit dynamic RAM into a sensible byte-wide format, and putting all the necessary support circuits right there on the chip.

To the outside world, the MK 4816 can appear just like a static RAM, but inside it's dynamic, so you get all the advantages of dynamic chips with none of the disadvantages.

One of the most striking advantages is the low power consumption of only 150mW when active, but that's not all, because there is also a low power standby mode when the chip is de-selected which reduces consumption to just 25mW (that's only 5mA from a 5V supply so you could power your RAM from batteries during a power loss if you needed to preserve valuable data.)

The MK 4816 comes in a 28 pin package where the lower 24 pins (3–26) conform to the standard 24 pin ROM/PROM format so that sockets can be used for either RAM or ROM as required by a particular system.

The MK 4816 is just becoming available, but in the future we can expect to see more chips following the lead it has set, including a 4K by 8 monster from Zilog!

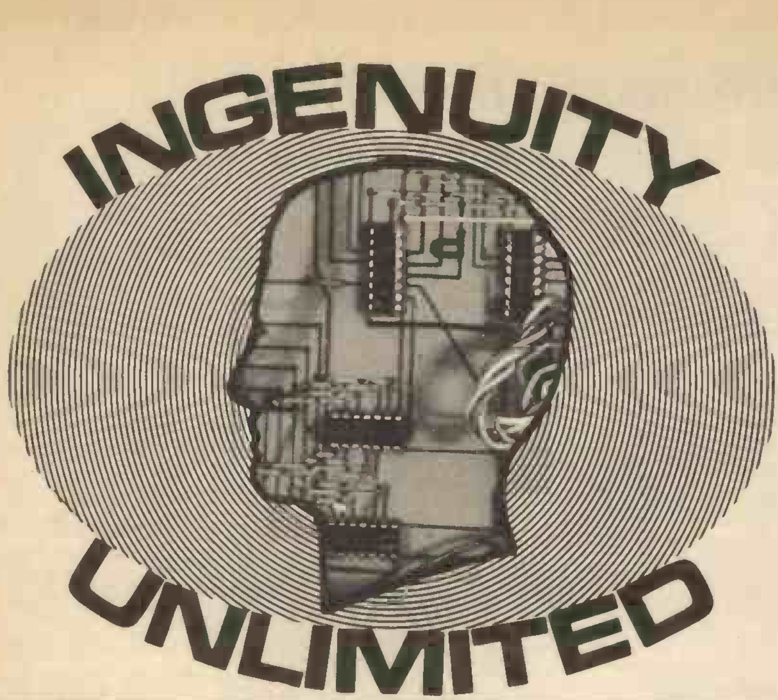
QUADRUPED

Voltage regulator circuits are old hat these days, and not the stuff of which headlines are made. Development continues however, and there is now such a range of regulator chips to choose from that it is important to keep up to date so that you can make the right choice for any new application that needs a stable d.c. supply voltage.

Most of the glamour seems to lie with the fixed voltage types, and their ever increasing current capability, but coming along strongly are the three terminal adjustable types which are good for the hobbyist's spares box because they can be used for any power supply application which takes one's fancy.

They can be a bit pricey though, and Fairchild have tackled this problem with a whole new family of *four*-terminal adjustable regulators which come in low cost plastic TO202 packages.

There are 0·5A and 1·0A, positive and negative versions, and typical advice codes are **μA78MGU1C** for a 0·5A positive regulator and μA79GU1C for a 1·0A negative regulator.



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

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

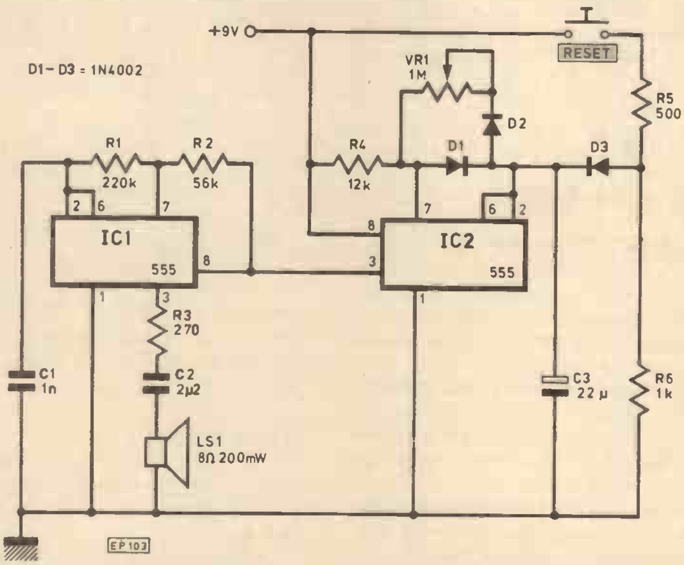
Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

LIGHTNING CHESS TIMER

An interesting and lively variation of the ancient game of chess is lightning chess. The rules for this game are very similar to those of ordinary chess, the main difference being the short time allowed each player to make his move (usually five seconds).

A lightning chess timer should give a distinct buzz (or bleep if a speaker is used in place of a buzzer) at regular intervals. The duration of each bleep should be about a quarter of a second while the interval between bleeps must be variable, and range up to fifteen seconds.

The circuit employs two 555 timers, both operating in a free-running mode. IC1 acts as an audio oscillator, delivering a frequency of about three kilohertz to the speaker. IC2 switches IC1 on and off at predetermined intervals.



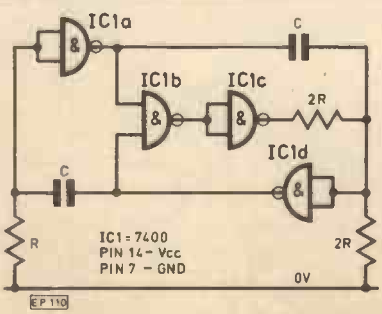
A reset facility is included whereby the timer may at any time be reset at the push of a button. This allows a slightly different version of lightning chess to be played. Every player presses the reset button after he has played his move, so that when the timer does bleep it means that the player whose turn it was to move has overstepped his time limit and he loses the game.

Y. H. Diamant,
Zaria,
Nigeria.

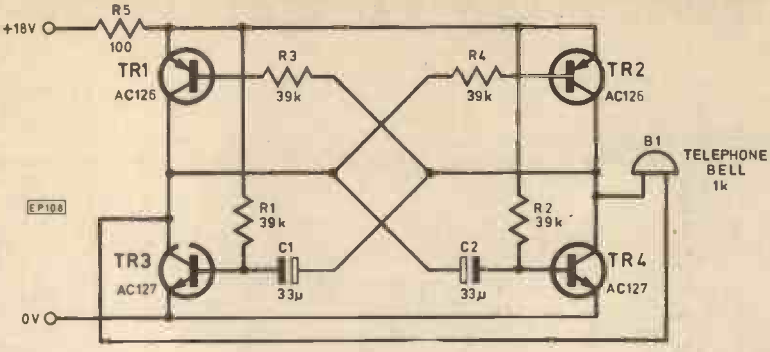
TTL OSCILLATOR

The 7400 quad NAND gate is often used as an astable multivibrator but has poor starting characteristics, usually requiring a "spike" on the supply line at switch on to initiate oscillation. This simple circuit uses the two spare gates in the package plus one extra resistor to ensure the circuit has positive self start characteristics.

R. D. Homerstone,
Daventry,
Northants.



D.C. RINGING FOR INTERCOMS



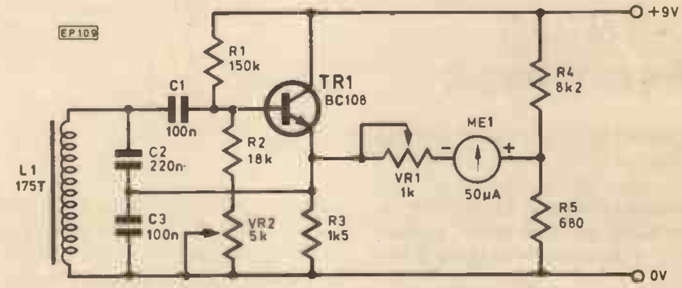
THE circuit shown is suitable for operating a polarised telephone bell from an 18V d.c. power supply *(on no account should P.O. systems be interfered with)*.

A low impedance output of approximately 35V peak to peak is obtained without the use of transformers. The circuit is basically an astable multivibrator formed by R1, R2, C1, C2, TR3 and TR4. However, the normal collector load resistors have been replaced by an active load, namely TR1 and TR2. TR1 base is fed via R3 to the collector of TR4. Consequently TR1 is always on when TR3 is off and vice versa. At each side of the circuit there now arises a push-pull output. By utilising both of these outputs and feeding them to the telephone bell, the output voltage is approximately double that of the supply voltage. R5 simply limits any excessive current surges from the power supply during transition of switching states when all transistors are partially on.

This circuit may be built on to a small piece of tag strip placed inside a telephone, and inserted into the two existing bell wires. The telephone may now be treated as having a d.c. operated bell and the basis for a home intercom using d.c. ringing. The relatively low voltage required for operating the telephone bell may be derived from the power supply feeding the speech circuits.

R. A. Sudron,
Leeds.

SHORTED TURNS DETECTOR



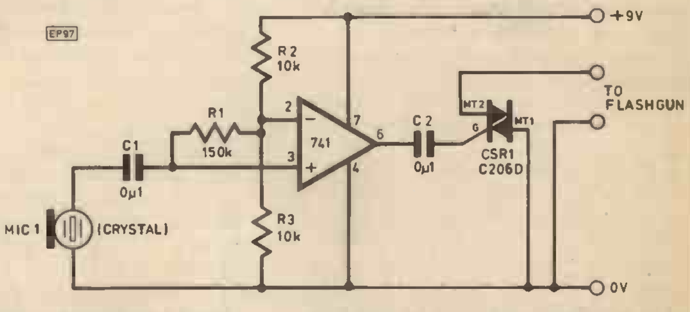
THE accompanying circuit shows a shorted turns detector of high sensitivity which may be built at low cost. The detector is based on a standard Colpitts oscillator.

Initially TR1 is biased into conduction by R1, R2 and VR2. As the oscillations build up rectification occurs at the base/emitter junction resulting in increased emitter current and therefore increased voltage across R4 if oscillations are damped by a shorted turn placed around L1, it follows that the voltage across R3 will now fall towards its quiescent value. This change of voltage is indicated by a 50µA meter, zero adjustment being performed by VR2.

VR1 is adjusted for full scale deflection with a shorted turn placed around L1. L1 is not critical, consisting of 175 turns of 30 s.w.g. enamelled copper wire close wound on a piece of ⅜in. diameter ferrite rod.

R. D. Homerstone,
Daventry,
Northants.

SOUND OPERATED FLASH



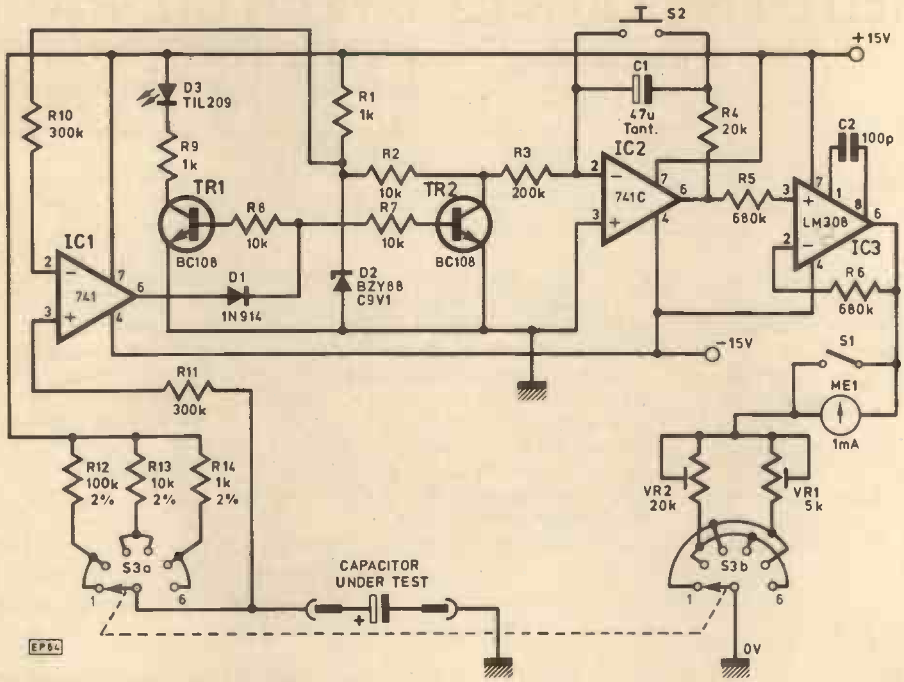
THIS very simple circuit will fire a photographic flashgun of any polarity, because of the use of a triac rather than a thyristor.

The output from the crystal microphone is coupled by C1 to the comparator, IC1. Positive input bias is supplied by R1 which, due to the input bias voltage drop, determines the input sensitivity. With the values shown this is about 30mV peak, although it can vary considerably depending on the characteristics of the op-amp.

When a sound is made near the microphone, the output of IC1 swings between the supply rails at the frequency of the input. On the first negative going excursion, the triac switches on firing the flashgun. The triac will remain on until the flash is complete, at which time the circuit is ready to supply another flash trigger.

P.R Williams,
Stevenage, Herts.

METER FOR ELECTROLYTICS



CAPACITORS of values up to 10,000μF can be measured with this instrument, and 6 ranges are available as follows:

Range	1	0–30μF
	2	0–100μF
	3	0–300μF
	4	0–1,000μF
	5	0–3,000μF
	6	0–10,000μF

The smallest value that can be measured accurately depends on the resolution of the meter used. No new meter scale need be made since the scale is linear and forward-reading, this simplifies construction.

There is one slight disadvantage with this instrument, this being that the capacitor under test may have over 10V across its terminals, and so low voltage capacitors may be damaged.

Before the capacitor under test is connected into circuit, the non-inverting input of IC1 is connected to the positive rail via a resistor. IC1 acts as a comparator, its inverting input being connected to a 9·1V Zener reference. The output of IC1 is high in value, about +13V. TR1 and TR2 are thus turned fully on, TR1 lighting the l.e.d. D1 protects the base-emitter junctions of the transistors from reverse breakdown. IC2, which is connected as an integrator, is fed with the output of TR2. When TR2 is turned off, IC2 produces a negative-going ramp output, this is buffered by IC3 and fed to ME1. When a capacitor is connected, the voltage of the non-inverting input of IC1 is lowered to zero, IC1 thus switches and TR1 and TR2 turn off. The l.e.d. extinguishes, and 9V is fed to the integrator. The negative-going ramp produced moves the needle of ME1, linearly with time, hence time is recorded on the meter.

Meanwhile the capacitor under test is charging up. When it reaches 9V, the comparator is switched and the integrator is stopped. The time for all this to happen is measured on ME1, and is approximately equal to the time constant of Cx and its series resistor, R12, R13 or R14.

Tolerances in the circuit, especially C1, are large, so the meter is calibrated using a capacitor of known value by varying VR1 and VR2. When the timing process has finished, D3 lights, showing that the capacitance can be read.

C1 is a low-leakage tantalum capacitor. In practice, however, its leakage is apparent since the meter needle does not remain at a steady value after the timing period. To counter this, current is fed into the capacitor when TR2 is turned off. This current is about 1μA. Since R3 is 200kΩ, then to counter the leakage the saturation voltage of TR2 needs to be 0·2V.

If needed, R7 can be adjusted to cancel the leakage exactly. The prototype needed a value of 10kilohm for R7.

R4 limits the current from IC2 when S2, a reset button, is depressed. The internal resistance of C1 is such that S2 needs to be closed for a few seconds to discharge it completely.

The power supply should be at least ±12V, and no more than ±15V. The prototype employed a power supply with two regulator i.c.s. S1, which shorts the meter to prevent damage when not in use, is ganged to switch the power supply.

D. P. Akerman,
Coventry.

P. Dinsdale

Solders & Soldering

SOLDERING is probably one of the aspects of this hobby to which the amateur radio or home electronics enthusiast gives least consideration. Applying a hot iron to a soft silvery coloured metal, which then melts and flows to form a joint is such a straightforward process that beyond taking a few simple precautions, for example, avoiding dry joints, not too much concern needs to be expended. It is this reliability in the formation of mechanically and electrically sound joints that has assured that soldering is still an accepted joining technique used by the enthusiast and by the electronics industry. The efforts of soldering equipment manufacturers have made sure that for the user, soldering remains a straightforward technique, despite more obvious advances in other areas of electronics and the increasingly stringent demands being placed on the production of electronic assemblies.

DEFINITION

Before discussing solders and soldering methods in detail it might be helpful to outline some of the basics. Soldering (sometimes known as soft-soldering) has been defined as the joining together of two metals using a low melting temperature tin-containing alloy as the filler metal. The melting temperature of this filler metal (the solder alloy) is usually considerably lower than that of its constituent elements, or than the melting points of the metals being joined. In fact the term "soldering" generally refers to processes taking place below 450°C.

Solders act in the following three ways:

(a) Wetting the basis metal surfaces forming the joint.
(b) Flowing between these surfaces by capillary action so as to fill the space between them completely.
(c) Metallurgically bonding to the surfaces when solidified.

The surfaces to be joined should be perfectly clean in order to ensure that wetting, and subsequent metallurgical bonding can take place. Part of the job of the flux is to dissolve any oxide coating adhering to the basis metal. Wetting of the basis metal surfaces is of prime importance. The nature of the wetting action itself is quite complex and results from the mutual solubility of tin (the active constituent) in the liquid solder and in the substrate.

The primary requirement of soldered joints in electronics is to provide an electrically conductive path, but considerations of mechanical strength may also be relevant on occasions. Although the electrical conductivity of solder is only about 8 to 13% that of copper, the short conducting path through the solder in a joint does not normally have to be considered as adding significant electrical resistance to the circuit.

SOLDER ALLOYS AND FLUXES

One of the most obvious characteristics of solders is that they are low melting point alloys; most of the commercially important solder alloys being fully molten below 250°C. It is also accepted that in general the higher the tin content of the alloy the better are its wetting properties.

A great many of the solder alloys in common usage are binary mixtures of tin and lead. The tin-lead mixture is known as a simple eutectic system. The eutectic is the composition of the binary mixture at which the two component metals solidify as a whole when the liquid is cooled, forming a solid solution. This point occurs at the lowest attainable temperature. In the tin-lead system the eutectic point occurs at the composition 62% tin – 38% lead, at a temperature of 183°C. At other compositions, particularly in alloys containing around 80% lead, the mixture has a wide temperature range over which it is neither completely molten nor completely solid; this is known as the "pasty" range. All tin-lead alloys will be partially molten at 183°C but only the 62% tin – 38% lead alloy, the eutectic alloy is fully molten at this temperature. For example, the commercially available 30% tin – 70% lead alloy is only fully molten above 255°C. The most commonly used tin-lead solders employed in electronic applications are 60% tin – 40% lead and 63% tin – 37% lead, of which both alloys are close to the eutectic composition and melt over temperature spans of 5 and 2°C respectively.

Sometimes up to 5% of antimony or silver may be added to tin or tin-lead mixtures to produce solders with slightly different properties. Such alloys may be useful in certain applications but may also introduce a number of undesirable factors, such as higher cost or deterioration in mechanical or wetting properties. Because of this they are only used when absolutely necessary. Tin-zinc solders are used for soldering aluminium, and alloys containing cadmium or indium may be employed when low melting point solder is required.

As already stated, for normal service in electrical and electronic applications, binary tin-lead alloys containing between 60 and 65% tin are chiefly used since they solidify at low temperatures over a short temperature range and, since they contain a high proportion of tin, have excellent wetting power, permitting short soldering times. This last factor is particularly important in industry where high production rates are necessary for economic operations. Sometimes such solder alloys are saturated with copper additions (around 1·5% copper) to reduce the corrosive attack by the solder on unclad copper soldering-iron bits. Tin-lead solders containing 50% or more lead are used for such applications as sheet metal assembly, copper plumbing, automobile radiator manufacture, and repairing and shaping car bodywork.

It may be necessary in some instances for joints to retain their strength at temperatures above 100°C, and here alloys of tin with 5% antimony or 3·5% silver can be used. In contrast, at very low temperatures a 90% lead - 10% tin alloy should be used where strength and toughness is important.

In the increasingly important commercial thick film hybrid circuits employing palladium-silver conductive tracks, a 62% tin - 38% lead - 2% silver alloy is frequently used to prevent the silver-containing layer on the circuit from dissolving in the solder alloy. A tin-lead-indium-zinc solder has been formulated to reduce the risk of embrittlement when soldering onto thick gold coatings, and a 70% cadmium - 30% tin alloy has been employed for systems where stray e.m.f.s due to thermo-electric effects must be kept to a minimum.

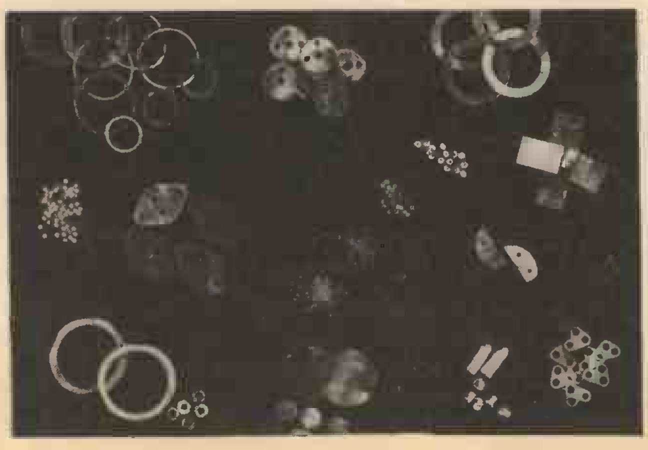
PHYSICAL TYPES OF SOLDER

Solder is manufactured in many different forms to meet the needs of particular applications. Perhaps the most familiar form for soldering with an electrically heated iron is that of solder wire, normally supplied in reels, in a range of diameters from about 0·7mm to over 5mm. These wires are manufactured by extrusion of the alloy followed by conventional cold drawing. Often there are one or more strands of rosin-based flux contained within the wire, introduced during the extrusion process. Normally the proportion of flux in the wire is around 3% by weight, and a number of flux cores are usually employed so that in event of a void in one of the cores there is sufficient flux available in other cores. The advantages of flux-cored solder wire include rapid flow of flux onto the joint when the wire is melted and quick melting of the wire on contact with the heated surface.

Solder paints, pastes and creams are made of finely divided solder particles suspended in a viscous flux together with a neutral carrying agent. Solder paints can be applied by brush or roller for tinning purposes. Pastes and creams, containing around 85% by weight of metallic solder, are applied by brush, syringe or spatula (in industry screen printers and automatic dispensers are also used) to the joint area to ensure exactly the right quantity of solder is employed. The viscous, tacky pastes readily stay in position and can act as temporary adhesives to hold components in place until the solder is melted.

In recent years the use of solder preforms has grown in the electrical and electronics industry and they are now available in a wide range of shapes and sizes, with or without flux cores. The types of preforms manufactured include washers, rings, discs, pellets and spheres as well as more elaborate shapes for more complex soldering jobs. Solder preforms are ideally suited to applications where a precisely controlled amount of solder needs to be applied to every joint, either by hand or automatic soldering.

Other forms of solder available include ingots, bars, sticks, sheet and foil strips, all of which are intended for different types of soldering jobs.



Solder preforms for various applications, which can be positioned prior to heating.

FLUXES

Soldering fluxes are liquid or solid materials which when heated are capable of promoting or accelerating the wetting of metals by solder. Any flux used in a given application should provide a liquid cover to exclude air from the joint up to the soldering temperature and dissolve away any oxide on the metal surface or on the solder. It should also be readily displaced from the basis metal by molten solder, and any residues should be easily removable following the soldering operation.

In electrical and electronics applications so-called "non-corrosive" fluxes are mainly used. It is possible to use pure, natural rosin dissolved in proportions of 20 to 50%w/v in a suitable organic solvent such as isopropanol. The active constituents in such a flux are abietic acid and its isomers, which become mildly active at soldering temperatures. However, it is usually necessary to improve the fluxing power by adding small quantities of organic halide activators. These activated rosin fluxes are formulated so as not to give rise to corrosive products after soldering.

In the case of more difficult to solder non-ferrous alloys, organic acid and organic halide fluxes are used, and for soldering steels and other alloys in general engineering, highly reactive and corrosive zinc chloride fluxes are necessary.

SOLDERING METHODS

Before undertaking soldering operations it is essential to assure that the surfaces to be soldered are perfectly clean. Some metals are more readily solderable than others; for example gold-, silver- and tin-coated parts normally display excellent solderability, copper and its alloys have quite good solderability, whilst aluminium can at best be regarded as difficult to solder. Whatever the substrate, it is necessary that the surfaces should be in a suitable condition for soldering. If soldering difficulties are encountered it may be that some sort of cleaning operation should be carried out before satisfactory joints can be obtained.

The surfaces should be free from all oil and grease. This consideration is of more importance for soldering in industry where quite elaborate degreasing procedures may be employed. Oxide films which form over a long period of time can be removed by using abrasive papers, although these should not be used for soft metals such as tin, as particles of abrasive may become embedded in the metal. Immersion in dilute acid may remove certain oxide and tarnish films.

MANUAL SOLDERING

Before applying solder to a joint it should be considered whether it is necessary to prevent heat flowing into areas that have already been soldered, or to heat-sensitive components. Heat shunts can take the form of specially designed tweezers, although the judicious use of a pair of pliers during hand soldering can also form an effective heat shunt.

In all irons the key component is the bit; it is essential that the bit surface is wetted or "tinned" by the solder in order to encourage the flow of solder onto the joint. The bit stores heat and conveys it to the work, stores and delivers a minimal amount of molten solder to encourage heat transfer (the bulk of solder should be applied simultaneously with the soldering iron), and the bit should also be capable of removing surplus solder from the joint. The size of the bit and the power rating of the iron are related to the amount of heat to be supplied during each soldering operation and to the intended rate of working. Copper is the material used most frequently for bit construction as it combines good melting properties with optimum heat capacity and thermal conductivity. To prevent erosion of copper bits by solder, copper saturated solders, or iron or nickel plated bits may be employed.

During the soldering operation the pre-heated iron is held against the proposed joint, and the solder, usually in the form of flux-cored wire, is applied to the work close to the bit, where it should melt immediately. If sufficient solder has been applied it should completely penetrate and fill the joint gap. The time required to keep the bit on the work will depend on the nature of the joint and the characteristics of the iron. Gentle movements of the bit during soldering can assist rapid penetration of solder into the joint spaces. It is important to keep the bit properly tinned.

There are other, more specialised forms of manual soldering, used in industry in certain applications. These include such methods as radio frequency induction soldering, ultrasonic soldering and hot gas soldering.

HIGH QUANTITY SOLDERING

In the industrial production of printed circuit boards it would be far too costly and time-consuming to make each individual joint manually using a soldering iron. It is necessary therefore to

Here, thick film hybrid circuits are being soldered, using a technique more recognisable by the home constructor—the soldering iron!

employ mass soldering methods in which large numbers of joints are made simultaneously by using the molten solder itself as the source of heat. The most common forms of mass soldering involve immersion in, or contact with, a molten solder bath. Another important advantage of mass soldering techniques is that they allow better control over all individual stages.

The simplest method of mass soldering is known as dip soldering. In this process the prefluxed assembly on which all the components have been mounted is lowered vertically into the solder bath sufficiently for the solder to spread and form all the joints, but not enough for the solder to flow over the top of the board. The temperature of the bath is maintained in the range 220 to 260°C for a 60% tin - 40% lead alloy. The solder surface is kept free of dross by a scraping mechanism which skims aside oxides and flux residues immediately before soldering takes place.

Perhaps the most widely used technique of mass soldering is that of wave soldering which solves the problem of maintaining a clean, bright solder surface by having the solder in continuous motion. In this process the circuit board, mounted on a conveyor, moves horizontally across the crest of a continuously circulating, standing wave of molten solder. The wave is formed by pumping solder up through a narrow slot, where it overflows back into a sump. Various wave configurations are available. The path of travel towards the solder wave may be inclined upwards at an angle of about 15° to facilitate drainage of solder from the board after it has passed over the wave.

A wave soldering machine in use for large quantity production.

QUALITY CONTROL

The application of quality control techniques to the production of soldered joints in industry is extremely important since the failure of a joint may not only result in the job having to be reworked, but also a fault occurring during service may be potentially dangerous. Therefore, high reliability is demanded, particularly in applications such as aerospace, military equipment, telecommunications and computers.

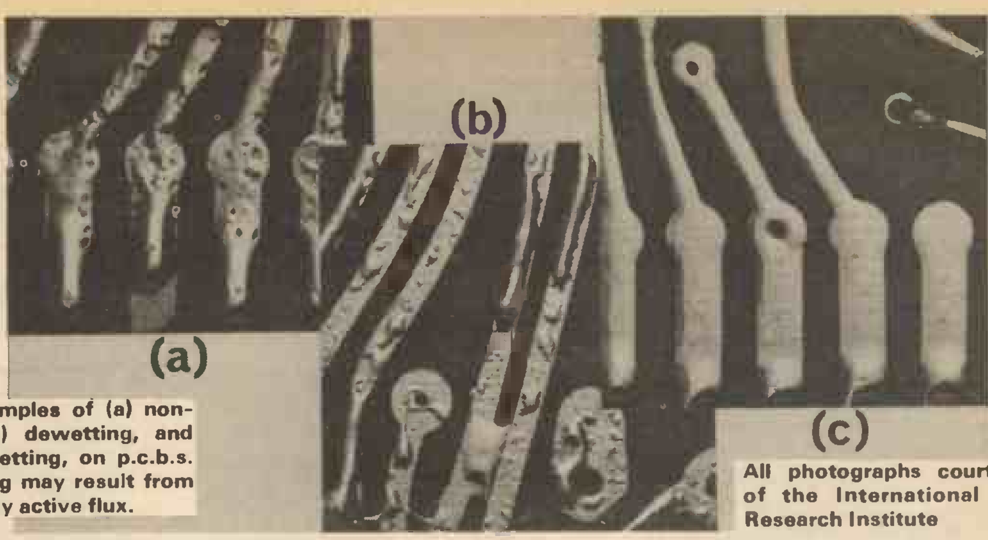
For the amateur, if the few relatively simple precautions outlined in this article are taken, soldering defects should not occur. One of the most common defects, known as dewetting, happens when the surfaces to be soldered have not been properly prepared. In dewetting there is a pronounced retraction of the solder into globules, after initial wetting has taken place, leaving an extremely thin, matt film of solder on the surface which the globules rest. A common cause of dewetting is the presence of a thin, discontinuous layer of surface oxide, or embedded particles of abrasive. If this phenomenon occurs it is necessary to further clean the surface before good wetting can be achieved.

It is also important during soldering to use the right amount of flux (this is controlled if flux-cored wire is used), not to apply too much solder, or to overheat the joint.

CONCLUSION

To sum up, the advantages of soldering (where soldering is applicable) may be stated as follows:

(a) Relative ease and speed with which it can be carried out.
(b) Versatility and range of heating techniques.
(c) Low cost when compared to other joining methods.
(d) Low temperatures involved do not normally affect the properties of the basis metals.
(e) Soldered joints may usually be taken apart by reheating, thus facilitating easy repair of circuits.



Typical examples of (a) non-wetting, (b) dewetting, and (c) good wetting, on p.c.b.s. Non-wetting may result from insufficiently active flux.

All photographs courtesy of the International Tin Research Institute

News Briefs

by Mike Abbott

FLICKER TO FLUORESCENT

LONDON'S South Kensington Science Museum now has a new lighting gallery showing artificial lighting from primitive oil lamps to the latest electric discharge lamps.

Scenes show visitors how people managed after dark throughout most history, and a variety of modern electric lights can be seen through filters for comparison of light source.

We are told that oil lamps have been mass produced for two thousand years, but until the 1780s they gave no more light than a candle. Argand's circular burner, patented in 1784, gave a much brighter light but suitable fuel was expensive until paraffin became readily available in the 1860s. The light of a gas flame was first used generally in the early 19th century, but the much brighter gas mantle dates only from the 1880s.

The exhibition includes a room lit by gas, and a pair of shop windows illustrate problems with the colour rendering properties of fluorescent lighting. (Too true! Have you ever discovered that those *chocolate brown* socks you bought are actually *maroon* when you get them outside the shop).

The museum is open from 10.00–18.00, Mon.–Sat., and 14.30–18.00, Sundays. Visit Gallery 41 on the second floor.

NO CAUSE FOR ALARM

IN PURSUIT of its ubiquity the microprocessor is creeping into the twilight world of crime prevention. The Silent Security System now available from Asmap Environmental Products of Newport, Isle of Wight, is Z80 based, and can be hooked up to an intruder alarm to watch out for that thief about! If it detects one, it doesn't reduce the burglar to jelly with a breathtaking siren, or ring a bell for the neighbours to ignore, it panics and phones the police. Well, it doesn't panic, but it *does* phone the police.

Up to nine digits can be preset (in PROM) for direct dialling to send an alarm message or tone to either a security officer, or via the normal police/public alarm system by means of a 999 call and a pre-recorded message.

Up to sixty hours of stand-alone operation is possible in the event of a power failure, and should the telephone lines be engaged a second number may be dialled, or if faulty, alternative actuations may take place such as that siren, or perhaps cameras or loudspeakers.

Of course, the system can operate from fire or smoke detectors, and make the appropriate alert.

COUNTDOWN

B.A.E.C. Amateur Electronics Exhibition —July 21-28. Held at the shelter at the centre of the Esplanade, Penarth, South Glamorgan. The exhibition is to display a large number of projects and electronic games made by members, and will be open every evening from 7 p.m. (except Sunday, July 22), and also on the afternoons of July 21, 22 and 28. Proceeds go to the Cancer Research Campaign.

Harrogate International Festival of Sound—August 18–19 (public), August 20–21 (trade) 1979. The Exhibition Centre + hotels. Details: Exhibition and Conference Services Ltd. Tel: 0423 62677.

Telecom '79—September 20–26. Palais des Expositions, Geneve. Details: Secretariat Telecom '79, Orgexpo, 18 Quai Ernest Ansermet, Case Postale 65, CH-1211, Geneve 4 (Suisse).

Eltro Hobby '79—October 3–7, Killesberg Exhibition Grounds, Stuttgart. Details: 01-236 0911.

Personal Computer World Show—November 1-3. West Centre Hotel, London. The *computer* versus *computer* Chess Championship will again take place, and this year the prize money has been increased to £1,500 (a considerable sum to give a computer we are told). Further details to be announced.

Compec—November 6–8, 1979. Grand Hall, Olympia, London. Details: Iliffe Promotions Ltd. Tel: 01-261 8437/8.

Professional Viewdata Exhibition '79—November 7–8. West Centre Hotel, London. Business orientated exhibition sponsored by Viewdata & TV User Magazine. An exposé of who's doing what on the Teletext and Prestel scene.

Electronics 79—November 20–23. Olympia, London. Details: 021-705 6707.

Breadboard 79—December 4–8. Royal Horticultural Halls, Westminster. Details: Trident International Exhibitions. Tel: 0822 4671.

IEA/Electrex—February 25–29, 1980. National Exhibition Centre, Birmingham. Details: Industrial and Trade Fairs Ltd. Tel: 021-705 6707.

Communications '80—April 14–18. National Exhibition Centre, Birmingham. Details: ITF Exhibitions. Tel: 021-705 6707.

All-Electronics Show (1980)—April 29–May 1, Grosvenor House, London. Details: 0799-22612.

RETURN OF STEAM

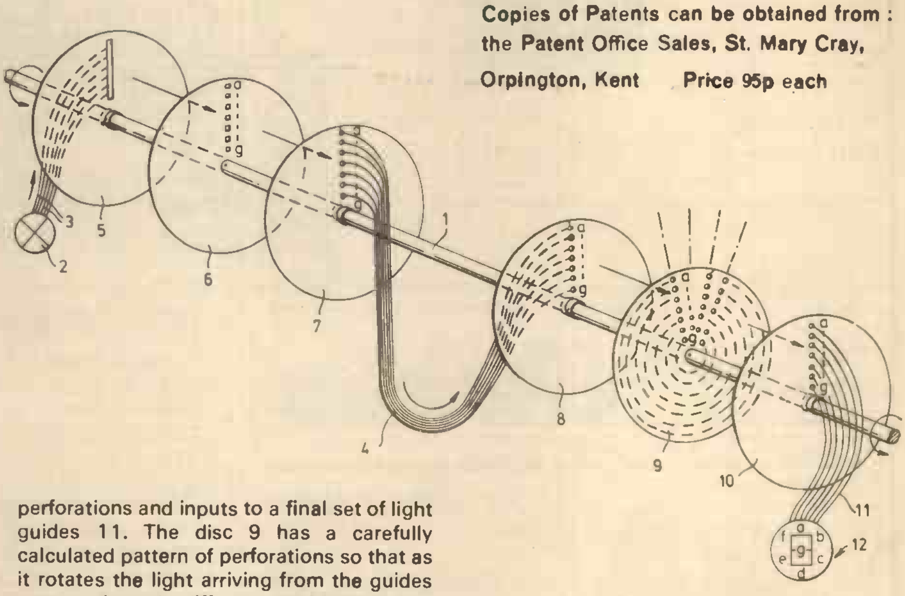
THE M-O Valve Company, in response to a demand for high quality audio valves, has reintroduced its *Gold Lion* range of output tetrodes. The valves are packed in a distinctive Gold Lion carton, each containing a test report, and the back-up literature includes full amplifier and pre-amp circuit information covering 30 to 200 watts.

B.A.E.C. HON. SEC. MOVE

THE B.A.E.C. Hon. Sec. has moved from Bristol to Cheltenham, the full address being: J. G. Margetts, Hon. Sec., B.A.E.C., 3 Bishopstone Close, Golden Valley, Cheltenham, Glos.

PATENTS REVIEW...

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



TORSIONAL METERING

An interesting opto-mechanical approach to metering is being patented by Ferranti Ltd. of Lancashire in GB 2 001 431 A. The application is under the new laws and dates back to June 1977. The object is to provide an instant digital readout of the torsion in a shaft, but the idea could well be applicable to other mechanical situations where digital readout is required.

As shown shaft 1 carries a series of discs, variously perforated with slits, holes and bars. At one end of the shaft a source 2 inputs light to the ends of a batch of optical fibre light guides 3. The light from the output ends of these guides can reach the input ends of further guides 4 only when the perforations of a first series of discs 5, 6, 7 are correctly aligned. This alignment gives the system a datum position. The light guides 4 output through perforations in disc 8 and the output light passes through perforations in disc 9 to disc 10 with perforations and inputs to a final set of light guides 11. The disc 9 has a carefully calculated pattern of perforations so that as it rotates the light arriving from the guides passes through different perforation patterns. Thus as the disc rotates a varying pattern of light reaches the inputs of the guides 11. The guides 11 output to a readout disc 12 with an arrangement of seven windows in a figure of eight configuration. In this way slight movement of the disc 9 can cause the transitional display of digits in the windows of the disc 12 to provide a readout which is representative of torsion in the shaft 1 between the discs 9 and 6. The patent describes these and other refinements of the system in great detail, including one arrangement for rotating the datum position to provide a continuous display.

DOUGHNUT DAMPING

A good example of how the new patents law can benefit the public and inventors alike is to be had from comparison of BP 538 847, in the name of the Rank Organisation, and GB 2 002 200A, in the name of the Nissan Motor Company of Yokohama City, Japan.

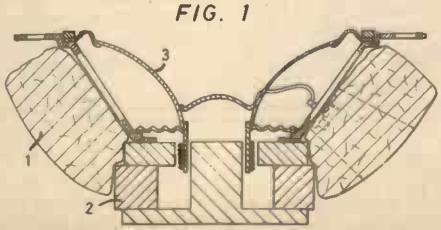
The Rank patent was applied for in 1975 and is thus granted under the old law; the Nissan patent is still in the pending stage and has been published under the new law. There is interesting common ground between the two patents and this common ground could be damaging to Nissan's chances of securing a granted patent.

Both patents concern methods of damping the rearward, antiphase radiation of sound from a loudspeaker. As the Rank patent explains, it is customary to mount a loudspeaker in a cabinet containing wool or plastic to damp the rear radiation. But the damping material results in high stiffness of the air cushion inside the cabinet and the cabinet walls tend to vibrate. Moreover there is a risk of overheating in the cabinet space due to heat dissipation by the loudspeaker voice coils.

Nissan make much the same point with particular reference to the problems encountered when mounting a loudspeaker in a motor car. Both teams of inventors propose a similar solution; an annulus of sound damping material clamped to the rear of the loudspeaker.

Nissan (see Fig. 1) show an acoustic absorber 1 of bitumen-containing urethane foam which takes the form of a ring like a large doughnut. This ring sits on the loudspeaker magnet 2 and overlies virtually the whole rear area of the conical diaphragm 3. Thus all sound radiating to the rear of the diaphragm 3 meets acoustic resistance. Nissan claim that in this way undesirable resonant peaks in the range 50 to 500Hz are suppressed to an acceptable level.

FIG. 1



The earlier idea from Rank goes a stage further. As shown (in Fig. 2) there is again a doughnut shaped ring 1 which sits on the loudspeaker magnet 2 and backs onto the rear of the loudspeaker diaphragm. But additionally Rank provide a second damping element 3 which takes the form of an open cylinder of foam surrounding the loudspeaker unit. Together the damping elements 1 and 3 absorb and deflect the rearwardly directed sound from the diaphragm.

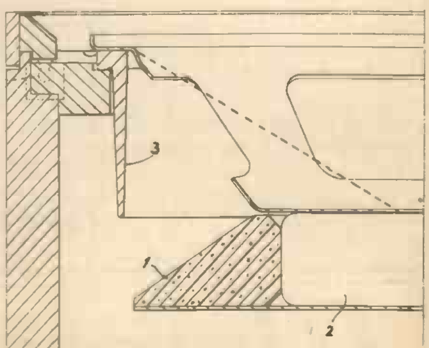


FIG. 2

QUARTZ LCD 5 Function

Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.,
Split and lap modes.
Back-light, auto calendar.
Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£10.65 Thousands sold!
Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs., month, date, day.
6 digits, 3 flags plus continuous display of day and date or seconds. Back-light
Only 9mm thick.

£12.65

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags,
22 functions.
Constant display of hours and mins., plus optional seconds or date display.
AM/PM indication, month, date.
Continuous display of day.
Stop-watch to 12 hours 59.9 secs., in 1/10 second steps.
Split and lap timing modes.
Dual time zones.
Only 8mm thick.
Back-light. Fully adjustable open bracelet.

£22.65

Guaranteed same day dispatch

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags
22 functions.
Solar panel with battery back-up.
6 basic functions.
Stop-watch to 12 hours 59.9 secs., in 1/10 sec., steps.
Split and lap timing modes.
Dual time zones.
Alarm. 9mm thick. Back-light.
Fully adjustable bracelet.

£27.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59.9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up.
6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.
Split and lap modes.
Back-light, auto calendar. Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£12.65

Guaranteed same day despatch.

M9

SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass.

List Price £130.00

METAC PRICE

£105.00

M10

SEIKO MEMORY BANK

Calendar watch M354
Hours, mins., secs.
Month, day, date in 12 or 24 hour format all indicated continuously.
Monthly calendar display month, year and all dates for any selected month over 80 year period.
Memory bank function.
Any desired dates up to 11 can be stored in advanced.
2 year battery life.
Water resistant.

List Price £130

Metac Price **£105**

M11

SEIKO-STYLE Dual time-alarm Chronograph

Mineral glass face.
Battery hatch for DIY battery replacement.
Top quality finish with fully adjustable bracelet.

£35.00

M12

HANIMEX Electronic LED Alarm Clock

Features and Specification:
Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright/dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm).
Weight: 1.43 lbs (0.65 kg). AC power 220V.

£9.65 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

HANIMEX portable LCD clock radio

- Time set & alarm controls.
- Snooze & sleep controls.
- Wake to music or alarm.
- AM/PM indicator.
- Battery operated. No plug required.
- Receives all standard AM radio broadcasts.
- Drawstring carrying case included.
- Back-light.
- Batteries supplied free.
- Quartz crystal controlled.

£17.95

M14

QUARTZ LCD Ladies 5 Function

Only 25 x 20mm and 6mm thick.
5 function. Hours, mins., secs., day, date and back light and auto calendar.
Elegant metal bracelet in silver or gold.
State preference.

£9.95

Guaranteed same day despatch.

M15

Price breakthrough only £18.95

OUTSTANDING FEATURES

- DUAL TIME. Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- CALENDAR FUNCTIONS include the date and day in each time zone.
- CHRONOGRAPH/STOPWATCH displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- ALARM can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch. M16

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and the order details clearly, enclose 30p for post and packing or the amount stated. We do not wait to clear your cheque before sending the goods so this will not delay delivery. All products carry 1 year guaranteee and full money back 10 day reassurance. Battery fitting service is available at our shops. All prices include VAT.

Trade enquiries: Send for a complete list of trade prices – minimum order value £100.
Telephone Orders: Credit card customers can telephone orders direct to Daventry or Edgware Rd., 24 hour phone service at both shops: 01-723 4753 03272-76545.

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327 Edgware Road
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FROM THE INVENTORS OF MICROPROCESSOR MUSICAL CHIMES

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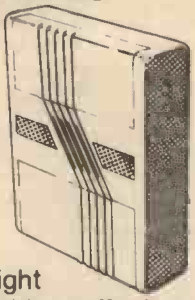

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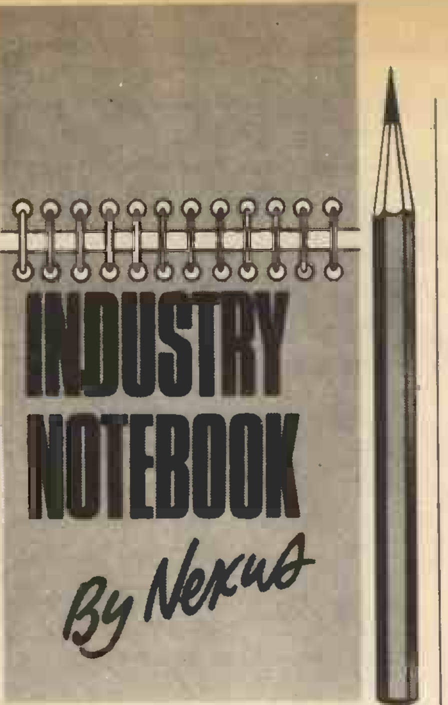

Right Turn

It is far too early to assess with any assurance the effect of the change of government on the industrial climate. The private sector almost universally welcomed the return of the Conservatives with a working majority which guarantees four or five years in which policies thought favourable to private industry can be implemented. Less central direction, less bureaucracy, less taxation, are all welcome. But, of course, nothing can change overnight in any material way.

The instant change was in morale. A fresh start became possible. Or so it seemed. In fact top performers like GEC and Racal historically have prospered as much under socialist governments as any other. The general feeling, however, was that the shackles are now off, or soon will be, and there is a real chance of winning. At least a company that does well financially will, one hopes, escape the old charge of "profiteering", while those who do less well are told they are "failing the nation". All will now get encouragement to do better.

To find out what will happen in the public sector we shall need to wait and see. Similarly, the future of the National Enterprise Board with its mixed bag of investments, not least the controversial Inmos venture.

Specifically helpful to the electronics industry is the new government's attitude to defence spending. Defence electronics has always been the spearhead of technological innovation and countries with a powerful defence industry traditionally maintain their lead.

Of perhaps less significance but worth recording is that Mrs Thatcher, as well as being Britain's first woman Prime Minister, is also the first with scientific training and laboratory experience.

For the past four years the most used political slogan has been "the regeneration of British industry". The electronics sector has done better than most during a difficult period. In some areas it has been outstanding and in the next decade it will be central to advance in all industries. No change of government in itself can regenerate anything, but a whiff of optimism and a return of confidence is not a bad start.

Manpower

However well intentioned a new Government, it inevitably inherits a number of constraints, both internal and external. It finds, on taking office, that it cannot move, except cautiously, if severe disruption is to be avoided. This is why the prospect of stable administration is welcome. There is a long haul ahead but over a period of five years much can be achieved, not least in attitudes.

A particular constraint in the electronics industry is the shortage of skilled manpower, particularly design engineers. The shortage was highlighted by Mr D. W. Morrell, President of the Electronic Engineering Association, in his recent address to members, as "one of our greatest problems of the moment". You can see how right he is just by reading the job ads in the papers.

Why the shortage? Relatively low pay for high qualifications (often mentioned in this column) is one, though not the primary, reason. Prospects are dazzling compared with most industries. The work is challenging, often exciting. It is a clean industry in which to work and has one of the best industrial relations records. It seems a "natural" for any youngster with talent. And yet not nearly enough come forward to take advantage of the opportunities offered.

An important factor is that engineering as a profession has been tarnished in recent years by adverse publicity eagerly taken up and propagated by socially conscious teachers in schools. Engineering is often represented as being somehow morally reprehensible—even obscene when topics like atomic power are mentioned. And quite unjustifiably so because engineers as a body are also socially conscious and responsible and ordered to be so by their professional institutions.

Much damage has been done. One thing the new government might do is to attempt to change the attitude in the schools and colleges to one of encouragement to budding engineers. A little more stress on the benefits of science and technology and a little less knocking might do a lot of good.

Cable & Wireless

Cable & Wireless, perhaps the most consistently successful of all our nationalised industries this year celebrated its 50th anniversary. It came into public ownership following the merger of the competing submarine cable and beam wireless businesses. From 1929 to the present day these two primary methods of long distance communications, one very old, the other then quite new, have been regarded as complementary.

Today the company has diversified into many new communications fields, all electronic based, and implemented throughout the world. In fact it is far better known overseas than in the UK and some 80 per cent of the employees work outside the British Isles.

British Aerospace

The newest of our nationalised industries, British Aerospace, has just completed its first full year and with good results. Trading profit was £79 million on a turnover of £894 million and the company went into its second full year with a record order book of close on £3,000 million, with nearly 70 per cent ticketed for export.

British Aerospace is the channel through which many of our most important electronics exports flow, especially in avionics and missile guidance and control systems. The possible termination of substantial contracts from Iran are not expected to seriously affect the overall buoyant outlook.

Convergence

The recent announcement by Racal Microelectronics Systems Ltd that their private in-house service to the Racal Group is now open to all comers is another interesting example of an equipment company expanding into the supply of sophisticated components. It is the opposite of the semiconductor manufacturers moving into the equipment field, of which there have been a number of recent examples. Perhaps in a decade or so the demarcation line between component and equipment people will have entirely disappeared.

Although only one year old, Racal Microelectronics Systems already claims to have developed over 20 complex LSI circuits for inclusion in Racal advanced products. The new service offered to industry includes designing with Uncommitted Logic Arrays (ULA) as well as LSI and thick-film hybrids. Using a standard Racal ULA wafer, working samples of new circuits can be designed and manufactured in less than three months, in some cases as little as seven weeks.

Keith Thrower, managing director, is an old Racal hand. He joined the company as an engineer in 1960 and was responsible for much of the design of early Racal digital instruments and frequency synthesisers before becoming head of Racal's Advanced Development Division some five years ago.

Musical Bargain

Semiconductor prices are keener than ever. Typical is the MPU chip used in the Chromatronics 24-tune electronic door chime which is based on the TI TMS1000. Now I note that you can buy this 28-pin package with all its built-in complexity for £4·95 (VAT included); even cheaper in quantity. Chromatronics believe that it will have many other applications, apart from door chimes, in the electronics toy and hobbyist markets.

readout

... a selection from our postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Gertcha!

Sirs—On seeing the cover of the May edition of *"Practical Electronics"*, and on reading subsequent disclosures inside, we noted several anomalies on the instrument panel of the car illustrated.

The car was apparently travelling at sixty miles an hour (engine speed 4,000 r.p.m.) with the handbrake on. This we feel was a rather pointless gesture, as the engine was in imminent danger of seizure, due to the fact that there was no oil pressure. The battery also seemed to be under a heavy discharge for such a high engine speed. This was presumably due to the current being drawn by the instrumentation, or the heated rear window and headlamps.

Anyway, function of the car apart, we consider that the driver was running a great risk as he was wearing no seat belt. The risk was compounded by the fact that he was driving with no hands on the wheel while initiating a right turn with the hazard warning lights on AND THE BONNET UP!

Assuming the car survived the almighty crash which followed, we would like to suggest a few repairs which should be undertaken:

1. New fan belt or alternator.
2. Top up with brake fluid (or release the hand brake!)
3. Top up with oil.
4. Replace clutch.

Alternatively, the car should be taken to the nearest scrap yard (after only 36·9 miles). Not one of Leyland's better attempts (We hope!)

A. Lorimer & A. Birse,
Clydebank.
Scotland.

Bouquet and Brickbat

Sir—Please accept this as a constructively critical letter–which is what it is intended to be.

First of all the bouquet. I have had subscriptions to several electronic magazines over the years, and still buy others on an occasional basis when they happen to have an item which interests me, but for some years now I have had a regular order for *PE*. My interests must be the very common ones—general "educational" items about new developments and, mainly, general constructional features. As it happens my particular interests are radio control and audio.

Overall a fairly typical reader and quite satisfied enough with *PE* to go on buying.

Now the brickbat. An increasing percentage of your magazine seems to be devoted to computer and microprocessor projects and programming. This was fair enough when it was a new field for the amateur, and I appreciate that it is still a growth area for the "home builder". However, there are now several magazines devoted entirely to home computers and, while I would not suggest that you exclude the field entirely, I would be grateful to see some of the space that you now devote to it returned to a wider range of constructional projects.

J. A. Purvis,
Sholing,
Southampton.

Thank you for your interesting letter—the points made have been noted and will obviously add to any others in a similar vein.

In reply we would like to make two points. Firstly, due to the increase, last year, in the relative number of editorial pages in PE we do not believe that we have reduced the number of projects in which you might be, interested! We have published only four m.p.u. projects since the end of the Champ series—the fifth is Compukit.

Secondly, a recent survey showed more regular readers are interested in m.p.u.s and related areas than in any other subject covered in our pages.

These points do not necessarily mean we have the mix right and we would like to thank you for passing on your views. The following letter may give you and others food for thought.

Any more bouquets or brickbats?–Ed.

Logical software?

Sir—I would like to comment on the "symbols" used in diagrams—basically I'm in agreement with you regarding the decimal point. However, the use of 0V2 in the text describing an amplifier input of 200mV destroys the flow. Personally I've used boxes for resistors for 10 years when drawing (also transformer windings) as they are neater and quicker to draw.

Please let's have more *Microbus*. There seem to be many mags devoted to those who have £XXX to spend upon a self-contained toy computer, monthly offerings of games and the like. However, your recent venture into the low-cost peripherals is most welcome, even though I'm not likely to extend my micro just yet.

Could I suggest another subject for a long series?–"Logical Software".

I have two projects which are nearing completion in that their requirements are known and the TTL/CMOS logic needed is reasonably understood. This normally leads to the next stage: buying the logic and making it work. The last stage is frequently omitted: pulling it apart and doing the job properly using the knowledge gained from the prototype.

Project 1–House alarm, giving various levels of entry/warning so the unit can be "on guard" most of the time.

Project 2–Heating control, giving various switching-on times and heat levels to optimise the fuel.

Both of these can be realised using "hard" logic—what I bought a micro for was to (eventually) design a universal micro-board which would cater for such projects by altering the software. Both require many inputs (door switches/temperature) and a few outputs (enter key code/hot water solenoid).

Your boffins could develop such a unit which would be of great use to engineers that want to use micros (rather than play with systems). There are countless projects which could be software-implemented so the interest could be renewed from time-to-time. However, may I give you a warning? Be careful not to have the whole thing *written* by a boffin. Your title is "Practical . . ." and you will realise there is a large gulf between building a "KOJAK" horn using multivibrators or 555 type timers and realising the same end (together with "Col. Bogey") by writing software.

There is yet another project for a "*PE* Micro project p.c.b." receiving hex data from micro and contact closures and displaying it on 7-segment readouts.

H. S. Lynes,
Carshalton Beeches,
Surrey.

Springs and Buckets

Sir—I was very interested to read your article on binaural stereo patents in March's *PE*. Of particular interest was mention of the Matsushita mechanical spring and the capacitance bucket brigade methods of introducing artificial reverberation, in headphone listening.

There is, as far as I am aware, no spring device on sale in the UK for hi-fi use, although systems for use with P.A. (disco's, etc.) are quite cheap (about £50). This compares with some bucket brigade equipment (for use with hi-fi) selling for £500 to £1,000.

Considering what is required of a reverberation system, I do not see why spring devices fall outside the scope of hi-fi as their ranges (100–10,000Hz) and distortion (1 per cent) compare with electronic systems.

I think Matsushita's spring transducer could be very successful and it may pay a British manufacturer to think of the mechanical system for other uses, say loudspeaker stereo, or surround sound experiments (dare I mention those words?).

J. W. Jones,
Widnes,
Cheshire.

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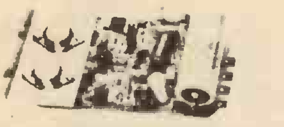

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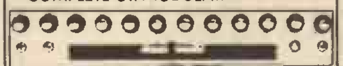

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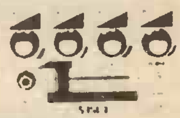

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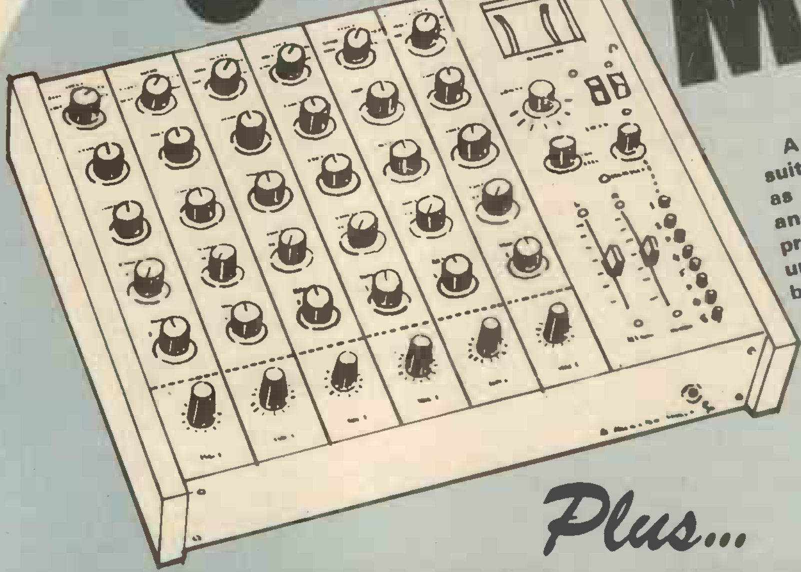

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Class A Headphone Amplifier

Stephen Price

THE stereo headphone amplifier described makes use of a straightforward design specifically intended to drive dynamic headphones with impedances as low as 50 ohms per channel. It includes its own mains power supply and will accept a low level stereo input direct from a radio tuner or tape deck. However, as the basic amplifier does not provide facilities such as source switching, disc equalisation, tone control and filtering it is best suited for use in conjunction with a separate preamplifier.

Numerous designs for solid state preamps have been published in recent years, but as an alternative, any ready built preamplifier unit or circuit module of commercial origin may be employed.

A trend in recent years has been the increasing popularity of stereo headphones as an alternative to loudspeakers. This is hardly surprising as headphones offer a number of important advantages: Firstly, they are very economical—a pair of headphones costing £30 might reasonably be expected to give the same quality of reproduction as a loudspeaker system which retails at over £100. Secondly, the nuisance factor of headphones is practically nil.

It is common practice for hi-fi manufacturers to provide a headphone output socket on the front panel of their amplifiers and stereo receivers. This headphone feed is derived from the final transistors of the two class B ouput stages and will normally be routed via a simple resistive attenuator.

There are numerous advantages to be gained, however, in the formulation of an amplifier design specifically intended for headphone operation. Dynamic stereo headphones have impedances far higher than moving coil loudspeaker systems. A typical high quality loudspeaker will present an impedance of between 6 and 8 ohms to the amplifier. In contrast, dynamic headphones have impedances in the range 50 to 2,000 ohms depending on their exact design. It will be apparent, therefore, that far less power is required to drive these transducers satisfactorily. High output power not being a requirement, a return to true class A operation with solid state transformer-less circuitry becomes practicable.

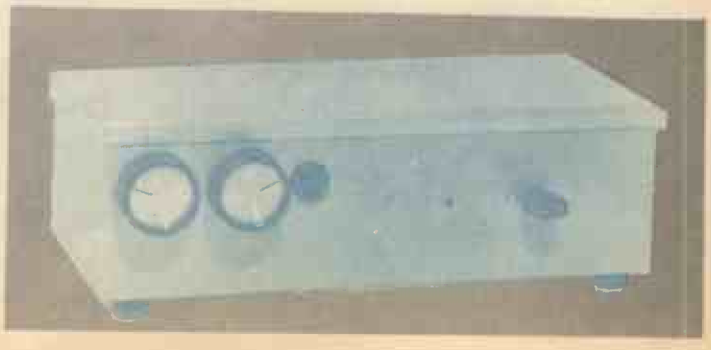
CIRCUIT

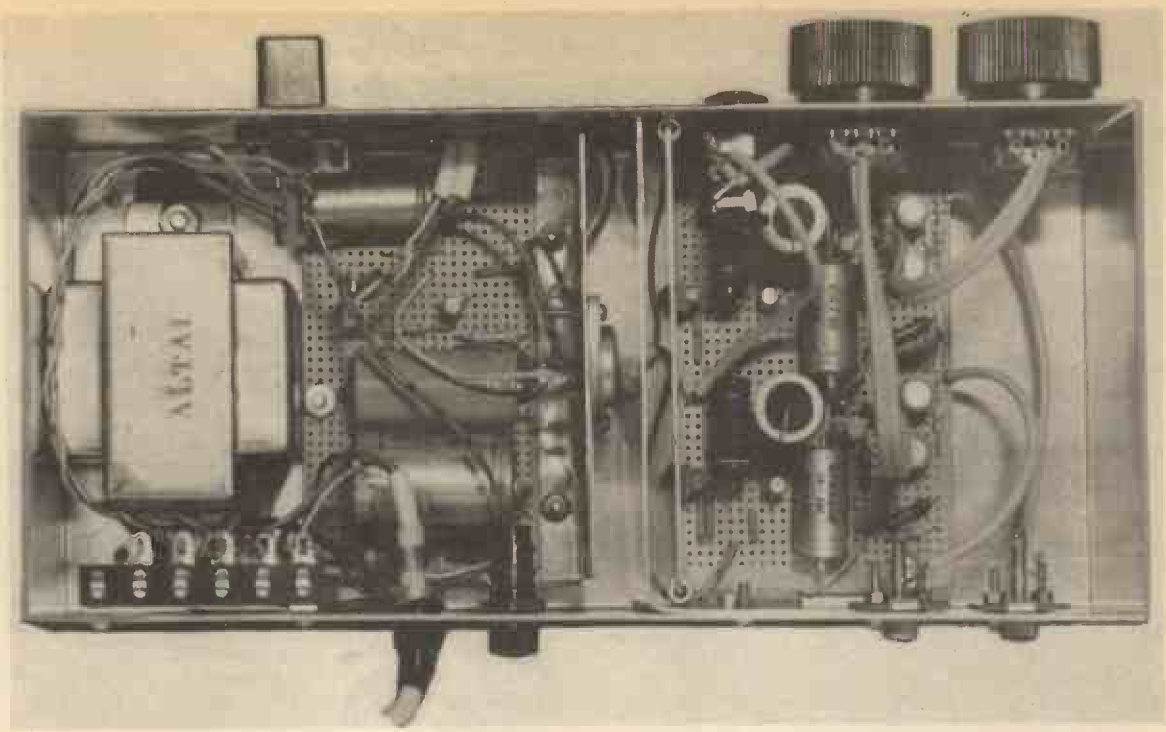
Fig. 1 shows the amplifier circuit diagram. For the sake of simplicity, only one channel is given. Two such amplifiers are, of course, required for stereo operation.

The input signal is taken via R1 and C1 to VR1, which functions as a volume control. Separate potentiometers are employed allowing gain adjustment of the left and right channels independently. This configuration eliminates the need for a balance control (if satisfactory volume control is already provided on the preamplifier to be used in conjunction with this design, then VR1 can be made an internal, preset component).

The signal from VR1s wiper is coupled to the base of TR1 through C2. TR1 forms a common emitter voltage amplifier which is shunt biased by R2. A small amount of negative feedback and stabilisation is provided by the emitter resistor, R5. C4 has no effect at audio frequencies but serves to suppress radio frequency interference. The first stage is decoupled from the supply lines by R6 and C3. The series combination of R3 and R4 provides a collector load for TR1.

The main function of the output stage is to obtain impedance transformation. TR2 and TR3 are therefore employed in the familiar Darlington pair configuration with R7 forming an emitter load for the final transistor. The output signal developed across R7 is taken via C5 to the headphone jack socket.





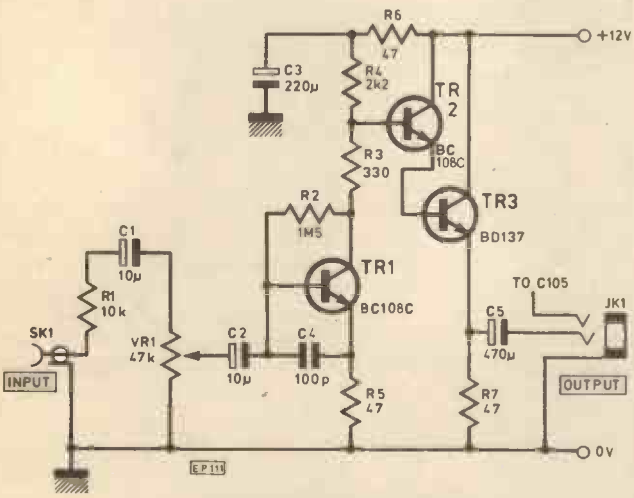


Fig. 1 Single channel of amplifier

TR1 must be biased so that its collector voltage equals half the supply value within 0·5 volts (i.e. between 5·5 and 6·5 volts for a nominal 12 volt rail). If when the circuit is first powered-up this is found not to be so, then the value of R2 should be altered accordingly (reducing R2 will drop the collector voltage and vice-versa).

R3 has the purpose of raising the potential at TR2 base so as to overcome the combined base/emitter voltage drops of this transistor and TR3 (approximately 1·2 volts). In consequence, the potential at TR3 emitter will equal roughly half the supply value also.

POWER SUPPLY

Fig. 2 shows the power supply circuit for both channels. The mains input is taken via a double pole on/off switch and fuse to the primary windings of transformer T1. The secondary voltage is full wave rectified by D1 and D2. C6 serves to suppress switching transients, thus eliminating interference and the possibility of damage to other components.

C7 is the main reservoir, or smoothing, capacitor which removes most of the 100 hertz ripple. Transistors TR4 and TR5 form another Darlington pair. The base of TR4 is held at a constant voltage by the potential divider consisting of

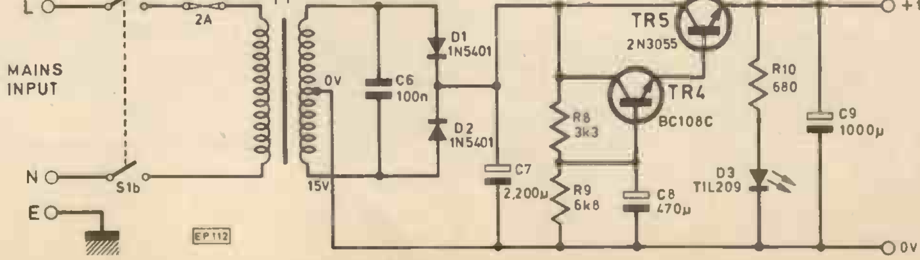


Fig. 2 Power supply circuit for both channels

R8 and R9. It is this resistive divider that determines the final output voltage of the supply. As all ripple is removed from this reference voltage by C8, the 12 volt output appearing at TR5's collector is absolutely hum-free.

A light emitting diode, D3, gives visual indication that the equipment is switched on. C9 decouples the power supply output.

The total current consumption of the stereo amplifier when operating from a 12 volt supply is approximately 260 milliamps (130 milliamps per channel) and the output transistors will dissipate 770 milliwatts each which necessitates the use of a small heat sink. The emitter resistor of TR3 also dissipates roughly 770 milliwatts and a 2 watt power rating has been specified for R7. The series regulator transistor TR5 operates with a potential difference of approximately 8·5 volts between its collector and emitter junctions. Therefore, assuming a supply current of 260 milliamps, this component will dissipate around 2 watts so it will also require a small heat sink.

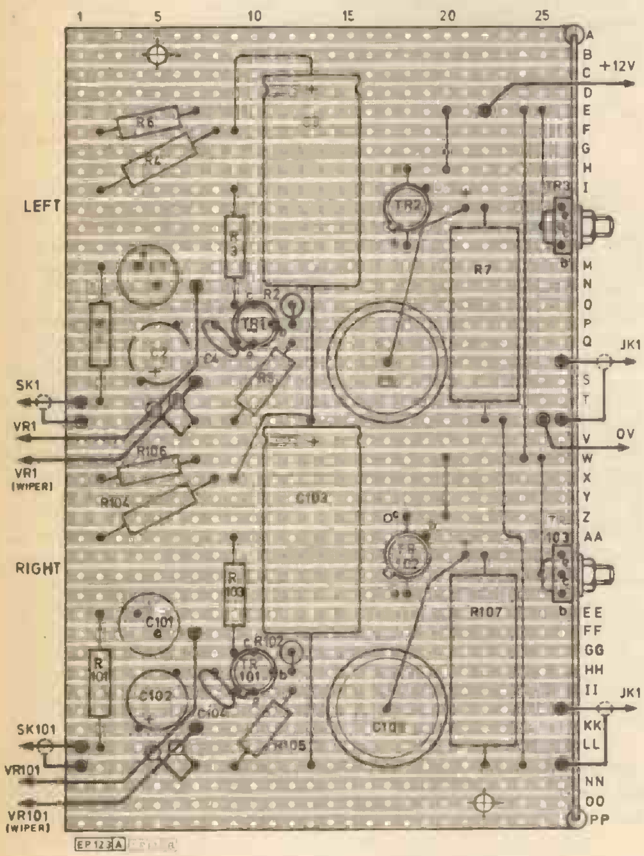


Fig. 3 Layout of stereo amplifier board

CONSTRUCTION

Most small components which comprise the amplifier and power supply are mounted on two separate pieces of 0·1 inch matrix Veroboard.

The amplifier circuitry can be assembled on a section of approximately $2\frac{1}{2}$ by $4\frac{1}{4}$ inches, as shown in Fig. 3. The BD137 power transistors are small plastic encapsulated devices which are easily mounted to a suitable heat sink. A piece of 18 s.w.g. aluminium measuring $4\frac{1}{4}$ by 2 inches is drilled with two 6BA clearance holes and bolted directly to the output transistors.

The BD137s act as physical supports to this heat sink and it should be noted that the metal face of each transistor, which will come in direct contact with the aluminium, is live at collector potential. As the collectors of both devices are connected to the positive supply rail, this mutual shorting will not affect the amplifiers' operation.

Short lengths of screened cable are soldered to the amplifier board where shown. These provide "flying lead" connections for input, output and volume controls. All resistors, except R2, are mounted horizontally. The leads of R7 should be cut to approximately 1 inch and then bent at right angles to the component body. Using long leads enables this resistor (which runs rather hot) to be mounted well above the Veroboard surface, thus ensuring adequate ventilation. The output coupling capacitors are mounted vertically.

COMPONENTS . . .

Resistors

R1, R101	10k
R2, R102	1M5
R3, R103	330
R4, R104	2k2
R5, R105	47
R6, R106	47
R7, R107	47 2W
R8, R108	3k3
R9, R109	6k8
R10, R110	680

All $\frac{1}{2}$W carbon, 5%

Potentiometers

VR1, VR101	47k log

Capacitors

C1, C101	10µ
C2, C102	10µ
C3, C103	220µ
C4, C104	100p ceramic
C5, C105	470µ elect. 12V
C6	100n
C7	2,200µ elect. 25V
C8	470µ elect. 25V
C9	1,000µ elect. 25V

Semiconductors

TR1, TR101	BC108C (2 off)
TR2, TR102	BC108C (2 off)
TR3, TR103	BD137 (2 off)
TR4	BC108C
TR5	2N3055
D1	1N5401
D2	1N5401
D3	TIL209

Transformer

T1 Pri. 240V; Sec. 15-0-15V 1A

Miscellaneous

FS1 (2A) fuse plus chassis mounting holder, tag strip, Veroboard, miniature audio coax cable, phono sockets (chassis mounting), stereo jack socket (chassis mounting), clip-on heat sink, four rubber feet, knobs, aluminium box 10 x $4\frac{1}{2}$ x 3in.

The power supply circuit board (Fig. 4) measures approximately $3\frac{3}{4}$ by $2\frac{5}{8}$ inches and carries all components shown in Fig. 2 except D3, S1, T1 and FS1. TR5, the series regulator transistor, is mounted on its own aluminium heat sink. This heat sink, which measures $3\frac{3}{4}$ by $2\frac{5}{8}$ inches, cannot be made self supporting and so the bottom $\frac{3}{8}$ inch is bent at right angles to form a bracket. Two fixing holes then enable it to be bolted to the edge of the Veroboard. Mounting holes are also drilled for TR5. The case of this transistor forms its collector connection and a solder tag affixed to one of the mounting bolts provides a collector terminal. This heat sink, therefore, is also live.

The amplifier was enclosed in a standard aluminium box measuring 10 by $4\frac{1}{2}$ by 3 inches. The two circuit boards can be affixed to the bottom of the case using 4BA nuts and bolts. Spacers are employed here to ensure separation of the Veroboard underside from the metal base. An aluminium screen is provided where shown in order to isolate the amplifier and power supply sections.

Chassis mounting phono sockets provide input connections and automatically give an earthing contact to the amplifier case. A stereo jack socket forms the standard headphone outlet.

A 3 core mains lead enters the power supply section through a sleeved rubber grommet and is terminated at a tag strip. An earthing point is available on one of the end tags which will be bolted directly to the metal casing.

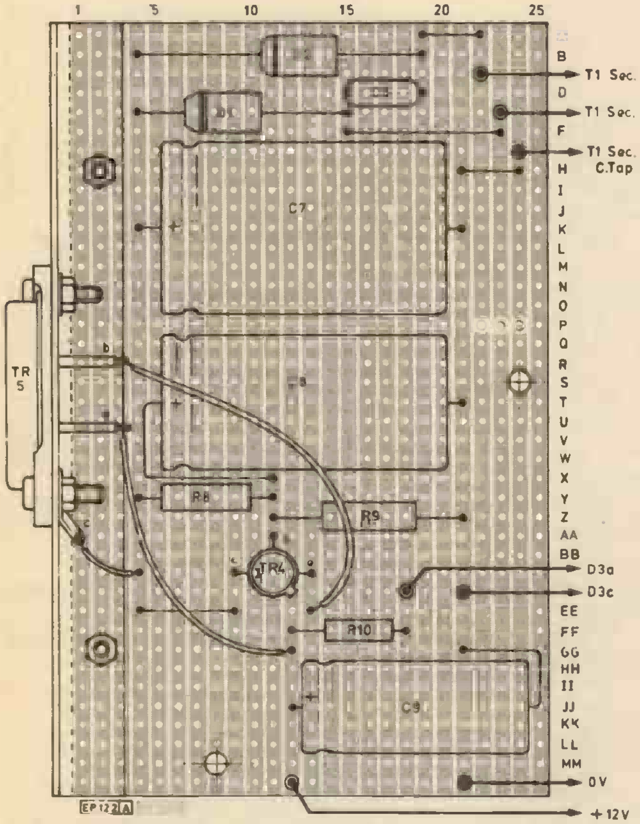


Fig. 4 Layout of p.s.u. board

A small light emitting diode, is pushed through a $\frac{1}{8}$ inch hole drilled into the casing. It can be held in place with a blob of Araldite.

Finally, four rubber feet are affixed to the base of the aluminium box with large self tapping screws. Ventilation holes were not drilled into the casing of the prototype as they reduce screening. But the underside of the casing lid has been painted matt black to assist transfer of heat from within the amplifier. ★

News Briefs

JAPANESE PRODUCTION IN USA

A $4m investment by Hitachi to establish a facility for the production of colour television sets and home appliances at Compton, California, has resulted in the birth of "Hitachi Consumer Products of America Inc." Initially with 120 employees, operations are expected to commence in January 1980, with partial operation starting this August.

YORKSHIRE COMPUTER CLUB

THE South Yorkshire Personal Computing Group (SYPCG) has been formed for the d.i.y. microprocessor and computing enthusiast. Initially the group will meet on the second Wednesday of each month at Sheffield University, and membership for 1979 has been set at £3 (nominal charge only for those still at school).

Details: Tony Rycroft, SYPCG Secretary, 88 Spinneyfield, Moorgate, Rotherham, S. Yorks.

A FLUKE OCCURRENCE

A NEW service centre has been opened by Fluke, based near Manchester. The full address is: Fluke International Corp, Middle Floor, Mersey House, 220 Stockport Road, Stockport, Cheshire

FAST DELIVERY

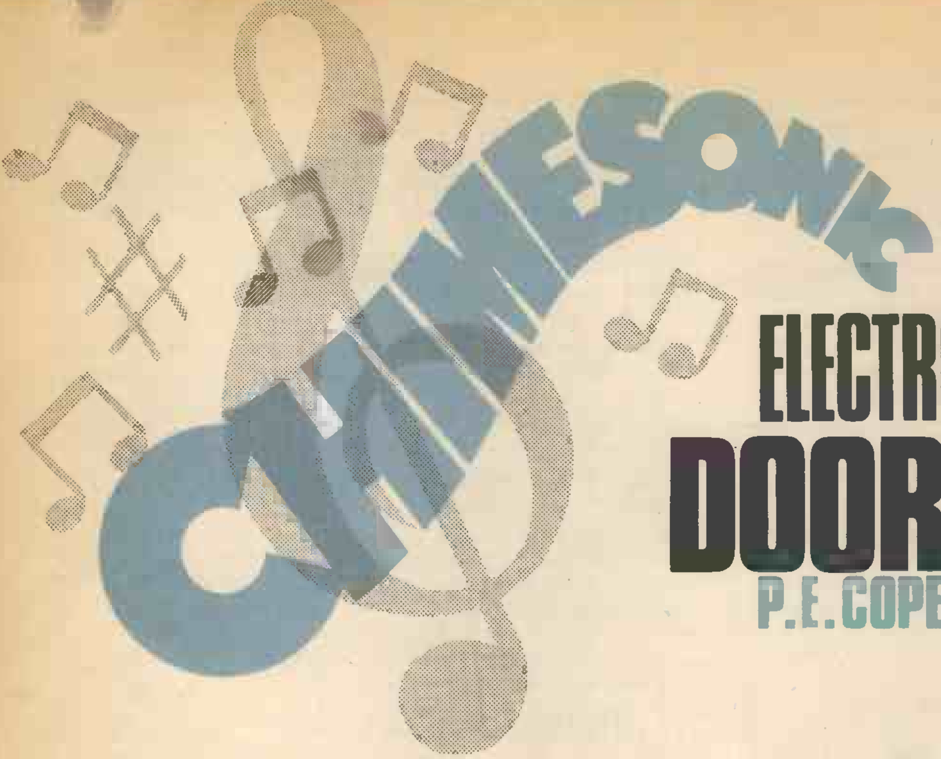
A NEW service called "Datapost" now replaces the Securicor service previously in operation at RS Components. Orders received at London, Birmingham or Manchester before 3.30 p.m. will normally be delivered the next day (Mon–Fri), with Saturday delivery if requested. Datapost should be specified when ordering, whereupon a nominal charge of £1 plus standard rate VAT will be made irrespective of the number of parcels to be despatched.

FIGHT-IT-YOURSELF

THE mechanical and electrical appliances which fill our homes, we all know can do anything. Freeze, fry, wash, dry, suck, blow, entertain, sew. What we don't know is that these contrivances talk to each other after we go to bed. The subject of discussion at their meetings each month is, naturally, the most inconvenient time to break down. A decision to fail might depend upon the holiday plans of your regular plumber, or the approach of a Bank Holiday. Two or three contraptions might simply agree to break down simultaneously. And the mower having chugged past your window while you sleep, to attend the kitchen summit, might suggest burning out at the height of the growing season.

After the blows have been dealt you contact a service engineer, for whom you may await the non arrival of repeatedly. When he turns up, one of two things will happen. He shakes his head and tells you it would cost more to repair than buy a new one, or the machine offers up a fault for him to find, to which he responds, "Ah, I can see what's wrong." He fixes it. Unfortunately this fault had nothing to do with the original trouble, and the machine ceases to operate again once the serviceman has left.

A new idea which may be the answer to the expense and uncertainty of picking telephone numbers from the Yellow Pages is MAC (Mutual Aid Centre), where £1 will buy you three hours in a kind of public workshop in which you can do-it-yourself! You might shudder, but skilled supervision and the *right tools* are part of the deal. The only additional expense is the prerequisite of being a member, costing £2 per annum (£1 for pensioners). The first MAC is in Longden Coleham, Shrewsbury, but it is hoped that they will eventually become as commonplace as public libraries. Open six days a week and nine hours a day, the first centre is expected to run training courses on the premises, in conjunction with Shrewsbury Technical College. The workshop has been launched by the Mutual Aid Centre, the London-based charity founded by Michael Young, originator of "Consumers' Association" and "Which?" magazine.



ELECTRONIC DOOR CHIME

P.E. COPELAND

THE Chimesonic is a nine note electronic door chime which can be powered by either battery or transformer and its design enables it to be easily installed or substituted for most existing door chimes or bells without rewiring. The Chimesonic unit enables a variety of melody modules to be plugged in so that the tunes can be varied to suit taste, occasion or season. These modules consist of a number of diodes and pre-sets which are simply adjusted to the particular note required. The same module can thus be "retuned" when a different melody is required or a selection of modules can be built-up and pre-tuned ready for use.

Installing the chime is quite straightforward since it will work from either a battery or transformer and can be operated from the simple type of push switch or the illuminated kind. The connections to the unit are marked on the p.c.b. and made using a standard 2A 6-way strip connector.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Chimesonic is shown in Fig. 1 and circuit diagram of the melody module in Fig. 2.

If the unit is being used with a simple push switch, the power supply can either be a 9V battery (PP6) or alternatively a transformer supplying between 6 and 8V at $\frac{1}{2}$A. If an illuminated bell push is being used a transformer supplying 8V at 1A is required. It is important to remove the fuse (FS1) for battery operation in order to conserve battery life.

The tempo generator produces a clock pulse, which determines the "beat" of the melody. If required this can be varied by altering the value of C3 and/or C4. The clock pulse drives IC3 which is a CMOS decade counter decoder. Each of the counter outputs go high in turn and drive their respective presets (VR1 to VR9) on the melody module to produce a series of notes.

The note generator is the familiar 555 timer with VR1 to VR9 each forming the variable element of the CR network when each counter output becomes active. The overall pitch of the melody is determined by C6 and although this could be varied, it will be found that a 100nF capacitor enables a good range of notes to be obtained simply by adjusting each of the presets on the melody module.

An output of sufficient drive for a number of speakers is provided by TR5 and TR6. With an 8 ohm load the output is approximately 2W square-wave and this is more than adequate for most applications. Should additional speakers be required these should be connected in series. The output loading is not critical (4 ohms min.) and a speaker or combination of speakers up to 80 ohms total impedance may be connected to still produce an adequate volume level. Remember to connect a link wire between terminals D and Ext Spk on TB1 if an extension speaker is not being used.

A staccato effect is made possible by joining the connections 3 and 17 on the melody module. This separates each note from the next and may be useful during tuning even if it is not used in the final melody.

If a 470nF capacitor is connected between pin 3 and 17 on the melody module an "echo" effect can be obtained.

The supply voltage is applied to the regulating circuit formed around TR3 and TR4. Diode D10 prevents possible damage due to the battery being incorrectly connected.

When TR4 is conducting the Zener diode D15 will maintain the voltage at the emitter of TR3 at 5V.

For TR4 to conduct, the voltage at its base must be low (ie 0V). This is achieved initially by the action of the push switch which when pressed connects the base of TR4 via R13 to the 0V rail. This action enables TR3 to supply a regulated voltage of 5V to the circuit which is maintained by the operation of IC1, IC2 and TR2.

IC2 is a monostable which is arranged to trigger whenever the regulated voltage is applied. This is achieved by the capacitor C5 charging via R3. A rising voltage thus appears at the Schmitt input of monostable IC2 (pin 5). At a certain threshold voltage the input triggers the monostable and a pulse (Q pin 6, $\bar{Q}$ pin 1) of duration determined by C7 and R8 is produced.

The negative going pulse ($\bar{Q}$ pin 1) is applied to the "set" input of IC1 (pin 9) and the bistable is latched to give a "high" output (+5V) on pin 8.

This "high" output drives the base of TR2 which is turned on maintaining the regulated supply to the circuit.

formed from the remaining gates of IC1. This output goes "high" due to the action of IC2 when the push switch is pressed.

One ouput of the astable multivibrator is taken to the "clock" input (pin 14 of IC3) which is a CMOS decade counter/decoder. This same output is also taken to the melody module socket (SKI).

The "clock enable" input (IC3 pin 13) is held "low" (0V) and the decade counter IC3 counts on the positive going edges of the pulses from the astable multivibrator.

Initially the Q output (high) generated by IC2 on switch-on is applied to the "reset" input of IC3. This ensures "count" output '0' in "high" and "count" outputs '1' to '9' are "low" immediately after the push-button is pressed.

Each of the ten "count" outputs of the counter/decoder IC3 go "high" (5V) in turn. "Count" outputs '0' to '8' are

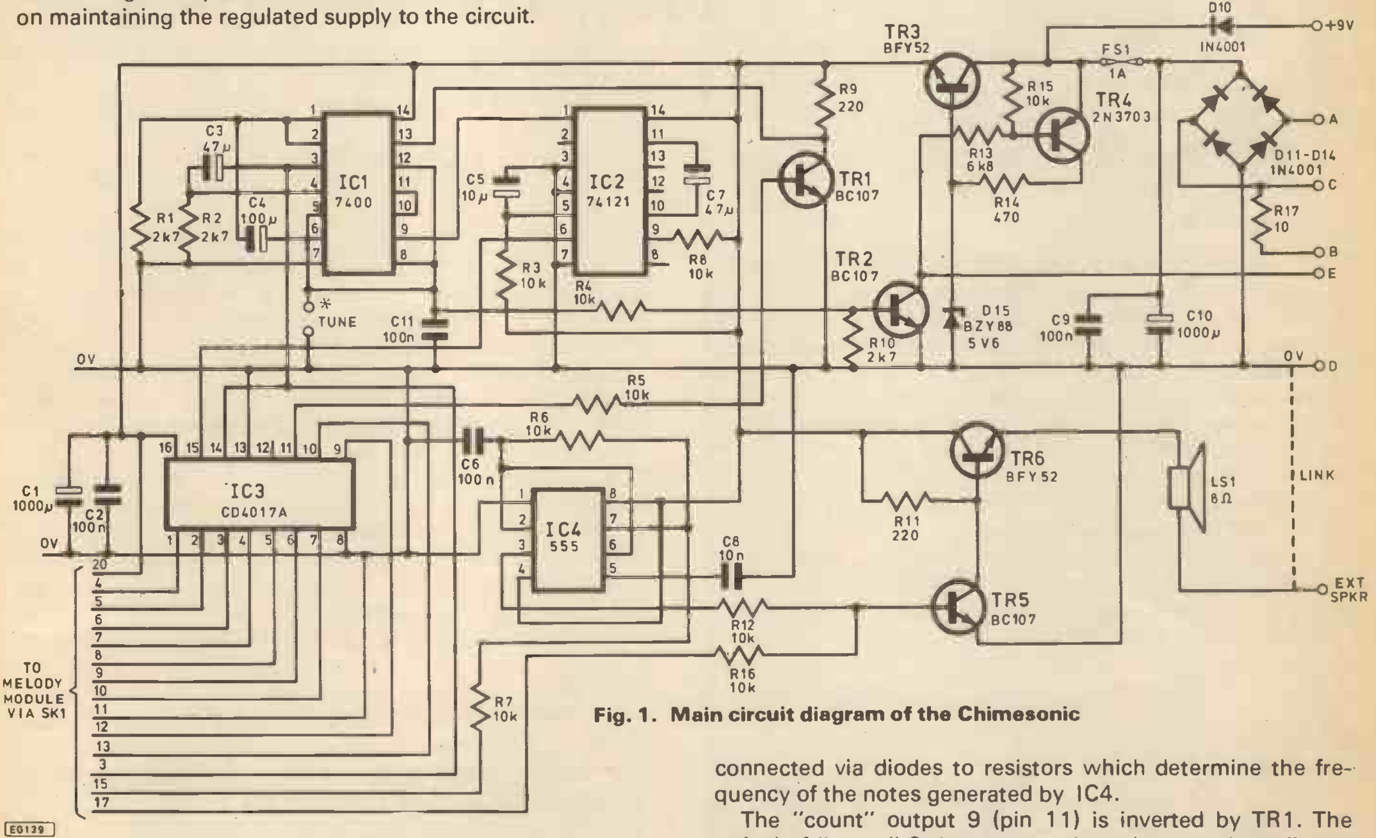


Fig. 1. Main circuit diagram of the Chimesonic

connected via diodes to resistors which determine the frequency of the notes generated by IC4.

The "count" output 9 (pin 11) is inverted by TR1. The arrival of "count" 9 thus causes the voltage at the collector of TR1 to go "low". Since this voltage is applied to the "reset" input (pin 13 IC1) of the bistable ($\frac{1}{2}$ IC1) the bistable changes state causing the Q (high) output to go "low". This action inhibits the astable multivibrator ($\frac{1}{2}$ IC1) and switches TR2 off. The voltage at the emitter of TR3 falls to zero unless the illuminated push switch is used. In which case the circuit remains on but the output remains silent since the tempo generator is inhibited and the count remains at 9.

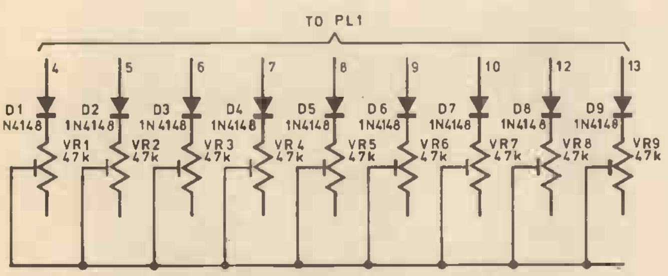


Fig. 2. Circuit diagram of the melody module.

TEMPO GENERATOR

Two gates of IC1 are used to form an astable multivibrator together with R1, R2, C3 and C4. Capacitors C3 and C4 may vary in value to those given in the components list to meet the tempo of the melody played. The astable is enabled when the input to pin 5 (IC1) goes "high" (+5V). This is achieved by using the Q output (pin 8 IC1) of the bistable

NOTE GENERATOR

The notes played by the Chimesonic are generated by IC4 and their frequency is determined by the value of the particular resistor being driven by the IC3 counter/decoder.

The overall pitch of the notes is determined by the values of VR1 to VR9 which are adjusted according to the melody required.

For melodies containing "rests" the particular preset and diode is not present at the "count" output (IC3) at which the "rest" occurs.

For melodies of less than nine notes certain resistors and their associated diodes are not included in the melody module circuit.

If it is necessary at some stage to retune notes then increasing the value of the presets concerned (VR1 to VR9) will lower the respective notes, and decreasing the resistor value will make the note higher.

For tuning purposes two small pins (Tune) are provided next to IC2 on the p.c.b. When these are linked together this inhibits the astable multivibrator and enables each note to be held whilst being tuned. To facilitate tuning solder a short wire to the pin marked with an asterisk on the p.c.b. layout.

COMPONENTS . . .

Resistors

R1, R2, R10	2k7 (3 off)
R3, R4, R5, R6, R7	10k (9 off)
R8, R12, R15, R16	
R9, R11	220 (2 off)
R13	6k8
R14	470
R17	10 7W

All resistors $\frac{1}{4}$W except where otherwise stated.

Potentiometers

VR1–VR9	47k min. hor. preset (9 off)

Capacitors

C1	1000µ 10V elect
C2, C6, C9, C11	100n 250V polyester (4 off)
C3, C7	47µ 10V elect (2 off)
C4	100µ 10V elect
C5	10µ 10V elect
C8	10n 250V polyester
C10	1000µ 16V elect

Semiconductor

D1–D9	1N4148 (9 off)
D10–D14	1N4001 (5 off)
D15	BZY 88 5V6 Zener
TR1, TR2, TR5	BC107 (3 off)
TR3, TR6	BFY 52 (2 off)
TR4	2N3703
IC1	7400
IC2	74121
IC3	CD4017A
IC4	555

Miscellaneous

20mm fuse
Fuse holder
LS1 8Ω loudspeaker and case
Battery connector
Battery PP6
Veropins
Terminal block (6 way) 2A
Plug and socket 0·1in 20 way (RS 488-365)
i.c. holders (if req)
Transformer*
* See text

OUTPUT STAGE

The output from the note generator IC4 (pin 3) is taken via R12 to the base of TR5. This transistor is used to provide enough voltage and current drive for the output transistor TR6. Both TR5 and TR6 are operated in the switching mode and thus the final output is square-wave.

Loudspeakers for Chimesonic should present an emitter load of approximately 8 ohms to TR6. Additional loudspeakers may be connected in series by replacing the wire link joining the terminals 'D' and 'ext spkr' with the leads from the extension loudspeaker(s). The impedance of the extension speaker is not critical and acceptable volume levels can be obtained with up to 80 ohm loading.

Alternatively the extension speaker output can be used to drive additional amplifiers for PA applications etc. For this application connect the unit into the high level input of the amplifier and take the screen of the connecting cable to the terminal labelled D, and the signal core to the 'ext spkr' terminal. A load resistor of 22 ohms may be substituted for the internal speaker if this sound source is not required.

CONSTRUCTION

The main p.c.b. of the Chimesonic is shown in Fig. 3 with the component overlay shown in Fig. 4. It is recommended that i.c. holders are used especially for IC3 since this is a CMOS device which should be placed in the circuit after the rest of the construction work is completed.

The melody module p.c.b. and overlay are shown in Fig. 5 and Fig. 6.

The use of Veropins or similar is recommended for the battery leads termination points, speaker connections and Tune contacts.

The p.c.b. has been designed to enable the constructor to have a choice in the melody module connection method. In the prototype a 20 way plug and socket was used. The socket should be mounted on the p.c.b. and the plug soldered onto the module board.

Alternatively the p.c.b. itself may be the 0·1 edge plug mating with an edge connector mounted on the module board. The first method is preferred since mating connection is positive via gold contacts.

If an illuminated bell push is to be used the 8V 1A transformer should be connected to terminals A and B with the bell push connected to terminals A and C. Terminals D and E should be linked together and the fuse (FS1) inserted in the p.c.b. fuse holder.

The lamp in the bell push together with R17 form a circuit driven by the a.c. voltage applied to terminals A and B.

TUNING

An appropriate tuning procedure for the Chimesonic is shown in Table 1

1. Temporarily link together the two Tune pins next to IC2 on the p.c.b.
2. Press the push-button and keep it pressed.
3. The first note will be heard constantly and it can be varied in frequency by altering the value of the resistor connected to the 'O' "count" output.
4. Remove the wire and the next note should be heard. If it is not bring the wire briefly in contact with the end of the resistor R8.
5. As soon as the note is heard link the two Tune pins again. The note for "count" output '1' (IC3) will now be held and the value of the resistor connected to "count" output '1' can be altered as necessary.
6. This procedure is continued and the link is removed and replaced for each count.
7. If any note is missed then the link must be removed and the sequence begun again.

TABLE 1

The "tempo" of the melody is determined by C4. A higher value capacitor will slow the tempo—a lower value will quicken it. ★

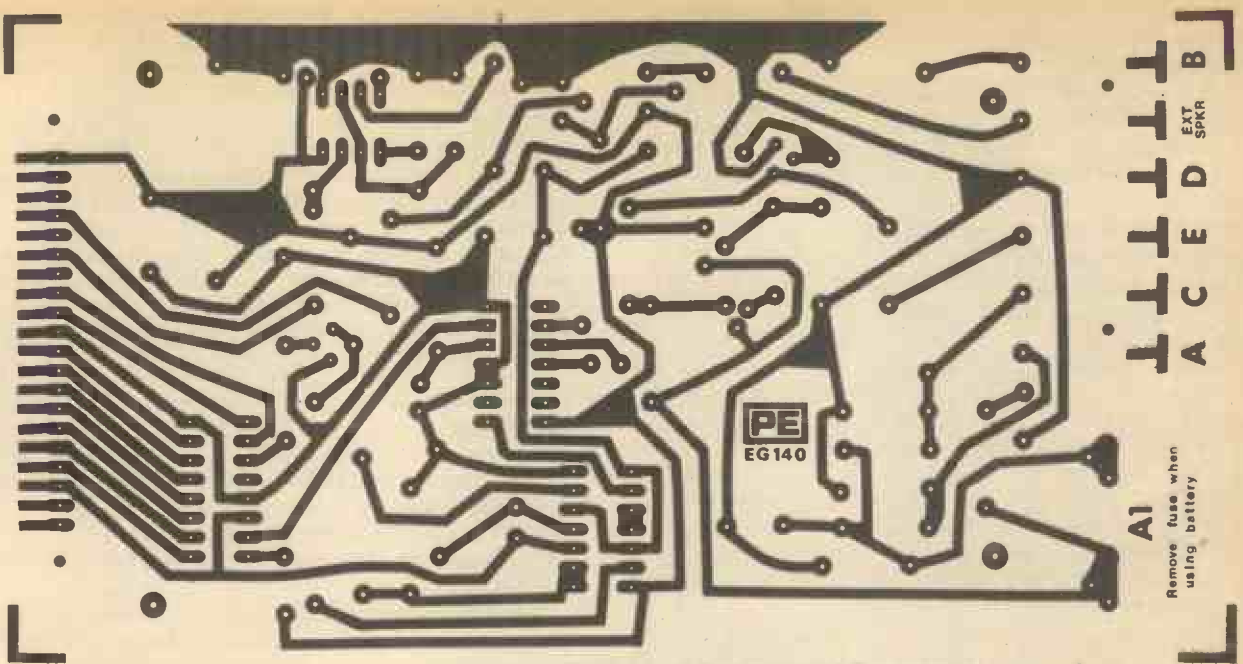
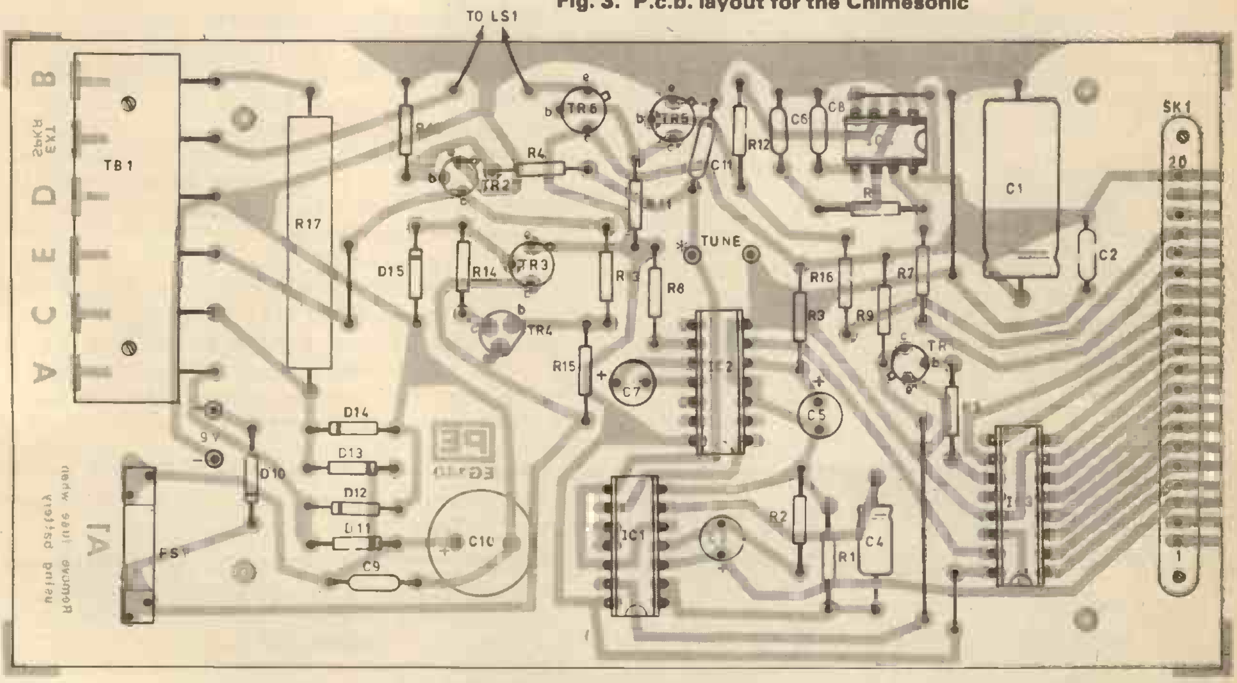


Fig. 3. P.c.b. layout for the Chimesonic



EG141

Fig. 4. Component overlay

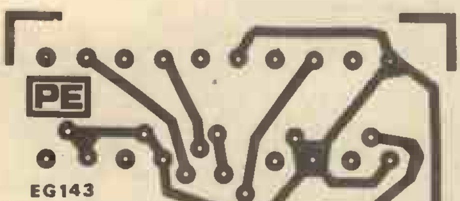
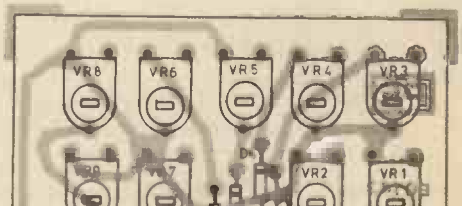
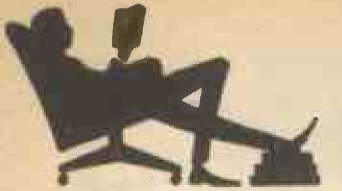


Fig. 5. P.c.b. layout of melody module



EG144

Fig. 6. Component overlay



BOOK REVIEWS

RADIO AMATEURS' EXAMINATION MANUAL

By G. L. Benbow, G3HB
R.S.G.B., 35 Doughty St., London WC1N 2AE
120 pages; paperback; 248 by 184mm; 8th edn; 1979
£1·85 (£2·16 from RSGB inc. p&p)

THE standard work for all would-be licensed radio amateurs studying for the UK Radio Amateurs' Examination, which has also proved popular in other countries which have similar licensing examinations.

This edition has been completely revised in order to take account of the current changes in RAE format and syllabus. A valuable feature is the provision of two sample examination papers, each containing 95 multiple-choice questions, answers being given separately.

Chapter titles are: Becoming a radio amateur: Electrical theory and calculations; Semiconductors; Radio receivers; Transmitters; Power supplies; Propagation and antennas; Transmitter interference; Measurements; Licence conditions; Operating practices and procedures; Tackling the Radio Amateurs' Examination; plus four appendices.

THE BASIC COOKBOOK

By Ken Tracton
Published by Tab Books
138 pages. Price £3·60

ORIGINALLY developed in the 1960s at Dartmouth College, by John Kemeny and Thomas Kurtz, the programming language BASIC has grown to become the primary home computer language today, and although rivals are appearing, anyone contemplating involvement in small business and home computing can ill afford to ignore it.

The book does not take you through the list of commands beginning with the simplest, but curiously goes through them alphabetically. This does however, allow quick reference to a particular command should you forget what it does, and examples with flow charts accompany each one. Basic is an easy language to learn, requiring no specialised knowledge, and the complexity of programs possible, built on simple instructions, is limited only by the logic and clarity of thought of the programmer. If you digest the contents of this book there should be nothing but "hands on" time between *you* and fairly complex programs.

There is one instruction not covered in the Basic Cookbook which you will find on a personal computer such as the Commodore PET, and that is GET, which enables the user to input single characters without hitting the Carriage Return key. This facility speeds up graphical games considerably, but unlike the INPUT instruction, requires a loop in the listing to operate successfully. The TRS–80 equivalent is INKEY$.

This is a good clearly laid out book, which of course, is what the beginner needs!

M.A.

ILLUSTRATED DICTIONARY OF MICROCOMPUTER TERMINOLOGY

By Michael Hordeski
Published by Tab Books (available W. Foulsham, Slough)
322 pages. Price £5·75

JUST when you think you've caught up on all the buzzwords and abbreviations used in microcomputer terminology, you read something like this:

Fully edified 8K system with Line Queue Multiplexing for the low end ZIF users, complete with turbulation shift and dummy-zero interpreter.

In fact, the above might be nonsense, but a newcomer to the technology could be forgiven for reading it and going away convinced if a little confused. The only answer to this state of affairs is to get yourself a comprehensive microcomputer dictionary, and with 4,000 terms listed, this one is as good as I've seen yet, although I was surprised to find CUTS missing!

Armed with this illustrated reference you can blast your way through OEMs (original equipment manufacturer), KSR teletypewriters (keyboard send/receive), PLAs (programmed logic arrays), and PIAs (peripheral interface adapters). In an instant, you would discover that not only magazines have editors, how machines shake hands with each other, and that the above, in *italics*—is a leg pull. Recommended.

M.A.

POINTS ARISING

METERMATE *(July 1979)*

The printer has reversed (left-to-right) the stripboard part of Fig. 8, so that the track cuts as shown are meaningless.

Any constructor requiring a correct copy of this can obtain one from the editorial offices at Poole.

AUTORANGING MULTIMETER *(April 1979)*

The Precision Monolithics Inc. REF-02 is *not available from Bournes Ltd.* (PMI agent) of Hounslow, to the amateur in one-off quantities, but may be obtained from **Ace Mailtronix Ltd., Tootal Street, Wakefield, West Yorkshire, WF1 5JR.**

GUITAR SOUND MULTIPROCESSOR *(Dec. 78)*

In Fig. 3 R1 should be 10kΩ. In Fig. 14 R53 is 100Ω not 100kΩ as in the components list.

CONSTANT DISPLAY FREQUENCY METER *(August 1978)*

In Fig. 4, a wire should be shown connecting the mains earth tag at IC17 to the negative terminal of C4.

ULTRASONIC REMOTE CONTROL *(June 1979)*

Transistor TR1 which is adjacent to TR2 in Fig. 4 is incorrectly annotated, it should be TR3. In the same diagram C1 should be C7. C1 which can be mounted off the board should have its positive terminal connected to the cathode of diode D1 and its negative terminal to the anode of diode D4.

SOUND OPERATED SWITCH *(May 1979)*

Operation of the Sound Operated Switch is improved by wiring an OA47 diode with its anode to IC2 pins 6 and 7, and its cathode to the junction of IC1 pin 7 and IC2 pin 2. This is easily carried out on the top side (component side) of the board using the lead to R12 (10kΩ) and the wire link between IC1 and IC2. Alternatively, the diode may be wired to the under side (copper track) of the p.c.b. This modification ensures that C6 does not start to charge until the audio input falls below the threshold level. The diode holds down the voltage across C6 until the output voltage from the comparator, IC1(b), goes high.

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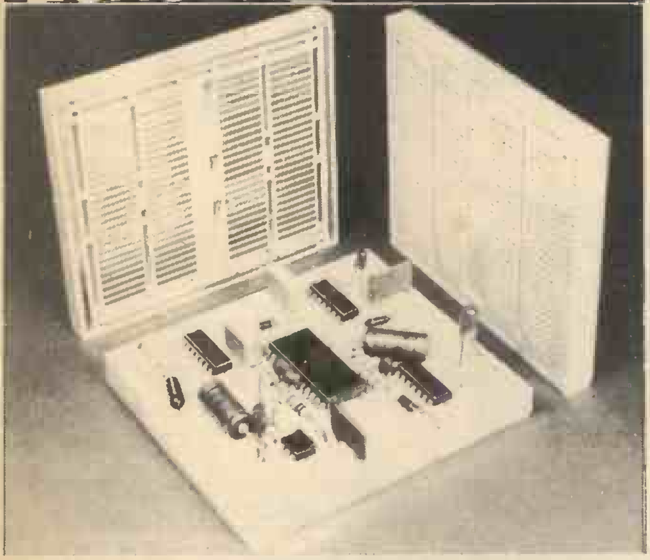

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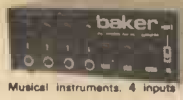

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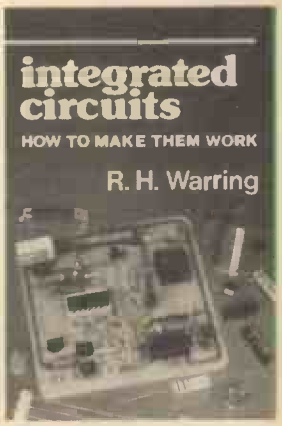

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74164	60p
74165	55p
74166	75p
74173	80p
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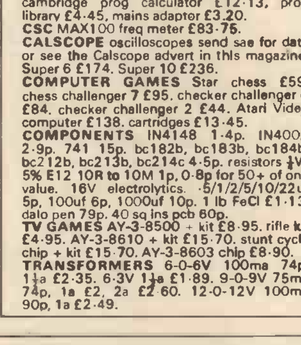

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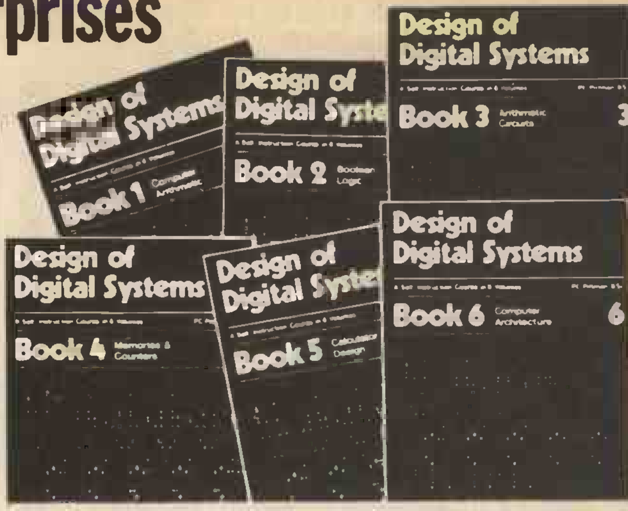

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AUY10	1.84	8F200	0.29	OC76	0.59	2N2222	0.19	7495	0.78
BA145	0.15	BF224	0.23	OC77	1.30	2N2223	2.97	7496	0.86
BA148	0.15	BF244	0.30	OC81	0.70	2N2368	0.18	7494	3.24
BA154	0.10	BF257	0.26	OC81Z	1.30	2N2369A	0.23	74100	1.62
BA155	0.11	BF258	0.28	OC82	0.70	2N2484	0.22	74107	0.49
BA156	0.10	BF259	0.35	OC83	0.70	2N2646	0.59	74109	0.76
BAW62	0.06	BF336	0.32	OC84	0.70	2N2904	0.27	74110	0.54
BAX13	0.07	BF337	0.32	OC122	1.62	2N2905	0.27	74111	0.76
BAX16	0.10	BF338	0.33	OC123	1.89	2N2906	0.23	74116	1.89
BC107	0.13	8FS21	4.28	OC139	2.43	2N2907	0.23	74118	1.08
BC108	0.13	BFS28	2.41	OC140	2.97	2N2924	0.24	74119	1.62
BC109	0.14	BFS61	0.23	OC141	3.51	2N2925	0.25	74120	0.90
BC113	0.14	BFS98	0.23	OC170	1.08	2N2926	0.16	74121	0.43
BC114	0.15	BFW10	0.70	OC171	1.08	2N3053	0.27	74122	0.65
BC115	0.16	BFW11	0.70	OC200	1.62	2N3054	0.54	74123	1.08
BC116	0.17	BFX84	0.24	OC201	1.89	2N3055	0.76	74125	0.59
BC117	0.19	BFX85	0.25	OC202	1.89	2N3440	0.65	74126	0.59
BC118	0.11	BFX87	0.23	OC203	1.89	2N3441	0.86	74128	0.65
BC125	0.18	BFX88	0.23	OC204	2.70	2N3442	1.19	74132	0.76
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BC149	0.10	8SX20	0.22	R2009	2.43	2N3706	0.15	74147	2.16
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BC171	0.11	8U208	2.25	T1P30A	0.50	2N3771	1.87	74156	0.92
BC172	0.11	BY100	0.49	T1P31A	0.49	2N3772	2.16	74157	0.81
BC173	0.13	8Y126	0.15	T1P32A	0.52	2N3773	3.24	74159	2.27
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BC178	0.15	BZX61	0.19	T1P34A	0.79	2N3820	0.51	74172	4.75
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BC213	0.14	CRS3/40	0.81	ZS140	0.28	2N4058	0.16	74179	1.35
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104	2·0	7·16	1·14
105	3·0	8·56	1·32
106	4·0	11·41	1·50
107	6·0	15·06	1·64
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152	250	13·28	1·50
153	350	16·43	1·84
154	500	20·47	2·15
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85	0·5	2·5	5·00	0·96
70	6	3	6·35	0·96
108	8	4	7·42	1·14
72	10	5	8·12	1·14
116	12	6	8·99	1·32
17	16	8	10·72	1·32
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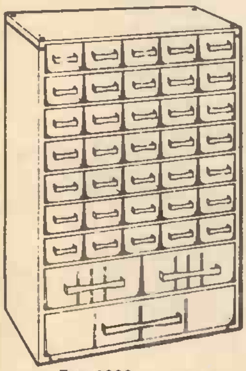

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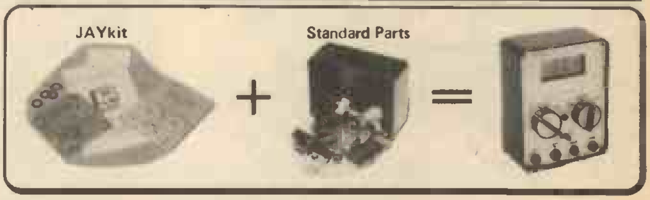

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VOLTAGE REGULATORS

Fixed Plastic TO-220

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15V	7815	75p	7915	90p
18V	7818	90p	7918	100p
24V	7824	90p	7924	100p

100mA	TO-92			
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15V	78L15	35p	79L15	80p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
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2N698	45p
2N706A	20p
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N1711	25p
2N2102	60p
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2N3055	48p
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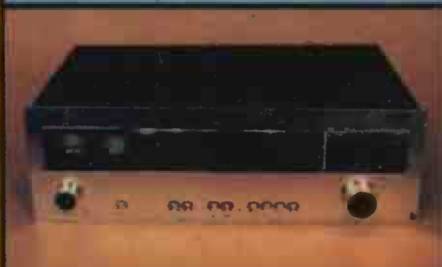

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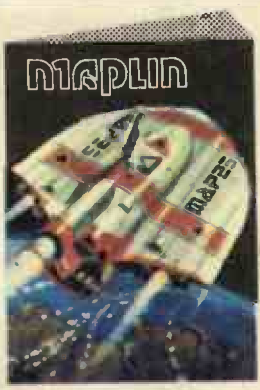

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