EVERYDAY ELECTRONICS and computer PROJECTS

JANUARY 1985 £1·00

POWER LIGHTING INTERFACE

For: SPECTRUM BBC and RML 380Z

8 EXTRA PAGES

SPECTRUM AMPLIFIER

GAMES TIMER

Australia $1.60 New Zealand $1.75 Malaysia $4.95

EVERYDAY
ELECTRONICS
and computer PROJECTS

VOL. 14 No. 1 JANUARY 1985

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PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

SEASONAL GREETINGS TO ALL OUR READERS

PROJECTS

SERIES

FEATURES

Our February 1985 issue will be published on Friday, January 18. See page 29 for details.

Rapid Electronics

MAIL ORDERS:
Unit 3, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD,
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	55p	66p	90p	150p
Right angle	90p	135p	200p	350p
Sockets solderlugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
Covers	100p	90p	100p	110p

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . . 38p
Socket free hanging . . . 60p
Socket with 2m lead . . . 120p

SCRs

▶C106D	35
400V 8A	70
400V 12A	95

TRANSFORMERS

3VA PCB Mounting
2x6V@0.25A;2x9V@0.15A
2x12V@0.12A;2x15V@0.1A 180p

6VA PCB Mounting
2x6V@0.5A;2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 270p

Standard. Chassis Mounting
6VA: 2x6V@0.5A; 2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 240p

12VA: 2x6V@1A; 2x9V@0.6A
2x15V@0.4A;2x20V@0.3A 350p

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 15p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

SOLDERING IRONS

Antex CS 17W Soldering iron	430
2.3 and 4.7mm bits to suit	85
Antex XS 25W soldering iron	530
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22 swg solder	100
0.5kg 22 swg solder	750

VERO

Verobloc	395
Veroboard Size 0.1 in matrix	
2.5 x 1	26
2.5 x 3.75	95
3.75 x 5	120
3.75 x 17	350
4.75 x 17	455
VQ board	190
Veropins per 100:	
Single sided	55
Double sided	65
Spot face cutter	145
Pin insertion tool	185
Wiring pen	375
Spare spool 75p Combs	6

MICRO

		27128-250	1225	6800	200	6522	330
		6116P3	480	6802	280	6532	520
		6264P15	2980	6809	600	6551	540
2716	310	4116P4	70	6810	140	8085A	320
2532	380	4164-15	480	6821	140	8156	380
2732 one time programmable	360	41256-15	2850	6840	360	8251	350
		Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
2732	430	Z80A CTC	320	6875	500	8259	400
2764-250	495	Z80A S10	880	6880	100	MC1488	70
2764 BBC	495	Z80A DMA	880	6502	370	MC1489	70

SOCKETS

	Low profile	Wire wrap
8 pin	7p	28p
14 pin	8p	45p
16 pin	10p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	15p	75p
24 pin	17p	82p
28 pin	15p	95p
40 pin	25p	135p

Professional ZIF sockets
24 pin 430p 28 pin 480p
40 pin 595p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

CABLES

20 metre pack single core connecting cable ten different colours. 75p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way gery ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	45
LM317K	270	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mWzen	6
▶1N4148	3	1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11

Clips to suit - 3p each.

Rectangular:		TIL32	40
red	12	TIL111	60
green	17	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	35

Seven segment displays:

Com cathode.		Com anode.	
DL704 0.3"	95	DL707 0.3"	95
FND5000.5"	100	FND5070.5"	100

10 bar DIL LED display, red 180
5mm superbright LED 250mcd red 30

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	65
▶12V Electronic buzzer	70
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	21
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

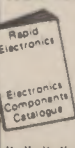
EURO CONNECTORS

Gold flashed contacts:	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

400V 6A	65
400V 16A	95
400V 4A	50
BR100	25

NEW 1985 CATALOGUE



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COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 150
SPECTRUM 2 x 28 way edge connector wire wrap. . . . 200
AMPHENOL PLUGS
24 way IEEE IDC. . . . 450
36 way Centronix IDC . . . 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p;

Tantalum bead:
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	70	70	70	–
16 way	75	80	80	–
20 way	90	90	95	130
26 way	105	110	115	155
34 way	115	130	130	180
40 way	140	140	145	210
50 way	165	165	170	240
60 way	195	195	200	–

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed.

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	5.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	18.0MHz	200

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2½ x 2"	95
71x46x22mm	50	6 x 4 x 2"	120
95x71x35mm	86	7 x 5 x 2½"	165
140x90x55mm	140	8 x 6 x 3"	205

LINEAR

		IC7611	98	LM358	50	LM3915	265	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM13600	110	NE570	370	TL061	40
555CMOS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	150	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	130	MC3302	75	NE5534	105	TL071	38
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	65	TL072	60
748	35	ICM7555	80	LM386	90	MF10CN	330	RC4558	40	TL074	110
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195	TL081	30
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220	TL082	50
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	105
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250	UA2240	140
CA3089	200	LMIOC	325	LM733	70	ML928	210	SP0256AL2	425	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	Speech data	50	ULN2004	80
CA3130E	85	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	365
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90	ZN414	80
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65	ZN423	135
CA3136	100	LM3342	85	LM2917N8	195	NE555	20	TBA950	220	ZN424P	130
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165	ZN425E	350
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	265	NE566	140	TDA1022	490	ZN427E	600
										ZN428E	450
										ZN459	285
										ZN1034E	200

TRANSISTORS

				BC548	5	BFR40	23	2N1613	30	2N3906	10		
				BC549	10	BFR80	23	2N2218A	45	2N4037	45		
				BC557	10	BFR81	23	2N2219A	28	2N4058	10		
AC125	35	BC158	11	BC558	10	BFX29	30	2N2221A	25	2N4060	10	TIP35C	125
AC126	30	BC158	10	BCY70	16	BFX84	30	2N2222A	20	2N4061	10	TIP36A	115
AC127	30	BC159	10	BCY71	16	BFX85	30	2N2368	25	2N4062	10	TIP36C	130
AC128	30	BC160	40	BCY72	16	BFX86	30	2N2369	18	40360	40	TIP41A	45
AC176	25	BC168C	10	BD115	55	BFX87	30	2N2484	27	40361	50	TIP42A	45
AC187	25	BC169C	10	BD131	40	BFX88	30	2n2646	60	40362	50	TIP120	60
AC188	25	BC170	8	BD132	40	BFY50	27	2N2904	28	40408	50	TIP121	60
AD142	120	BC171	10	BD133	50	BFY51	27	2N2904A	28	2N5457	30	TIP122	60
AD161	42	BC172	8	BD135	35	BFY52	27	2N2905	28	2N5458	30	TIP141	110
AD162	42	BC177	16	BD136	35	BFY53	30	2N2905A	28	2N5459	30	TIP142	120
AF124	60	BC178	16	BD137	35	BFY55	30	2N2906	28	2n5485	35	TIP147	120
AF126	50	BC179	18	BD138	35	BFY56	30	2N2906A	28	2N5777	45	TIP2955	70
AF139	40	BC182	10	BD139	35	BRY39	50	2N2907	24	2N697	20	TIP3055	60
AF186	70	BC182L	10	BD140	35	BSX20	22	2N2907A	24	2N698	40	TIS43	40
AF239	55	BC183	10	BD204	110	BSX29	35	2N2926	10	2N706A	20	TIS43	40
BC107	10	BC183L	10	BD206	110	BSY95A	30	2N3053	28	2N708	25	TIS44	45
BC107B	12	BC184	10	BD222	85	BU205	160	2N3054	55	2N918	35	TIS45	45
BC108	10	BC184L	10	BF180	35	BU206	200	2N3055	50	TIP29	35	TI590	30
BC108B	12	BC212	10	BF182	35	BU208	170	2N3442	120	TIP29A	35	TI591	30
BC108C	12	BC212L	10	BF184	35	MJ2955	99	2N3702	9	TIP29B	35	VN10KM	65
BC109	10	BC213	10	BF185	25	MJE340	50	2N3703	10	TIP29C	35	VN46AF	94
BC109C	12	BC213L	10	BF194	12	MJE520	50	2N3704	9	TIP30	35	VN66AF	110
BC114	22	BC214	10	BF195	12	MJE521	90	2N3705	10	TIP30A	35	VN88AF	120
BC115	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10	TIP30B	35	ZTX107	11
BC117	22	BC237	7	BF197	12	MPF102	40	2N3707	10	TIP30C	40	ZTX108	11
BC119	35	BC238	7	BF198	15	MPF104	40	2N3708	10	TIP31A	35	ZTX109	11
BC137	40	BC308	10	BF199	18	MPSA05	23	2N3709	10	TIP31B	35	ZTX300	14
BC139	38	BC327	8	BF200	35	MPSA06	25	2N3772	170	TIP31C	40	ZTX301	16
BC140	29	BC328	8	BF244B	35	MPSA12	29	2N3773	195	TIP32A	35	ZTX302	16
BC141	30	BC337	8	BF245	35	MPSA55	30	2N3819	32	TIP32B	38	ZTX304	20
BC142	28	BC338	12	BF256B	45	MPSA56	30	2N3820	50	TIP32C	40	ZTX341	20
BC143	30	BC477	22	BF257	32	MPSU05	55	2N3823	65	TIP33A	65	ZTX500	13
BC147	10	BC478	22	BF258	30	MPSU06	55	2N3866	90	TIP33C	75	ZTX501	18
BC148	10	BC479	22	BF259	30	MPSU55	55	2N3903	10	TIP34A	70	ZTX502	18
BC149	10	BC517	30	BF337	35	MPSU56	55	2N3904	10	TIP34C	80	ZTX503	18
BC157	11	BC547	5	BFR40	35	2N118L	22	2N3905	10	TIP35A	105	ZTX504	25

TTL

		7412	25	7440	25	7476	40	74107	40	74157	80	74180	85
		7413	36	7442	74	7480	50	74109	60	74160	90	74181	230
		7414	60	7444	105	7483	65	74121	50	74161	90	74182	85
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120
7402	25	7420	25	7448	98	7489	170	74125	50	74164	115	74192	120
7403	25	7421	30	7450	25	7490	55	74126	50	74166	90	74193	110
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80		
7411	25	7438	45	7475	55	74100	125	74154	135	74179	90		

CMOS

		4016	26	4034	145	4054	70	4081	18	4502	50	4529	80
		4017	43	4036	270	4055	70	4082	20	4503	45	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	18	4019	35	4040	46	4060	70	4086	60	4508	115	4538	70
4001	18	4020	48	4041	55	4063	80	4089	120	4510	48	4543	65
4002	18	4021	55	4042	45	4066	24	4093	26	4511	50	4549	390
4006	65	4022	60	4043	45	4067	230	4094	70	4512	50	4553	215
4007	18	4023	18	4044	50	4068	18	4095	70	4514	115	4555	60
4008	50	4024	35	4046	60	4069	18	4097	260	4515	115	4556	50
4009	40	4025	18	4047	52	4070	22	4098	70	4516	48	4559	390
4010	40	4026	120	4048	50	4071	18	40106	38	4518	48	4560	110
4011	18	4027	28	4049	26	4072	18	40109	100	4520	48	4584	38
4012	18	4028	40	4050	26	4073	18	40163	75	4521	110	4585	65
4013	26	4029	45	4051	48	4075	24	40173	100	4526	70	4724	140
4014	50	4030	18	4052	48	4076	60	40175	75	4527	60		
4015	42	4031	125	4053	60	4077	24	40193	90	4528	45		

LS TTL

		LS20	22	LS75	38	LS123	70	LS161	60	LS221	78	LS365	42
		LS21	22	LS76	28	LS125	37	LS162	60	LS240	105	LS366	42
		LS22	22	LS78	28	LS126	37	LS163	60	LS241	80	LS367	42
LS00	22	LS26	22	LS83	68	LS132	53	LS164	70	LS242	80	LS368	42
LS01	22	LS27	22	LS85	82	LS136	35	LS165	95	LS243	80	LS373	80
LS02	22	LS30	22	LS86	35	LS138	48	LS166	88	LS244	80	LS374	80
LS03	22	LS32	22	LS90	40	LS139	48	LS170	120	LS245	88	LS375	55
LS04	22	LS37	22	LS92	50	LS145	92	LS173	80	LS247	77	LS377	100
LS05	22	LS38	22	LS93	45	LS147	130	LS174	60	LS251	55	LS378	88
LS08	22	LS40	22	LS95	58	LS148	115	LS175	60	LS257	55	LS390	82
LS09	22	LS42	60	LS96	120	LS151	55	LS190	75	LS258	55	LS393	82
LS10	22	LS47	78	LS107	42	LS153	80	LS191	55	LS259	90	LS399	115
LS11	22	LS48	78	LS109	42	LS154	220	LS192	75	LS266	28	LS541	115
LS12	22	LS51	22	LS112	42	LS155	55	LS193	75	LS273	80	LS670	170
LS13	35	LS55	22	LS113	32	LS157	48	LS195	60	LS279	55		
LS14	45	LS73	28	LS114	32	LS158	48	LS196	75	LS283	70		
LS15	22	LS74	28	LS122	56	LS160	60	LS197	75	LS353	85		

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VOL 14 Nº1 JANUARY'85

EVERYDAY ELECTRONICS and computer PROJECTS

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TRUMPETING

UNLIKE some hobby publications we feel it is our duty on EE to keep readers abreast of technology in general and more specifically informed about anything which may affect their lives. For this reason we carry regular news and new products pages, features on various aspects of technology and information pages like *For Your Entertainment.* Of course, EE is also committed to putting over the basics of electronics and enabling our readers to develop their knowledge of circuit operation etc.

Our Teach-In courses are unsurpassed in any electronics magazine. The experience gained in publishing seven different Teach-In courses since EE started in 1971 is invaluable in planning and coordinating subject matter for future series. Over those years EE has also built up a fine relationship with many educational establishments and with teaching staff at all levels, a relationship that enables us to keep in touch with the requirements of those thirsty for knowledge of our particular subject.

This general information is backed up by our regular handful of projects designed to be of interest to a wide range of readers. Many of our projects are now aimed at computer users, projects like the *Power Lighting Interface, Alfred* and the *Spectrum Amplifer* in this issue. While it may seem that three "computer peripheral" projects is too many for one issue we must point out that two of the projects will connect to various computers and that all three items are aimed at a wide range of users. The *Power Lighting Interface* could be used in the home, but is more likely to be found with an amateur dramatics group or disco; *Alfred* will no doubt soon be found in many schools and colleges demonstrating robotic principles while the *Spectrum Amplifier* is almost essential for any user of the computer, particularly the games players at home.

While all the above may sound like blowing our own trumpet (which is just what it is!) it is designed to give you some insight into our present editorial policy. A policy which is set with you in mind, a policy which you can change, a policy which will go forward with EE into the future of electronic technology around the world.

What we would like you to do is to keep us informed of your requirements and of how well our policy and the magazine meet them so that together we can go forward gaining in ability as we go.

Mike Kenward

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POWER LIGHTING INTERFACE...

SPECTRUM: BBC-B: RML 380Z: VIC-20

M. P. HORSEY

Control banks of coloured mains lights by computer, using this easy-to-build project. Any effect can be achieved by simply changing the program data.

AUTOMATIC switching of mains lights poses several problems for the constructor. Either the electronic controlling circuit is at mains potential (as in commercial dimmer units)—in which case numerous safety precautions must be taken, or some form of isolation must separate the mains output from the input control.

Relays offer suitable isolation, but are unsuitable for fast or continuous switching. Sound to light units often use isolating transformers, but these require an a.c. input.

OPTO-COUPLED TRIAC

Fortunately, a package looking like a small i.c., and known as an opto-coupled triac, comes to the rescue. Pins 1 and 2 are connected internally to an infra-red light emitting diode. When energised, the infra-red light causes a triac to switch on. A triac is an a.c. switching device, and may be used with the mains supply. Since there is no electrical connection between the l.e.d. and triac, complete safety is assured.

APPLICATIONS

The circuit was originally planned to control five channels, but it soon became clear that there would be many applications for a power interface of this type, and a sixth channel was added to enable a greater variety of lighting effects to be achieved.

Any d.c. signal (within the working voltage limits) may be used as an input, even one derived from an a.c. signal—for example an audio output. However, the circuit is designed for digital signals, and an analogue input could cause overheating and/or interference, unless extra suppression is added.

CHANNELS

It will be apparent both from the circuit diagram, and the p.c.b., that the basic circuit is fairly simple, and is repeated six times over, for the six channels. In practice, any number of channels may be built, and some constructors may prefer a full eight channels if used with a computer.

COMPUTER CONTROL

Clearly the design lends itself to control by computer, and with a suitable computer program, virtually unlimited lighting displays can be achieved. The computer program listed will enable synchronisation of the lighting effects to verses, lines, or even words of a song. Once the master program is on tape or disc, the lighting effects required can be quickly added as DATA statements.

Obvious applications are parties, discos, and stage shows. The prototype was used in a school show with 48 coloured lights around the stage. The effects were synchronised with the script via the computer.

A user port is required on the computer, and the lighting interface unit has been used with a Research Machines 380Z, BBC, and Vic-20 computer. Any computer with a suitable port should work with the interface; alternatively some firms now advertise adaptors for computers without user ports, as for example, the RE-350 from Redditch.

POWER RATING

The power triacs specified will each handle a maximum current of 8 amps, and allowance must be made for the possibility of all channels switching on together. Thus with a 13 amp mains supply of which 12 amps is available with the specified circuit breaker, 2 amps may be drawn from each channel. This provides up to 480 watts per channel, and a total power of 2880 watts from the system.

CIRCUIT DESCRIPTION

Channel 1 will be considered, as all the channels work in the same way. Refer to Fig. 1. The positive 5 volt supply from the computer is fed into the infra-red l.e.d. at

pin one of IC1. If input 1 is "high" (ie. about 5 volts), then no current will flow through the l.e.d. and channel one will be switched off. If input 1 is "low" (about 0 volts), current will flow via limiting resistor R1 and the channel will switch on. The other channels are fitted with separate current limiting resistors as several inputs may operate at the same time.

If the infra-red l.e.d. in IC1 is switched off, no current will flow through the triac in IC1, and the power triac CSR1 will be switched off as well. Assuming that the circuit is connected to one or more lights, if the l.e.d. is switched on, a very small current will flow through the triac in IC1, and limiting resistor R7. The power triac CSR1 will allow a much larger current to flow, switching on the lights connected to channel 1.

FUSING ARRANGEMENTS

Each channel is fused separately with a 3 amp fuse on the p.c.b. These fuses were not placed in the "live" side of the circuit, because in practice the live connections are "commoned" to the lighting display unit. A 12 amp circuit breaker CB1 is included separately in the live connection.

INTERFERENCE SUPPRESSION

Although triac circuits tend to produce radio interference, and mains supply interference, this circuit is designed for "clean" digital operation, and drives a mainly resistive load. Extensive tests have been carried out with the prototype, to ascertain the amount of interference produced, and therefore the amount of suppression needed.

In fact, with the circuit indicated, no interference could be detected. The worst possible conditions were created, with computer leads, audio leads, the lighting output cables and mains input cables all tangled together. None of the three computers used showed any ill effects, even when sharing the same mains adaptor with the interface. No interference was detected on TV radio and audio circuits.

Thus no suppression was included in the design. However, there is space on the p.c.b. for the addition of a snubber network in each channel if desired. A snubber network consists of a high voltage capacitor and resistor in series. It should be connected to the points marked with an X on each channel. Note that a capacitor must not be used without the resistor, or the power triacs will burn out.

CONSTRUCTION

The circuit is constructed on a printed circuit board. See Figs. 2 and 3. Care should be taken to ensure that the common neutral track can handle the required current—hence the reason for three connecting points. The tracks leading to each power triac are wide enough to allow the drilling of additional holes for the connection of the snubber network if required.

When drilling these holes, take care to allow sufficient clearance for the heat sink, which is made from a single piece of aluminium measuring about 230mm × 110mm, earthed to the case. An earthed track surrounds the p.c.b., and runs between the input/output pins of the i.c.s for additional safety.

Begin by soldering i.c. terminals to house the 6-pin d.i.l. opto-triacs. Next solder the resistors, fuse holders, and connecting wires—ensuring that the mains connecting wires will carry the required current.

The power triacs are soldered directly to the p.c.b., their metal bases being fixed to a suitable heat sink. Note that the metal bases are *"live"* and *must* be insulated from the heat sink with proper heat conducting material.

Finally, plug in the opto-isolators—the correct way round—and check the p.c.b. carefully for hair-line cracks in the tracks, and short-circuits.

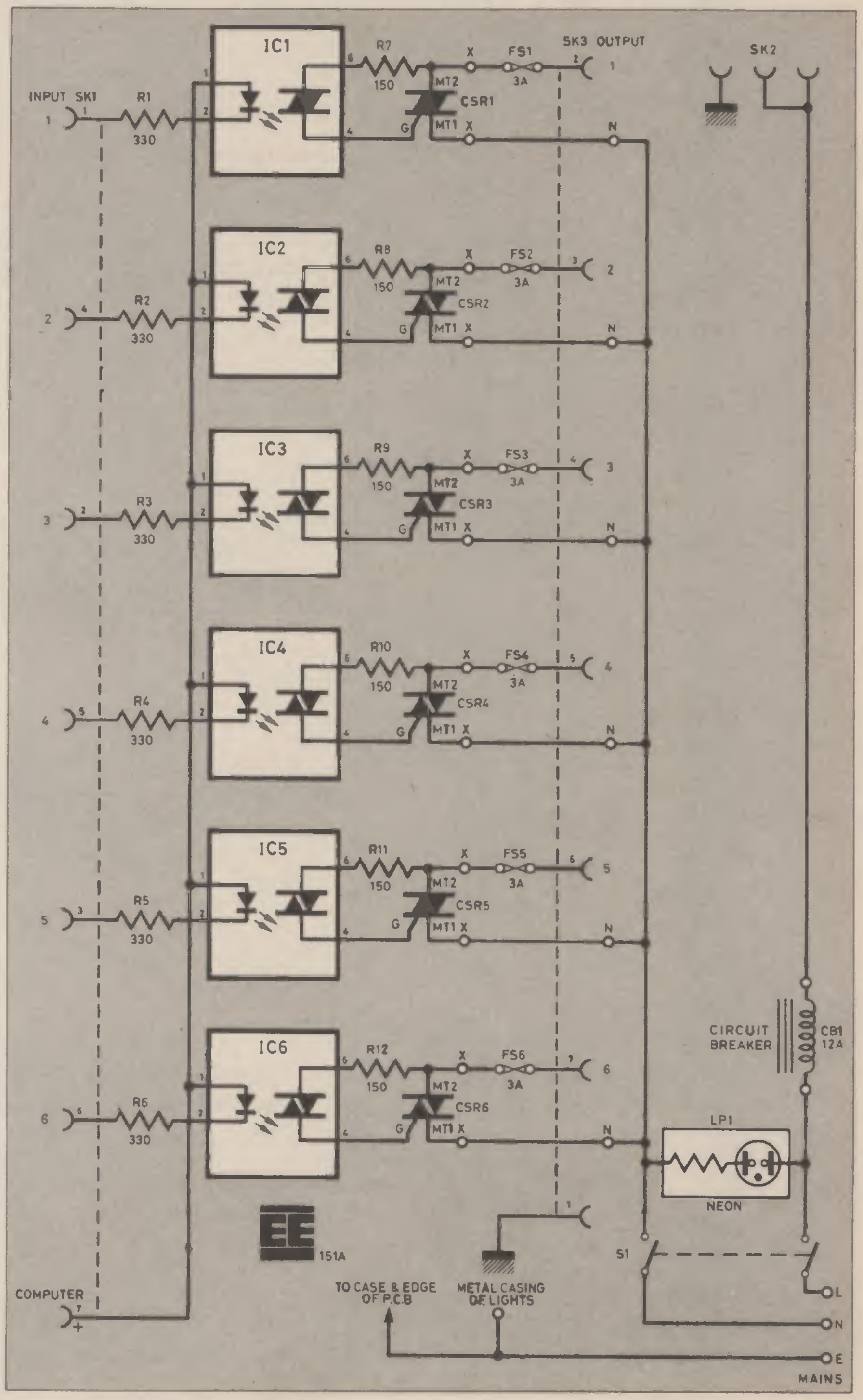
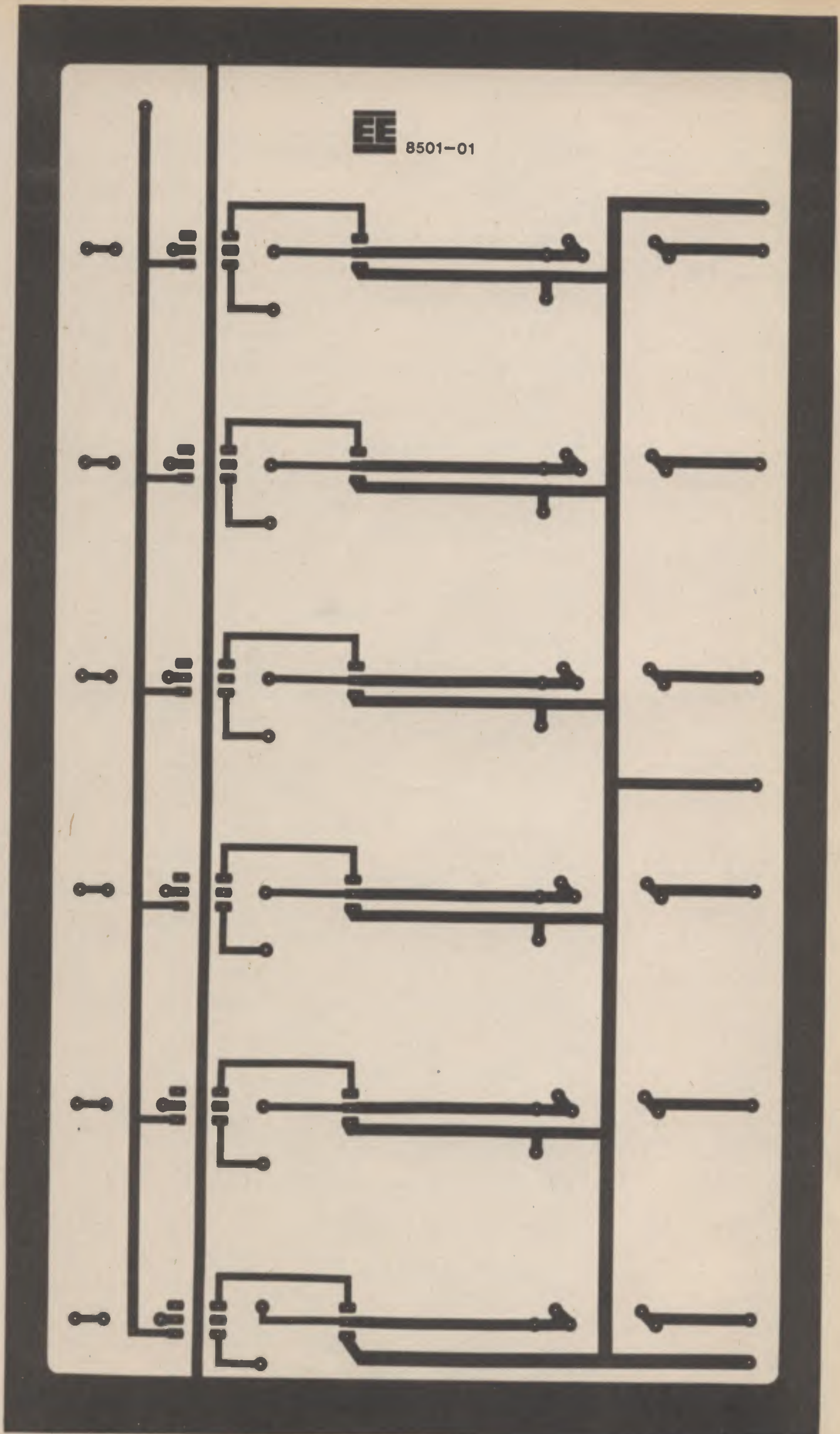
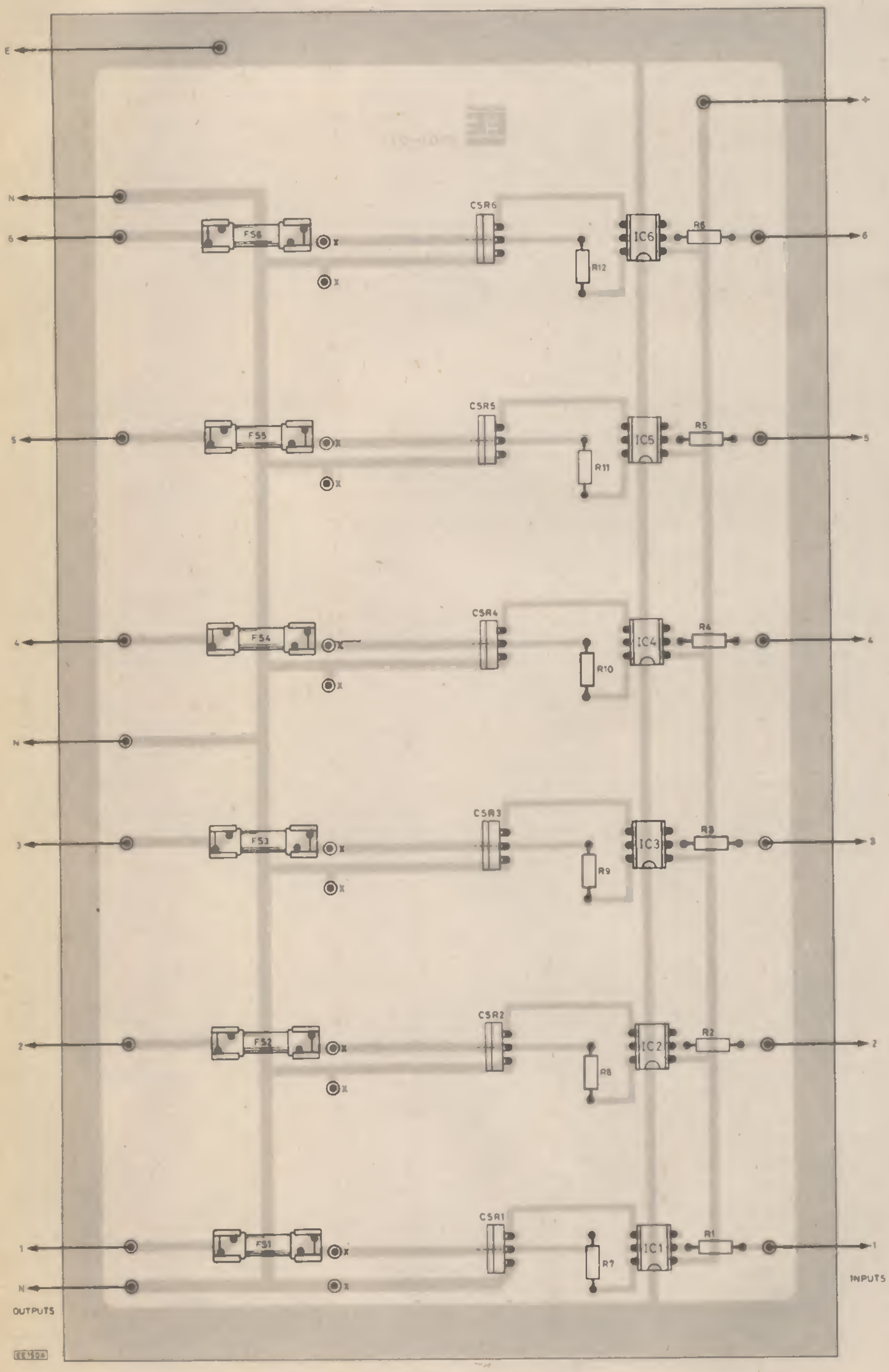


Fig. 1. Circuit diagram for the Power Lighting Interface.


EE 8501-01

Left: The metal-cased prototype.
Fig. 2 (Opposite). P.c.b. design. Available from the *EE PCB Service*, code 8501–01.
Fig. 3 (Below). Component layout.



HOUSING THE UNIT

The original unit was housed in a plastic case, and performed very well. The second "prototype" was housed in a metal case, which—if properly earthed—provides greater security. All the mains connections are at the rear of the unit, with the low voltage connections at the front.

OUTPUT CONNECTORS

An 8 pin chassis socket (rated at 6A 250V) is used to connect the channel outputs with the lighting system. The centre pin MUST be used as an earth connection, thus only one 6A pin is available to supply the common "live" connection. Since a 12A supply is required, a second "Euro Facility Outlet" socket is included with both sides used as a "live" connection, as shown in Fig. 4. The earth connection should be used as intended. Note that if 6A cable is used, two wires must be used as "live" conductors, and two as "earth" conductors.

The following holes will be required:
Input connector: A seven way DIN socket may be used.
Output connectors: Eight pin chassis socket (rated at 6A 250 volts), 3 pin Euro Facility Outlet (rated at 6A 250 volts).
Mains 13A cable inlet hole (with room for grommet).
Mains 13A d.p. switch.
Mains 12A circuit breaker.
Mains neon with integral resistor.
Holes to mount p.c.b., heat sink supports, and handle.

COMPONENTS

See **Shop Talk** page 18

Resistors

R1–R6	330 (6 off)
R7–R12	150 (6 off)
All $\frac{1}{4}$W ±5%	

Semiconductors

IC1–IC6	Opto-coupled triac (6 off)
CSR1–CSR6	Power triac 8A, type C226D (6 off)

Miscellaneous

FS1–FS6	Fuse clips and 20mm fuses 3A or 3·15A (6 off)
CB1	Mains circuit breaker 12A
S1	Mains toggle switch 13 or 15A d.p.s.t.
LP1	Mains neon with integral resistor

Printed circuit board (255mm x 145mm)
7 way DIN socket
8 way Bulgin socket
Mains Euro socket
13A cable
Insulators for mounting power triacs
Heat sink
Case (Length 300mm, width 160mm, height 135mm)
Interconnecting wire, screws etc.

FINAL ASSEMBLY

When drilling is complete, fit the various connecting sockets, switch, neon etc. Fix the p.c.b. to the base, using spacers to ensure that the copper tracks are well clear of the metal base. Complete all the connections, not forgetting the earth wire from the p.c.b. and case.

HEAT SINK

The heat sink may be made from a sheet of aluminium measuring about 230mm × 110mm. The aluminium should be shaped as shown in the diagram, Fig. 5, thus allowing it to be fixed to the p.c.b.—taking care to avoid the "live" tracks. One or both of the mounting screws should also "earth" the heat sink. Note that the metal tabs on the triacs are connected internally to one of the leads. They *must* therefore be insulated from the aluminium, using the special insulators available. Nylon nuts and bolts may be used to fasten them to the aluminium.

Examine the unit carefully for faults, paying particular attention to the isolation of the low voltage parts of the circuit. Finally, attach the lid of the case, ensuring that it does not touch any electrical parts inside.

TESTING

A d.c. supply of between 4·5 and 6 volts may be used to test the circuit. Connect a lamp(s) to one or more channels, plug in the unit, and switch on. The lamp(s) should not light. If they do, unplug immediately, and check the circuit for mistakes or short circuits.

Connect the positive of the d.c. supply to the positive connection on the interface. Connect the negative to input 1, then 2 etc. The appropriate light should work.

If no channels work, unplug the unit, and check that the opto-triacs and power triacs are connected the correct way round. If these are correct, check the external wiring carefully for mistakes.

If only one channel fails to work, the fault may be a poorly soldered joint, or hair-line crack in the p.c.b. In this event, the unit must be dismantled for checking. Assuming the tests work with a d.c. supply, a computer may be connected to the power interface, and test programs can be run.

INTERFACING WITH A COMPUTER

Connect up a suitable lead between the computer and power interface, as indicated in the diagrams, Fig. 6. Switch on the computer, and type one of the following test programs:

RESEARCH MACHINES 380Z

```
20 POKE &FBFF,255
30 PRINT"State number for poking"
40 INPUT N
50 POKE &FBFF,N
60 GOTO 30
```

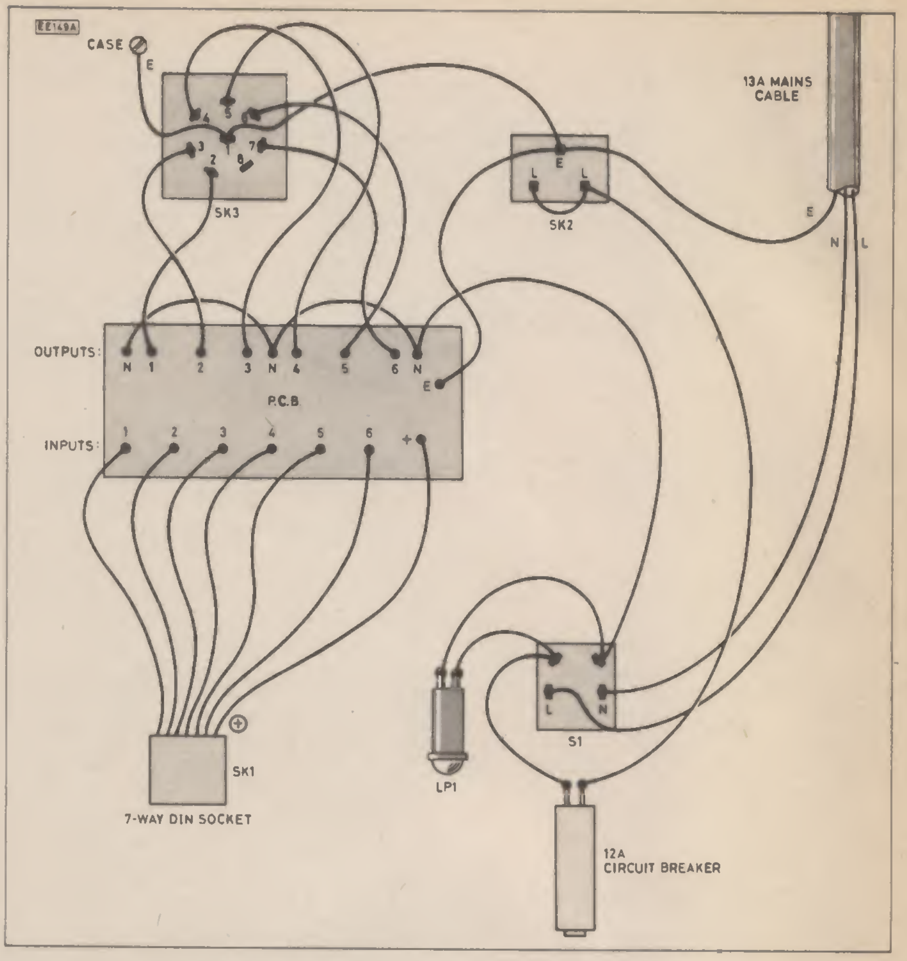


Fig. 4. Wiring diagram for the Power Lighting Interface.

VIC 20 COMPUTER

```
10 POKE 37138,255
20 POKE 37136,255
30 PRINT"State number for poking"
40 INPUT N
50 POKE 37136,N
60 GOTO 30
```

BBC COMPUTER

```
10 ?65122=255
20 ?65120=255
30 PRINT"State number for poking"
40 INPUT N
50 ?65120=N
60 GOTO 30
```

Line 10 configures the user port in the Vic and BBC computers, for outputting. Line 20 causes all the output lines to go "high", thus switching off each channel in the power interface. Line 50 causes only those lines selected by the number N, to go high. Thus typing 0, will cause all the channels to switch on. Typing 1, will cause all except channel 1 to light. Typing 2, will cause all except channel 2 to light. Typing 4 will cause all except channel 3 to light. The series continues in this way with 8, 16, and 32. Typing 3 will light all channels except 1 and 2; typing 5 will light all except 1 and 3 etc.

Switch on the power interface, and check correct operation. In the event of any failure, disconnect from the mains, and from the computer.

It may be more convenient to work positively, rather than in an inverse way as described above. A line 45 may be added to the program as follows:

45 LET N=255−N

Typing zero will now turn off all channels; typing 1 will turn on channel 1; etc. An understanding of this system is not necessary as the Master Program listed provides a simple means of creating various lighting displays.

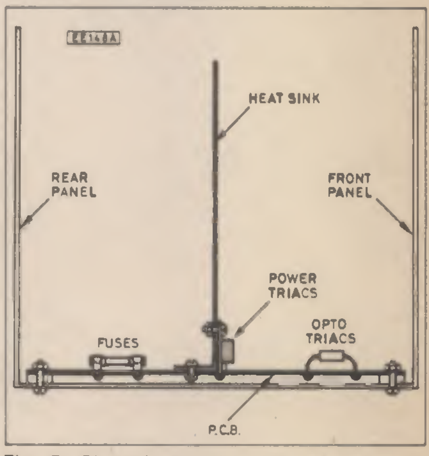


Fig. 5. Side view of case, showing heat-sink.

MASTER PROGRAM

The original program was written for the RML 380Z. The Vic-20 version differs in screen layout (to allow for the much larger print), and in requiring a data direction indicator at line 60. The BBC program, listed, uses a different command to POKE, and also requires a data direction indicator. Apart from this, the programs are very similar, and the method of coding the lighting sequences identical.

CODING

Brief instructions about the coding system are contained in lines 790 to 890 of the program. The actual codes are contained in the form of DATA statements starting at line 1000. The codes may be general—for a complete song, or relate to a particular line or word of the song. In the example the codes are arranged line by line. In practice, "SONG LINE 1" could be the actual words in the song, "SONG LINE 2" the next set of words etc.—though slow typists may prefer the minimum effort eg. line 1010 could simply be DATA 1.

The first DATA statement—line 1000—provides the time delay between each change of lights. Various different values may be tried here when testing the unit, but when running normally, most applications will require a fast display, obtained by reducing the value at line 1000. The last DATA statement must be the word END.

All the other DATA statements are information lines (eg. lines or verse numbers of a song), alternated with the lighting codes required for that line or verse. Note that commas must not be used unless the whole line is enclosed by quotation marks.

LIGHTING CODES

Each lighting channel is denoted by a letter, in this case from A to F. (ie. channel 1 to 6). Thus, typing DATA A will switch on channel 1 for line 1. A space, or letter X will switch off all channels. Thus line 1020 will cause channel A, then B, then C etc. to light singly. The time each channel stays on is set at line 1000. The letter Y switches off all channels, but pauses for the time set by line 1000. The sequence then repeats indefinitely.

Typing letters without spaces will cause the next channel to switch on without the previous one switching off. Thus in line 1060 channel A switches on, followed by the other channels until all are on. The letter Y switches them all off, and the sequence repeats. A double letter eg. AA will simply double the time delay at that point.

A letter H at the end of a line (see line 1120) will prevent the sequence repeating, and the last command holds indefinitely. A letter Z (see line 1140) will cause the previous channel only to switch off. The letter R causes the channels to operate at random. Omitting any commands (but note that the word DATA must still be present), will cause the previous effect to be retained.

Channels may be programmed to light in any order, and the examples contained in the Master Program give only a brief indication of the type of effects which may be achieved.

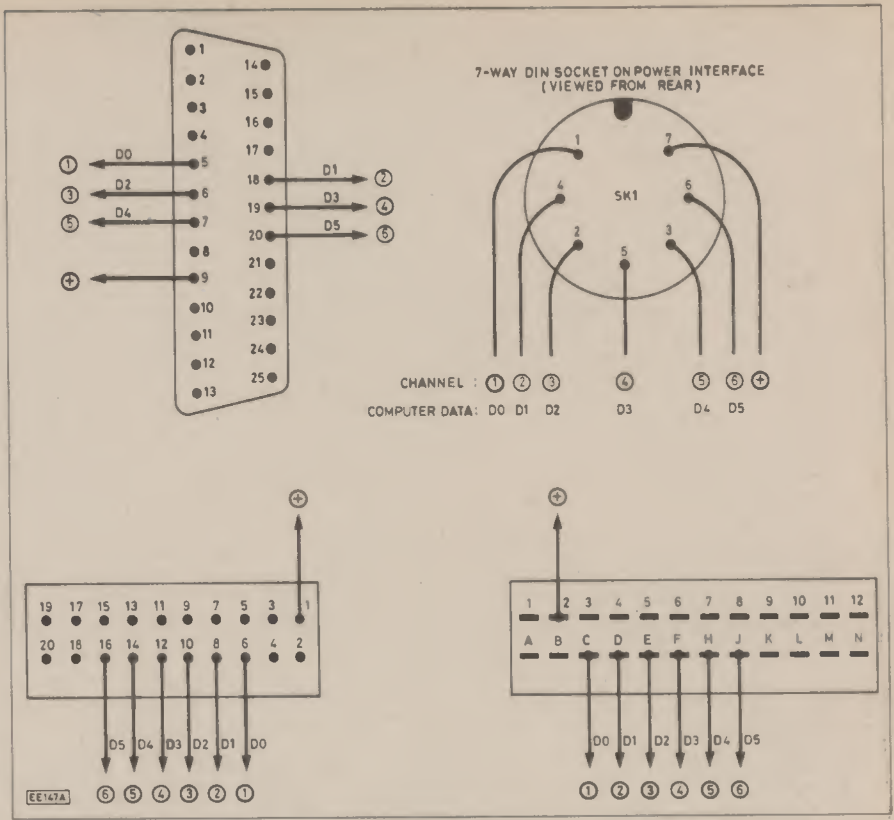


Fig. 6. Connections to DIN socket and user ports.

MASTER PROGRAM for the Power Lighting Interface.

```
  5 MODE6
 10 REM"LIGHTS" FOR BBC
 20 REM CONVERTED BY LEE TRICE
 30 CLEAR
 40 VDU 23;8202;0;0;0;
 45 ?65122=255
 50 REM P=I/O ADDRESS
 60 LET P=65120
 70 CLS
 80 PRINT" CHASER LIGHTS WITH WORDS"
 90 PRINT" ********************************"
100 PRINT
110 READ TI
120 LET X=0
130 PRINT"            Time="TI
140 PRINT:PRINT:PRINT
150 PRINT"TO READ LINES OF SONG:"
160 PRINT
170 PRINT"FOR NEXT LINE AT END OF SEQUENCE,"
180 PRINT"                          TAP SPACE"
190 PRINT
200 PRINT"TO MOVE IMMEDIATELY TAP RETURN"
210 PRINT
220 LET G$=GET$
230 LET X=X+1
240 LET TT=TI
250 READ W$
```

```
260 IF W$="END"THEN 530
270 READ L$
280 IF L$=" "THEN LET L$=LK$
290 LET LK$=L$
300 PRINT TAB(0,20)X" "W$
310 LET T=0:G=0
320 FOR Y=1 TO LEN(L$)
330 LET A$=MID$(L$,Y,1)
340 IF A$="R"THEN 730
350 IF A$="X"OR A$=" "THEN LET T=0:GOTO 470
360 IF A$="Z"THEN LET R=255-(S OR Q):?P=S OR Q:GOTO 450
370 IF A$="Y"THEN R=0:GOTO420
380 IF A$="H"THEN Y=Y-1:GOTO 480
390 LET A=ASC(A$)-65
400 LET Q=INT (2 ^ A+0·5)
410 LET R=Q OR T
420 LET T=R
430 LET S=255-R
440 ?P=S
450 GOSUB 590
460 FOR K=1 TO TT:NEXT K
470 IF G=32 THEN 500
480 LET G=INKEY(0)
490 IF G=13 THEN 230
500 NEXT Y
510 IF G=32 THEN 230
520 GOTO 320
530 ?P=255:PRINT
540 PRINT TAB(0,21) "DO YOU WANT TO REPEAT SONG ";
550 INPUT R$
560 IF R$="Y"OR R$="y"THEN RESTORE:GOTO10
570 IF R$="N"OR R$="n"THEN END
580 GOTO 580
590 REM DENARY TO BINARY CONVERTER
600 LET B1$="0":B2$="0":B3$="0":B4$="0":B5$="0":B6$="0"
610 IF R/32>=1 THEN B1$="1":R=R-32
620 IF R/16>=1 THEN B2$="1":R=R-16
630 IF R/8>=1 THEN B3$="1":R=R-8
640 IF R/4>=1 THEN B4$="1":R=R-4
650 IF R/2>=1 THEN B5$="1":R=R-2
660 IF R=1THEN B6$="1"
670 LET BB$=B1$+B2$+B3$+B4$+B5$+B6$
680 PRINT TAB(0,3)BB$
700 RETURN
710 ?P=255
720 END
730 REM RND GENERATOR
750 LET T=0
760 LET A=INT(6*RND(1))
770 LET TT=INT(TI*3*RND(1))
780 GOTO 400
790 REM********DATA INSTRUCTIONS******
800 REM 1ST.DATA STATEMENT=TIME DELAY
810 REM EACH LINE OF SONG TO BE FOLLOWED BY THE LIGHTING
    CODES A TO F
820 REM IF LIGHTING CODES ARE OMITTED        THEN PREVIOUS LINE
    CODES ARE USED
830 REM*****************************
840 REM CLOSE SPACED LETTERS=LIGHTS STAY ON AS SEQUENCE
    BUILDS UP.
850 REM A SPACE, OR X, TURNS OFF LIGHTS.
860 REM Y= TURN OFF LIGHTS WITH PAUSE
870 REM Z= TURN OFF LAST LIGHT ONLY
880 REM H= HOLD ON LAST PART OF SEQUENCE UNTIL "RETURN" IS
    PRESSED
890 REM R= FLASH LIGHTS AT RANDOM
```

```
1000 DATA 100
1010 DATA SONG LINE 1
1020 DATA A B C D E F Y
1030 DATA SONG LINE 2
1040 DATA A B C D E F E D C B Y
1050 DATA SONG LINE 3
1060 DATA ABCDEFY
1070 DATA SONG LINE 4
1080 DATA ABCDEFYFEDCBAY
1090 DATA SONG LINE 5
1100 DATA ABCYBCDYCDEYDEFY
1110 DATA SONG LINE 6
1120 DATA ACE BDF ACE BDF ACH
1130 DATA SONG LINE 7
1140 DATA ABCDEFZEZDZCZBZAZ
1150 DATA SONG LINE 8
1160 DATA R
1170 DATA SONG LINE 9
1180 DATA
1190 DATA SONG LINE 10
1200 DATA
1210 DATA END
```

OPERATING THE PROGRAM

Once the commands are programmed, the operator RUNs the program, and presses **RETURN** to cause the first line of the song to appear on the screen. The first lighting sequence will start, and continue until he presses **RETURN**. The next line will appear, and the next lighting sequence will take over. The **SPACE-BAR** may also be used like **RETURN**, but now the program waits until the end of a sequence, before moving on. (Note that the **SPACE-BAR** cannot be used if the sequence is "holding" ie. the line ends with the letter **H**).

Lines 590 to 700 provide a running report of the lighting effect, by placing a binary number on the screen, equivalent to the binary output into the power interface. Even those not familiar with the binary system will understand that the number 00000001 turns on channel A, 00000010 turns on channel **B**, and 00100000 turns on channel F. 00111111 will turn on all six channels.

NOTE: Readers requiring program listings for the RML 380Z, Commodore Vic-20, or Spectrum, should send a large SAE together with a P.O. for 50 pence to EE Editorial offices (see page 7), quoting this project title, and stating which listing is required.

SPECIAL REPORT
AMSTRAD CPC4

THE CPC 464 design from Amstrad is the company's first venture into the personal computer market and reflects their overall marketing strategy of consumer electronic products.

Amstrad believes the mass market appeal is towards "complete systems" and this policy which has been very successful for them in the hi fi field is now being applied to the computer market.

The CPC 464 is a complete computer system housed in two matching units with just one mains lead and overcomes the "spaghetti" effect of leads and wires which seems to accompany most home computer set-ups.

The computer has been designed around the Z80A processor running at 4MHz and a list of the LSI chips used is given in Table 1.

The computer, keyboard and cassette recorder have all been placed in one case measuring 580 × 170 × 70mm and the usual TV set has been replaced by a choice of two monitors: You can either have a high resolution monochrome display with a green screen or a medium resolution colour display.

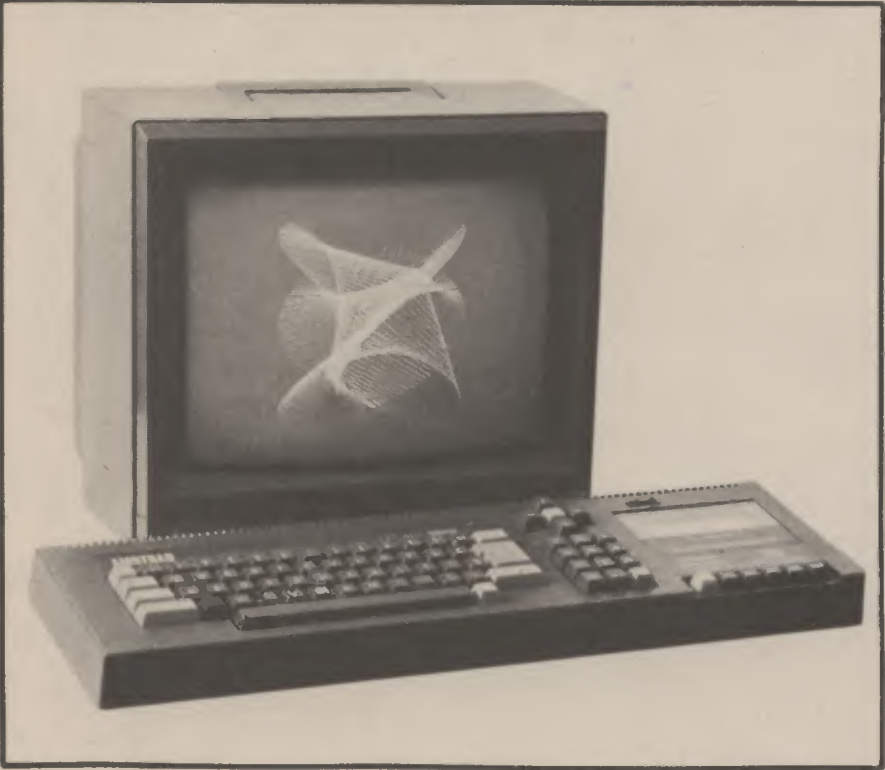
The power supply for the system has been placed inside the monitor. Any problems that could be encountered if you wanted to use a different monitor or your own TV set have been overcome by Amstrad with a power supply/modulator unit which is sold separately for £30. This is especially useful if you need the high resolution of the monochrome monitor but want to use your colour TV for the full effects when playing software games.

KEYBOARD

All the keys on the CPC 464 are redefinable. The keyboard itself is a full 74-key QWERTY layout with a numeric keypad and cursor keys. The feel of the keyboard is very good, especially the large blue enter key. The addition of the keypad is a real bonus not only for typing in data but it can also be user defined with up to 32 single key functions to provide BASIC keywords. When the keypad is used in this way the numeric keys at the top of the keyboard can still be used in the normal way. The only snag is that the keypad keys cannot be labelled with the functions because there is not enough room around them. The 32 functions can be defined with strings of up to 32 characters.

Table 1. LSI chips used in the CPC 464.

Z80A	Processor running at 4MHz
64K	Bytes of RAM (over 42K available to the user)
32K	Bytes of ROM containing the BASIC and the operating system
6485	CRT controller device
AY-3-8912	3-voice, 7-octave sound generator chip
8255	Parallel I/O device, interface to the sound chip



CASSETTE UNIT

The use of a built-in cassette recorder has overcome many of the error problems associated with loading and saving cassette programs. Another advantage is that because the performance of the cassette recorder was known, Amstrad have been able to offer two standard tape speeds; 1000 and 2000 baud, with the computer being able to sense automatically the speed at which the program was saved, on playback.

The forward and rewind controls of the cassette can be used at anytime whereas play and record are under software control and will only operate the cassette motor when the micro is instructed to load or save a program; a very useful feature when storing or loading a number programs on one tape.

REAR VIEW

The rear of the unit houses all the expansion sockets. There is a user port for use with joysticks. Strangely though, the joysticks from Amstrad are connected in series; the first is connected to the port and the second plugs into the first. So unless you use the Amstrad joysticks only one can be used. Although the second joystick is mapped over some of the keys on the main keyboard so these can be used in its place. The next port is for a printer and has a Centronics interface. Any Centronics type printer can be used and Amstrad supply the DMP-1, 80-column dot matrix printer which is priced at £199.99.

The expansion port can be used for a series of add-on's including additional ROMs and RAMs, but the main use of the port is for the disc drive units. Here, Amstrad has decided on the 3in Hitachi disc system complete with PSU, interface, CPM; which is a standard disc

The DMP-1 dot matrix printer.

operating system, and a specially designed version of Dr. Logo, a simple graphics based language incorporating the sound and graphics command of the CPC 464. The disc drives are double sided, double density, 40 track units.

One small point is that both the printer and expansion ports are edge connectors on the main PCB and could become worn with use. Perhaps it would have been better if sockets had been fitted.

Finally, there is a handy socket for stereo sound. When this is connected up to a hi fi unit it certainly improves the sound of your games.

THE CPC 464 MODEL RANGE AND PERIPHERALS

System 1: Computer and green monitor £239.00
System 2: Computer and colour monitor £349.00.
System 3: Computer, disc drive and green monitor £429.00.
System 4: Computer, disc drive and colour monitor £529.00.
Disc Drive DD1-1: Complete with p.s.u., plug-in controller and interface unit which will support up to two drives £199.95.
Disc Drive FD-1: Second drive unit less p.s.u. and interface £159.95.
Printer DMP-1: 80-column dot matrix model £199.95.
Modulator/p.s.u. MP1: For driving a TV £29.95.
Joystick JY1: £14.95.
All prices includes VAT

COLOUR DISPLAY

There are three display modes on the Amstrad and in each mode there is a maximum number of colours which can be displayed on the screen at one time. This is the usual trade-off between resolution and colour. These colours can be chosen from a palette of 27 colours.

Mode 0 is a 20-column display with a choice of 16 colours (from 27), Mode 1 is a 40-column display with four colours (from 27) and Mode 2 is an 80-column display with two colours (from 27). Text and graphics can operate together in all modes.

The maximum graphics resolution in Mode 0 is 160×200, in Mode 1 320×200 and in Mode 2 640×200.

When in Mode 2 the 80-column text on the colour monitor is difficult to read so if you wanted to work in this mode for long periods the high resolution green screen monitor would be best.

The difference between a colour monitor and a modulated TV picture is shown quite vividly on the Amstrad. The display is completely steady and gives well defined, crisp colours.

The screen colours are controlled by the BORDER, PAPER (the character area) and PEN (the character itself) commands. Further changes of the paper and pen can be carried out using the INK command.

SOUND

The sound effects of the machine are generated by the General Instrument's 3-voice AY-3-8912 chip. The level of sound can be adjusted by the volume control on the right hand side of the computer.

You can specify the tone period, duration, volume (that is the starting volume of the note), volume envelope, tone, tone envelope and noise period. All these can be used in conjunction with the STEP TIME command so each step is variable in amplitude with respect to the last step. White noise is also available for gunshots, explosions, etc.

All the sound effects are easy to program and each new sound can be held until the last sound has been completed. But the best part is the stereo output which enables you to feed the sound through your hi fi. The three voices are separated into left, right and middle.

BASIC

The overall impression of the BASIC from Locomotive is that it is a well designed, easy to use system with a number of interesting features.

Among the programming and debugging features are RENUMBER and AUTOLINE NUMBERING with editing carried out either by the standard line edit command or the copy cursor method. To reset the machine the CONTROL, SHIFT and ESCAPE keys have to be held down in that order, so resetting the machine by mistake would be somewhat difficult!

Any key can be redefined by the KEY DEF command, for example, the D key can be changed to the £ character. Also the repeat period of any particular key can be altered by the SPEED KEY command.

The EVERY command will interrupt a program at regular intervals, determined by one of the four timers, and switch the program to a sub-routine whilst the AFTER command will carry out the same function only once.

A program can be halted by pressing the escape key once and to break into the program the escape key must be pressed twice.

CONCLUSIONS

A great many opinions have been expressed about the wisdom of Amstrads' design concept; whether or not the p.s.u. should have been included inside the monitor, the advantages of the internal cassette unit, the restraints imposed by a custom-designed monitor, etc. My own opinion is that the Amstrad CPC 464 is exceptional value for money, it is easy to use and the "complete system" idea will attract many people into computing who have been waiting for just such a system to appear.

Because the CPC 464 has been designed by a well known and respected manufacturer which is already a household name, the machine is certain to make a major impact in the next year. Although the software and add-on's currently available are not at the same level as many of its rivals this will quickly be rectified as designers and companies jump on the Amstrad bandwagon.

Another pointer to Amstrad's commitment is its claim that over 200,000 units will be sold by the end of 1984 and over 350,000 units in 1985. When you consider the UK sales of the BBC Micro is less than 200,000 and the total UK sales of the Spectrum is 1,600,000 the market will certainly feel the effect of the CPC 464.

One final note of interest is that Amstrad is developing a range of peripheral items of hardware which will be launched in the Autumn of '85. These items they claim will keep them well ahead of the opposition. So Amstrad seems totally committed to the computer market.

464 COMPUTER

DAVID SHORTLAND

SHOP TALK

BY DAVE BARRINGTON

Catalogue Received

The latest edition of the **Electrovalue** components catalogue contains 44 pages, with each item priced on the page. The range of items listed extends from aerosols and batteries to integrated circuits and Eprom programmer/copiers.

When you consider that they only produce three editions throughout the year, it just shows how confident they are in their pricing system being able to withstand (for four months) all the elements that can affect prices.

We have only one minor criticism and that is the lack of an index. However, as items are listed in alphabetical order this has not detracted from its usefulness in the office when pricing projects.

Copies of the Electrovalue catalogue may be obtained Free of charge from **Electrovalue Ltd., Dept EE, 28 St. Judes Road, Englefield Green, Egham, Surrey TW20 0HB.**

Hot Tip

Having endured the frustration of trying to replace a broken electrical lead in the car, without the facility to make a simple solder joint, the latest soldering product from **Greenwood** gets our vote for money well spent.

Little bigger than a felt-tip pen, the Oryx Portasol iron works on entirely different principles from conventional gas types. There is *no* flame during operation, the chemical energy of the gas is converted into heat by means of a catalytic converter in the solder tip.

The iron delivers the equivalent of 60W, the tip temperature being adjustable between 250 and 450°C. The iron will run for 60 minutes on its internal gas supply, and refuelling is identical to filling a gas cigarette lighter. It is claimed that the same principles that make gas lighters safe are applied to the Portasol.

Capable of being clipped in the work overalls pocket, by the protective top, the iron incorporates a built-in igniter. Replacement tips, which include the converter, are readily available.

The Oryx Portasol is priced at £17.25 and is available from: **Greenwood Electronics, Portman Road, Reading, Berks, RG3 1NE.** At this price it's far cheaper than being towed in!

Equally, it should prove invaluable to the service engineer, prototype wireman and the constructor.

CONSTRUCTIONAL PROJECTS

Spectrum Amplifier

We do not expect any component purchasing problems for the *Spectrum Amplifier* project. However, some difficulty may be experienced in locating a source for the "reverse log" Volume Control potentiometer VR1. If a lin. or log/law "pot" was used here, the control of volume would be very abrupt and concentrated at one end of the track.

The reverse log potentiometer is available from Magenta Electronics. They are also able to supply a complete kit of parts (including p.c.b.) for this project for the sum of £5.98. This price includes VAT, but a further 50p per order will have to be added for post and packing. They will, of course, sell all parts separately.

The printed circuit board for this project is also available from our "Printed Circuit Board Service", see page 50.

Readers requiring a complete kit should contact: **Magenta Electronics, Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs, DE14 2ST.**

Power Lighting Interface

There are several components that are likely to cause purchasing troubles when tackling the *Power Lighting Interface* project.

The only source we have been able to locate for the opto-coupled triacs is Maplin Electronic Supplies. This device should be ordered as: QQ10L (Triac Isolator). The 8A triacs, type C226D or suitable alternatives, are listed by Maplin, Bi Pak, Electrovalue, Rapid and TK Electronics.

The 12A mains circuit breaker is available from Maplin and carries the order code: BK24B (Thermal Breaker 12A). The Euro and Bulgin sockets, SK2 and SK3, are stocked by Cirkit, Skybridge and Maplin.

One final note of warning. As mains voltages are present: *It is most important that the details regarding insulating, cable ratings and "earthing" are followed most carefully.*

Alfred

This month's final instalment of *Alfred the hobby robot* deals with the setting up and software listings.

A complete kit of parts for *Alfred* would normally cost £170, plus VAT. However, special arrangements have been made with Robot City Technology whereby readers of EE may purchase a kit for the sum of £160, plus VAT. A saving of over £10. This kit includes a fully expanded version of the software on cassette.

Robot City Tech are also prepared to supply all components as individual items. This includes mechanical mechanisms and pulleys, servo motors and interface board.

For full details, readers should write to: **Robot City Technology, Dept EE, 437B Midsummer House, Midsummer Boulevard, Milton Keynes, MK9 2HE.**

Games Timer

The case used in the prototype unit of the *Games Timer* was an old plastics digital watch presentation case.

If a case of this type is not to hand, then one of the common "flip-top" cases, stocked by most of our advertisers, could be used. This would probably necessitate a slight rearrangement of the component layout, but should not be to difficult to accomplish. The actual arrangement will obviously be governed by the "physical" size of the relay used.

The AC128 transistor used to drive the "buzzer relay" is quite commonly available; however, we see that **Grandata** are offering this device for 15p—this appears to be about half current prices.

Truth Table Display

A suitable case for the *Truth Table Display* is available from Enfield, Maplin, Rapid and TK Electronics.

The red and black 1mm plugs and sockets should be stocked by most of our advertisers. The semiconductor devices are currently listed by Rapid and Skybridge.

NEW · NEW · NEW · NEW

PRODUCTS

NEW · NEW · NEW · NEW

MICRO MODULES

THE new range of **Zenith I/O** Modules are designed to interface between 5V logic microprocessor control systems and 240V mains and low voltage d.c. load devices. Optically isolated between Inputs and Outputs, the modules are moulded in epoxy compound and mounted on heavy duty heatsinks.

The Input modules 505 A&D have been designed to provide feedback information to the Input Ports of a computer. It is therefore logic compatible when an input ranging from 150 to 280V a.c., or an input ranging from 5 to 30V d.c. is applied to the input of the modules.

Applications include feedback information from a robotic machine or position sensing.

The AC Output module 106 provides power control of medium to high voltage and current to various electrical loads. The logic of a computer port will drive the photo-coupled circuit, the output load operating on an a.c. supply between 50–280V a.c. The maximum load current is 6A.

The DC Output module 103 is intended to provide power control of low voltage and current to d.c. loads such as motors, solenoids and lamps. The maximum load current being 3A.

For further details and prices write to:

Zenith Electronics,
Dept EE, 21 Station Road
Industrial Estate, Hailsham,
E. Sussex BN27 2EW.

CLEAN HEAD

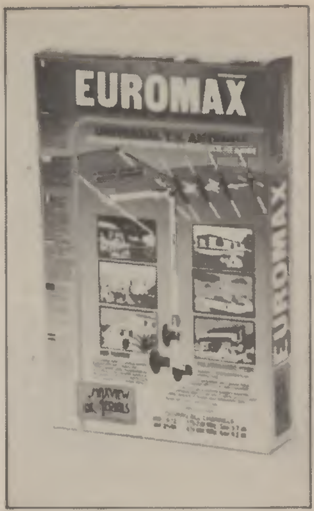
THE latest cleaning solvent from **Electrolube** is claimed to loosen and remove accumulated deposits of dirt and tape oxide and dry quickly without leaving any residue on the tape head or tape.

The solvent comes in 110 gram aerosols and is applied by spraying directly on to the heads and mechanisms. Incidentally, it can be sprayed onto other cleaning devices, such as cotton buds or felt and chamois leather sticks.

The Video Tape Head Cleaner can be used for tape heads on video, tape and cassette recorders. It is also ideal for use in data processing, word processing and computer machines.

For prices and local stockist write to:

Electrolube Ltd.,
Dept EE, Blakes Road,
Wargrave, Berks RG10-8AW.



AERIAL VIEW

SUPPLYING television aerials for family touring caravans is now big business. A domestic TV receiver, operating off the vehicle 12V supply, or from mains where available, is today as essential to the holiday traveller as his portable cooking facility.

Any portable aerial must be capable of receiving adequate signals wherever the owner may venture and it must be readily removable before transit. Because large numbers of British holidaymakers travel abroad, their aerials must also be designed to provide signals from the various stations operating on the continent and beyond.

Now **Maxview Aerials** have launched a new aerial design intended to meet all of the above requirements. Appropriately, it is called the Euromax Universal and is, in effect, two antennas in one to cover both the v.h.f. and the u.h.f. black-and-white and colour wavebands.

A fixing kit is supplied with the aerial and includes suction pads, for attaching to smooth surfaces in caravans or boats, as well as a bracket and mast for use when it is to be installed at a more permanent site, such as a holiday home, villa or apartment.

The Euromax Universal retails for £23.75 and details of nearest stockists may be obtained from:

Maxview Aerials Ltd.,
Dept EE, Maxview Works,
Setch, King's Lynn,
Norfolk PE33 0AT.

RIGHT NOTE

THE technique of Sampling, as associated with music, involves the recording of natural sounds and playing them back at a different pitch. When digital electronic techniques are applied to this process, the result is that one sound, such as a bird warble, can be used as the basis for a complete sound spectrum. Link up a keyboard and the possibilities are limited only by the musician's creative imagination.

Until now the equipment to produce these effects has usually carried a price tag of thousands of pounds and consequently mainly used by the professional. However, the latest MCS–1 Digital Sampler from **Powertran Cybernetics** in kit form retails for

£499 plus VAT. Ready-built models will cost £699 plus VAT.

The unit incorporates a sophisticated "looping" technique which makes infinite sustain possible. This can be applied to any part of the recorded sound wave, giving the player very precise control over the sound being played.

It can operate on either MIDI signals or control voltage (1V/Octave). Owners of the machine can, therefore, use their existing keyboards and avoid further expense. Alternatively, the stored sounds can be triggered from an external source such as a drum machine.

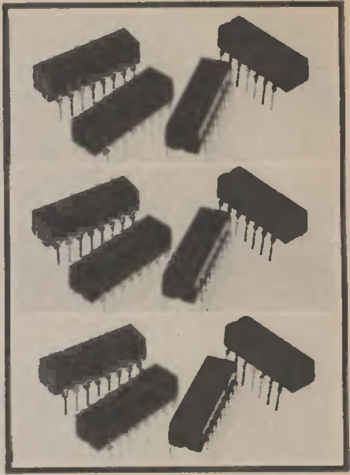
A feature of the MCS–1 is that it can be used in conjunction with a BBC Micro and a special interface (extra cost) to save sounds permanently on floppy disc. This allows the formation of a digital sound library to be created. Saving direct to tape provides an alternative for those without a BEEB. Further details may be obtained from:

Powertran Cybernetics Ltd.,
Dept EE, Portway Industrial
Estate, Andover,
Hants SP10 3NN.

DIGITAL ELECTRONICS

D.W. CRABTREE B Sc Tech Eng (CEI)

PART FOUR



IN the articles already covered in this series, we have not, as yet, included any details of systems that require 'clocks' or other pulsing mechanisms. Future systems to be described will all require 'clocks' of some shape or form and so now is a good time to describe the various types, design and implementation of such mechanisms. We will also describe the timing characteristics of components that are often encountered in data books and are, at the same time, of great importance when designing systems that work efficiently.

CLOCK SYSTEMS IN DIGITAL ELECTRONICS

Let us consider a microprocessor, which is the heart of any modern computer system. The processor is basically a device capable of carrying out a list of instructions in a preset pattern. Each of these instructions is carried out sequentially within a programme. However, how does the microprocessor, on the first instruction, know when to pass on to the second and subsequent instructions?

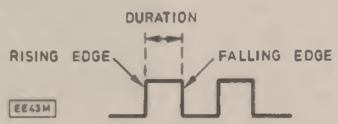
It must be true to say that no microprocessor could ever function without the very basic of circuits, namely the clock circuit. This is purely and simply a circuit that gives out a continuous stream of pulses in a fixed manner. The microprocessor together with other components, like bistables utilises these clock pulses by stepping on to the next instruction with each subsequent pulse.

Clock 'pulse train' producing a series of square waves.

Usually a clock pulsing system produces a series of symmetrical square waves as shown above. The width of each pulse must be wide enough (ie: of sufficient time delay) for all circuits using the pulses to have sufficient time to detect that the pulse is there and carry out the required work for each particular pulse.

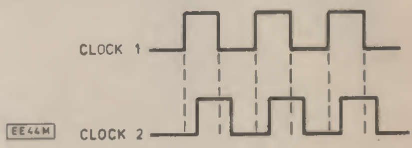
Similarly, the amplitude of each pulse must be large enough to be detectable, since too low an amplitude may mean a pulse goes unnoticed. Equally important is the frequency of the pulse 'train' (ie: series of pulses) since, if the frequency is too high, the rate of pulsing will be greater than component characteristics can allow and so inefficiencies will result. Likewise, if the frequency is too low, then the system that the pulses are being used for will become slow in operation with, again, inefficient working.

In practice a frequency is chosen that is as high as possible, without exceeding the characteristics and tolerances laid down in the component data books. That is to say, the maximum frequency depends on the 'logic family' used. For example, Standard TTL which has a maximum frequency of operation of 25MHz, compared with LS TTL which has a max imum of 40 MHz and Schottky TTL, which has a maximum of 110 MHz. CMOS families depend very much on the supply voltage level, since the higher the voltage gives a higher maximum frequency. (5V gives a maximum of 500 kHz whilst 15V gives a maximum of 1 MHz).



Some systems use both the rising and trailing edge of the clock pulse.

Besides the points mentioned above, it is important to note that some systems utilise clock 'rising edges' whilst other systems use clock 'falling edges' as shown above. It is also important to note that some systems use both the leading edge and the trailing edge, where one edge is used for one function (say, setting data on address lines) and the other edge is used for another function (say switching or reading data). Alternatively, multiphase clocks may be used, as shown below for this purpose. For example, the Motorola 6800 series microprocessors use 2 clocks working in antiphase (ie: 1 clock is rising whilst the other is falling) whilst the 9900 series of microprocessors use 3 clocks, each out of phase with each other.



A multiphase clock system employing two separate pulse trains.

TIMING CHARACTERISTICS OF COMPONENTS

When serious design work in digital electronics is to be undertaken, reference at some time must be made to the various data books available for the different logic families. When looking at these data books, certain timing characteristics are given for the families and, unfortunately, different books have different ways of saying the same things. Some of these characteristics are set out below.

PROPAGATION DELAY. This is the time between a change in input state (or receipt of a clock edge) and the change in the output caused. It is also sometimes called 'Response Time'. It is generally specified by:

(A) t_{PD} + (or t_{PLH}) meaning the delay on low to high transition.

OR

(B) t_{PD} – (or t_{PHL}) meaning the delay on high to low transition.

SET UP TIME. This is the minimum time for the data inputs to be correctly set (ie: 'settled down') so that a correct response is obtained when a subsequent clock pulse appears. It is generally shown as t_{su}.

HOLD TIME. This is the time that data must be kept constant, after the start of the clock pulse, to ensure that a correct response is obtained. (ie: Data put onto lines must remain in the same state for a certain time after the switching clock edge has appeared.) Generally given as t_h.

TRANSITION TIME. Given as t_{TLH} or t_{THL}, this is the time taken for an output (or for a clock pulse) to change from a low to a high or a high to a low respectively. Also sometimes given as rise time or fall time and for the clock rise or clock fall it can be shown as t_r (CL) and t_f (CL) respectively.

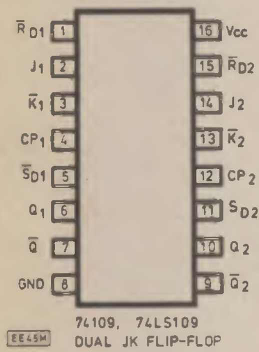
CLOCK PULSE WIDTH. Where a clock pulse is required, the clock pulse width is the minimum width of the pulse required for a system for correct detection.

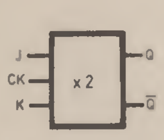
CLOCK FREQUENCY. As previously described, this is the maximum frequency of the 'train' of clock pulses to be used by a system to ensure correct operation, usually given as f_c.

So far we have given brief descriptions of the most common timing characteristics that will be met in digital electronics data books. Others do exist but those will only be of great use to the experienced designer. Further details, if required, can be sought from the many text books available. We shall now go on to describe the different types of bistable circuits in use.

J-K BISTABLE

These bistables are generally called 'J-K flip-flops'. Let us look at one such device in the TTL range, the 74109, which is a 'dual J-K +ve edge-triggered flip-flop'. As the title suggests, this chip incorporates 2 J-K flip-flops in one package, each being triggered (ie: allowed to function) on the +ve edge of the clock pulse. If observation is made of the pin connections, it will be seen that, besides those connections described below, there are also 'set' ($\bar{S}_D$) and 'reset' ($\bar{R}_D$) connections which may be used to put the flip-flop into certain modes of operation, (See below). These functions will not be described here.





The pin-out and circuit symbol of the Dual J-K flip-flop (74109 TTL).

Let us now look at the truth table for the J-K flip-flop. We will not look at the way the gates within the flip-flop work since such information is not really necessary for our purpose. However there are many excellent books available if further understanding is required. The truth table shows that the J-K flip-flop has 4 modes of operation, and the circuit symbol shows that the device has (apart from the set ($\bar{S}$) and reset ($\bar{R}$) functions previously mentioned) 5 connections. The 'clock' input has been adequately described in previous passages and so its function needs no further comment. J and K are 2 inputs to the device and Q and $\bar{Q}$ are the 2 outputs from the device, with $\bar{Q}$ being the complement of Q (ie: negated.) Now the truth table shows two columns Q— and Q+, which perhaps need further explanation. Q— represents the state of Q IMMEDIATELY BEFORE a clock pulse, whilst Q+ represents the state of Q IMMEDIATELY AFTER the clock pulse. So looking at the 'No operation' mode in the truth table, if, as in the first row, J and K are both low and Q is also

J	K	Q–	Q+	MODE
0	0	0	0	No operation
0	0	1	1	
0	1	0	0	Reset
0	1	1	0	
1	0	0	1	Set
1	0	1	1	
1	1	0	1	Toggle
1	1	1	0	

EE40M

Truth table showing the four modes of operation of the J-K flip-flop.

low (ie: Q is 'O' before the clock pulse) it can be seen that, after the clock pulse, Q remains at O. Similarly, looking at the last row of the truth table (in the 'Toggle' mode), where both J and K are '1' then, with Q at 1 before the clock pulse, it is seen that this changes to a 'O' after the clock pulse. (Q+).

From the truth table it can be observed that the J-K flip-flop has, therefore, 4 ways of operating, all dependent upon the states of the inputs, J and K. (Although, obviously, the bistable could not work without the clock pulse, either). With J and K both set to 'O', the flip-flop is put ino the 'no operation' mode, whereby no change of state occurs to Q after the clock pulse. In the 'reset' mode, J must be at 'O' whilst K is at '1', in order to set Q to 'O' after the clock pulse. In the 'set' mode, J must be at '1', whilst K is at 'O,' in order to reset Q to '1' after the clock pulse. In the 'toggle' or 'switching' mode, this is where both J and K are set to logic 1, in which case Q output 'toggles' (ie: changes state) after a clock pulse. If, in this last stated, a '1' was maintained on both J and K, the subsequent clock pulses applied would merely give a continuous change of state to Q output. In other words Q would become a delayed function of the clock pulse. (Delayed because of the propagation delay of the device plus the type of triggering required, say +ve or —ve edge triggering).

We have considered edge-triggered J-K flip-flops but we must be aware of the use of 'Master-Slave' flip-flops, for example the TTL device 74107. This device operates in a similar way to that described above, but, because it is effectively split into 2 sections ('master' and 'slave') it creates a further time delay over and above the usual propagation delay.

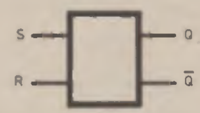
On the first clock pulse, the data on the J-K inputs is 'fed into' the 'master' section and on the next clock pulse the information is used, as per the modes previously described, by the slave in order to give the required outputs at the Q and $\bar{Q}$ terminals. In other words, the Master becomes a temporary store of information and the Slave acts in a manner previously described, to the effect that information put onto the J-K inputs is delayed by one clock pulse before any change (if not in the no operation mode) is witnessed at the output.

For either the edge-triggered or the master-slave flip-flop the characteristic equation for Q+ and $\bar{Q}$+ are:

$$Q+ = J\bar{Q} + \bar{K}Q$$
$$\bar{Q}+ = \bar{J}\bar{Q} + KQ$$

S-R BISTABLE

The 'S-R' bistable is a flip-flop which has many uses, since it is a 'latch' that, basically, is a form of data storage. It remembers an item of data for as long as power is applied. The symbol is shown below together with the truth table.



Circuit symbol of the S-R flip-flop.

S	R	Q–	Q+	MODE
0	0	0	0	No operation
0	0	1	1	
0	1	0	0	Reset
0	1	1	0	
1	0	0	1	Set
1	0	1	1	
1	1	0	X	Ambiguous
1	1	1	X	

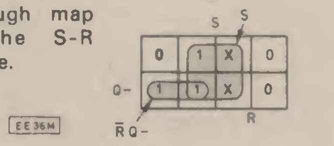
EE41M

Truth table showing the four modes of operation of the S-R flip-flop.

Note that here, Q— and Q+ refer to the states of Q immediately before and after a change of input. (Not clock pulse). It will be seen that the Set/Reset (S-R) bistable functions, according to the truth table, are very similar to the J-K flip-flop. Certainly the 'No operation', 'reset' and 'set' modes are identical, with S and R inputs being equivalent to the J and K inputs respectively. However, the similarity ends, because, with both J and K set to '1' on the J-K flip-flop, that device toggles, (ie: changes the Q output from a 'O' to a '1' or vice versa). On the S-R bistable the situation described, where both inputs are '1', should be avoided. This is called the 'Ambiguous' mode and, in this mode, the output could go to any state, dependent upon the characteristics of the actual circuitry within the chip used. If S-R bistables are used, supporting circuitry (ie: input circuitry) should be included that does not allow both S and R inputs to be at '1' at the same time, otherwise false operation will result.

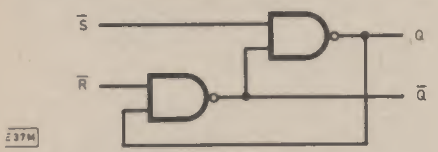
If we now look again at the truth table, we can draw the Karnaugh map for the S-R bistable, and thus formulate the Characteristic Equation. Again Q— is the state of Q output before an input change, not before the clock pulse, since the S-R is an unlocked device, unlike the J-K flip-flop.

Karnaugh map for the S-R bistable.



CHARACTERISTIC EQUATION

Hence $Q+ = S + \bar{R}.Q-$ is the characteristic equation for the S-R bistable.

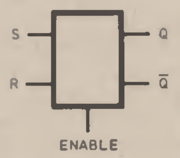


Implementation of the S-R function using NAND gates.

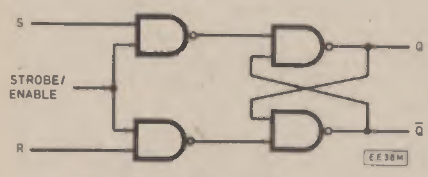
If observation is made of the characteristic equation, it can be seen to be implemented simply by use of Nand circuit.

The same function as above using a more common method of drawing.

(Note: Invert S and R if required as inputs.) This circuit is usually as shown in the alternative diagram. Note that most S-R chips have active low inputs hence $\bar{S}$ and $\bar{R}$ are shown.



The circuit symbol of the S-R flip-flop.

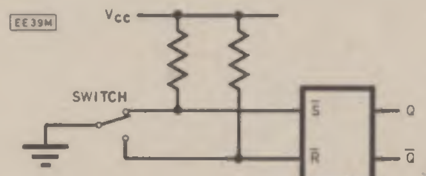


The S-R latch circuit.

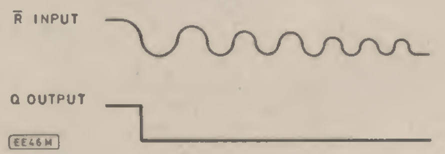
As stated previously, the S-R bistable is the basic "latch" circuit and with the addition of two more gates to those shown above, we have the ability to 'strobe' or 'enable' the latch.

APPLICATIONS OF S-R FLIP-FLOP

One main, ideal, use of the basic S-R flip-flop is in switch 'de-bouncing'. Here we show a changeover switch which is connected across the $\bar{S}$ and $\bar{R}$ terminals of an S-R bistable, with the common terminal of the switch to ground potential ('low'). Each of the inputs is connected to a 'high' via resistors. These are provided to ensure that the S-R flip-flop cannot enter the 'ambiguous' mode. (Note that if $\underline{S}$ and $\underline{R}$ inputs were available, instead of $\bar{S}$ and $\bar{R}$, then the switch common would be connected to a 'high' whilst the inputs would be connected via resistors to a 'low'.)



Looking at the circuit as shown, with the switch set to the S position, it will be seen that, due to the characteristics of the S-R bistable, nothing will change until the switch is thrown and it makes the first contact at the $\bar{R}$ position, at which time the Q output will change from a '1' as it was, to a 'O'. Subsequent 'bouncing' of the switch will not affect the output Q. (See waveforms below.)



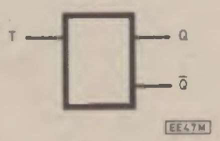
Another use of the S-R flip-flop is in counting systems, where the device is used as a 'latch' to ensure that only stable data is encountered. It is, for example, used in digital voltmeters, frequency counters and the like, as well as in many other industrial processes, to avoid flicker on the display. When the data is stable the latch allows the data to be read and subsequently displayed.

T BISTABLE

This bistable, which is unclocked, has, generally, only one input (T) and two outputs, Q and $\bar{Q}$. The device works in very much the same way as the J-K flip-flop when in the 'toggle' mode since whenever an input is received at the T input the outputs change state, ie: they 'toggle'.

The truth table and circuit symbol are shown below.

T	Q–	Q+
0	0	0
0	1	1
1	0	1
1	1	0



Truth table and circuit symbol for the 'T' type bistable.

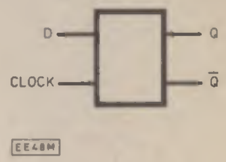
The truth table shows the state of T together with the state Q—, which is the state of Q output immediately before T appears. It follows, then, that Q+ is the new state of Q after T and Q— were present in the given states shown.

Therefore, it can be seen that if T is 'O', Q does not change state, but if T is '1' then Q will toggle. The truth table then becomes:

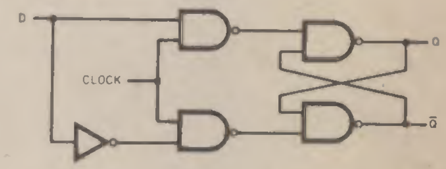
$Q+ = \bar{Q}T + Q\bar{T}$ Which is, from a previous article, the EX-OR function.

THE D BISTABLE

This bistable is clocked and is a single input device. It accepts data onto the D input and when the clock pulse is received, the data present at D is transferred to the output Q. $\bar{Q}$ is also available. The symbol for the device is shown below together with the logic circuit. With Clock Active Low, the 'mark' can be used to 'set' the data on D, whilst the 'space' can be used to 'read' the data at the output.



The circuit symbol for the 'D' type bistable.



Logic circuit of the 'D' type bistable.

D-type flip-flops are available in many packages, but in CMOS, for example the 4013 which is a dual D-type flip-flop, and in TTL, for example the 74173 which is a quad D-type flip-flop. This latter device does not have a clock pulse input as on the 4013 CMOS device and as described above. Instead it has 'enable' inputs. Functionally, the device works as described above. A 'Master Reset' pin is also available on the device to set outputs when the 'MR' (master reset) pin goes to the required state ('high' for the 74173).

The Bistables discussed above are extensively used in counting circuits, which will be described in great detail in the next article in this series. Because adequate numbers of examples and exercises will be given in that article, we do not propose to give any more here since it may confuse the issue at this point.

TRUTH TABLE DISPLAY

O.J. BRUERE

THE unit was developed as an educational aid and a simple constructional project suitable for sixth form students following a course in digital electronics. Depending on the way in which the display is arranged it can be used to display either a conventional Truth Table or a Three-Variable Karnaugh Map as shown in the photographs.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Three-Variable Truth Table and Karnaugh Map is shown in Fig. 1. As can be seen from the circuit diagram, IC1a, IC1b, IC2a and IC2b form a 3-bit binary counter. The outputs of the 3-bit binary counter, *A*, *B* and *C* cause a binary coded decimal to decimal decoder (IC3) to light up eight l.e.d.s (D1–D8) in sequence.

The *D* input of the decoder (the most significant bit) is fed by the inverted output of the circuit under test ($D=\overline{F}$). *F* is inverted by IC1c a 2-input NAND gate. Note that the notation for an inverted figure is given by a bar (–) over the figure.

The display is inhibited if the *D* input is held high (logic "1") and none of the l.e.d.s will light up irrespective of the states of *A*, *B* and *C*. Whenever the *D* input falls to a logical "0", just one of the l.e.d.s will light depending on the states of *A*, *B* and *C*. It is worth noting that although a "0" causes a diode to light, this must be read as a "1" on the display.

CLOCK PULSE

The outputs *A*, *B* and *C* also provide the inputs to the combinational logic circuit under test. If a fast clock is used some of the l.e.d.s will appear to be lit continuously, whereas others will not light at all. Each lit indicator is interpreted as a "1". The clock itself can be used to generate *A*, thus saving a bistable. A TTL dual D bistable IC2 is wired as a 2-bit divider, and a TTL quad 2-input NAND gate IC1 serves as a clock pulse oscillator and an inverter.

The l.e.d.s D1–D8 are wired in a common anode configuration. A single resistor R3 with a value of about 180 ohms restricts current flow through the conducting diode to about 15mA. The decoder outputs are normally high (logic "1") falling to logic "0" when activated.

OSCILLATOR CIRCUIT

Two gates, IC1a and IC1b are wired as an astable multivibrator with a mark/space ratio of 1. The time constant is provided by an RC network, R1, C1 and R2, C2.

The frequency is not critical. If high value electrolytic capacitors are used a low frequency is produced and the outcome of each set of inputs can be observed separately. For a frequency of 1Hz a capacitor with a value of about 200µF should be used. If a continuous readout is desired the oscillator frequency should be above 100Hz, which means a capacitor of less than 2µF value should be used.

CONSTRUCTION

The circuit is constructed on a piece of 0·1 inch matrix stripboard, 10 strips by 40 holes (Fig. 7). The breaks in the copper strips should be made first and then the components may be positioned as shown in Fig. 8 and Fig. 9. Note that if the Truth Table Display and Karnaugh Map are both being built, twice the number of components will be needed.

A plastics case having dimensions of 114 × 64 × 26mm should be used to house this project. The front panel should be marked with the socket and l.e.d. positions and then these drilled. Once the front panel has been drilled and the l.e.d.s and sockets have been fitted in place the interwiring may be completed.

The anodes of D1–D8 are linked via R3 to the sockets SK5, SK6 (+5 volts). The cathodes can now be wired to the corresponding outputs of the decoder IC3 using flexible wire.

POWER SUPPLY

An external 5V power supply is required although a 6V supply can be used if two silicon diodes are wired in series with it, to drop the voltage to a safe level.

TESTING THE UNIT

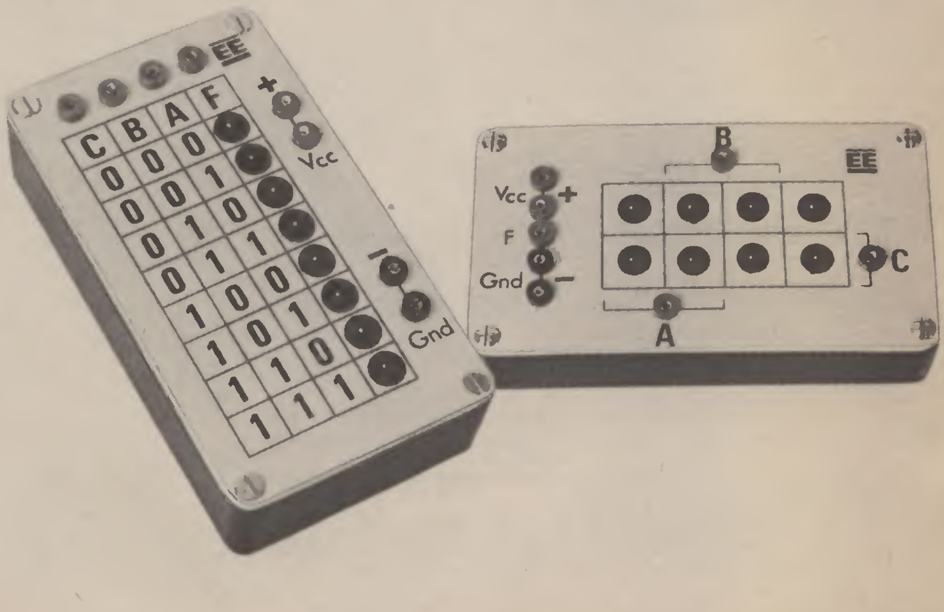
When the power supply is connected, l.e.d.s D1-D8 should all light. Using a connecting wire, make a connection between the socket marked *F* (SK4) and the negative side of the power supply. D1–D8 should now extinguish.

Connect a lead between *F* (SK4) and *A* (SK1) and all the odd numbered l.e.d.s should light. Connect *F* to *B* (SK2) and l.e.d.s, D2, D3, D6 and D7 should illuminate. Finally connect *F* to *C* (SK3) and l.e.d.s, D4, D5, D6 and D7 should illuminate.

USING THE TRUTH TABLE DISPLAY

A convenient test deck may be constructed from a piece of breadboard. The i.c. under test should be placed on the breadboard and leads brought out from each of the i.c. pins, using flexible connecting wire and 1mm plugs.

Shown in Fig. 2 is a 7400 TTL i.c., this device contains quad 2-input NAND gates which can be interconnected to perform many logical functions. The outputs of the Truth Table Display *A*, *B* and *C* provide the inputs to the logic circuit



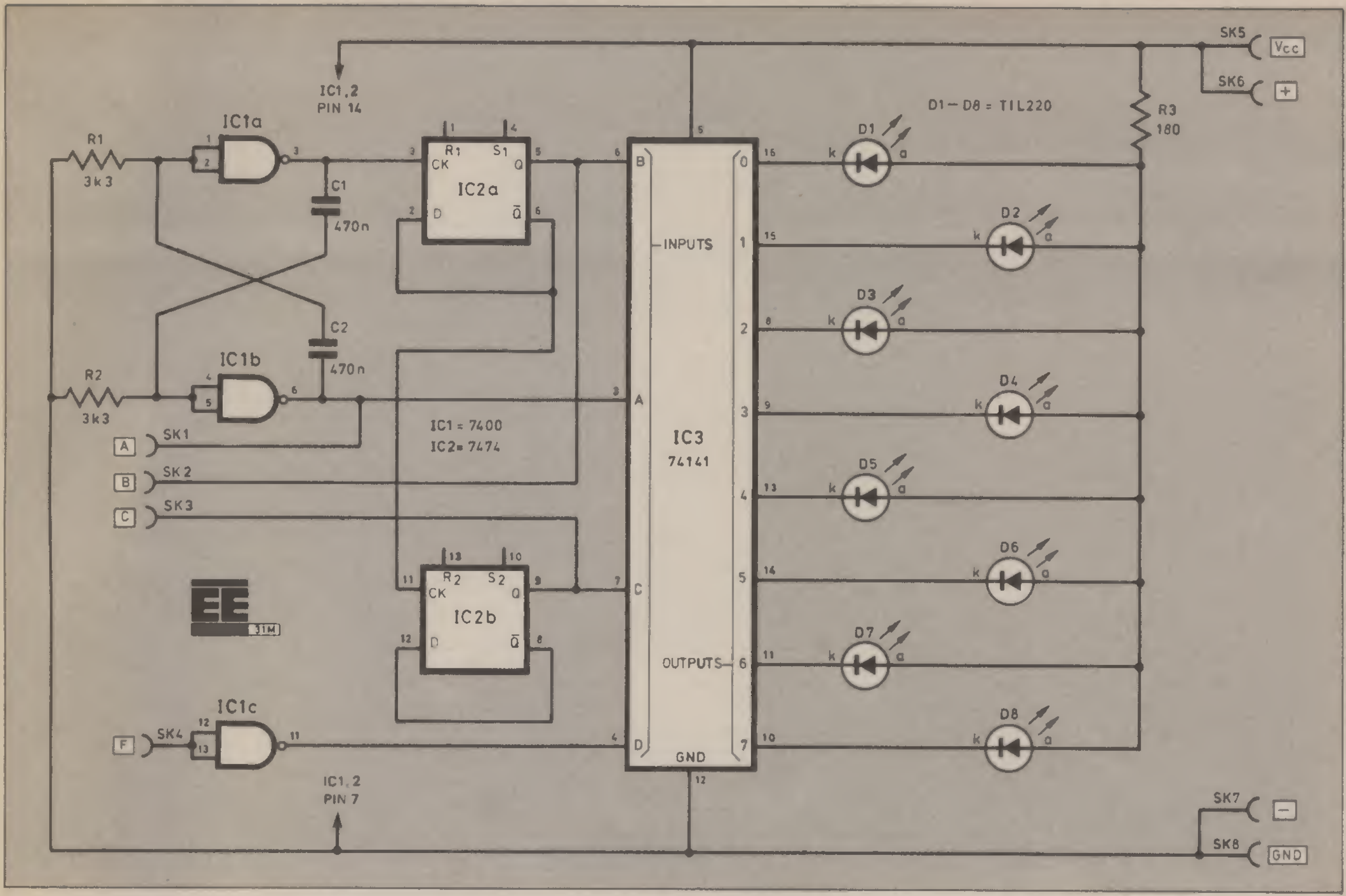


Fig. 1. The circuit diagram of the Truth Table Display

under test. The final output of the display is fed back to the F input. Use the spare power supply sockets to provide power for the i.c.

The tests on a 7400 i.c. are shown in Figs. 3, 4, 5 and 6.

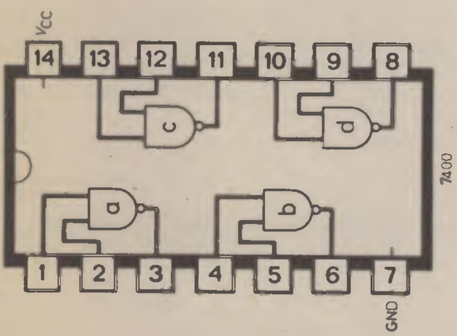


Fig. 2. The internal logic and connection of the TTL 7400 i.c.

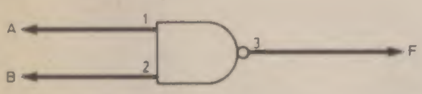


Fig. 3. Examine the truth table for $\overline{A.B}$. The bottom four l.e.d.s can be covered up for this exercise.

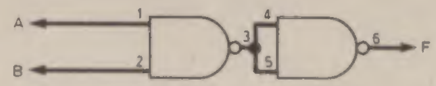


Fig. 4. Negate this expression by adding an extra inverter to give $A.B = F$.

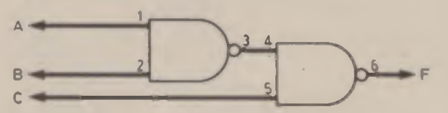


Fig. 5. Remove the link between pins 4 and 5 of the i.c. under test and connect C to pin 5. The function is now $\overline{\overline{A.B}.C}$. This is equivalent to A.B + $\overline{C}$.

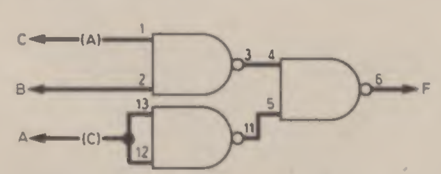


Fig. 6. A third gate can be used to invert any one of the inputs before it is fed into the circuit in Fig. 5, or the output can be inverted yielding a further four possibilities. Interchanging inputs A and C in this circuit yields

$$F = \overline{\overline{A}.(\overline{B.C})} = A + B.C$$

BOOLEAN ALGEBRA

Useful Identities

A.0 = 0	A + 0 = A
A.1 = A	A + 1 = 1
A.A = A	A + A = A
A.$\overline{A}$ = 0	A + $\overline{A}$ = 1

Commutative Laws

$A + B = B + A$
$A.B = B.A$

Associative Laws

$A + B + C = (A + B) + C = A + (B + C)$
$A.B.C. = (A.B) \cdot C = A.(B.C)$
AND "." takes precedence over OR "+" as in ordinary algebra. (AND terms behave as though they have brackets round them.)

Dé Morgan's Theorem

If all the signs are changed in a Boolean expression retaining brackets where present (or implied) and all the terms are negated, the new resulting expression will also be true.

$$F = (A \cdot B) + C$$

then $\overline{F} = (\overline{A} + \overline{B}) \cdot \overline{C}$. Hence

$$F = \overline{(\overline{A} + \overline{B}) \cdot \overline{C}}$$

Distributive Laws

$A \cdot (B + C) = A.B + A.C.$
$A + (B.C) = (A + B) \cdot (A + C)$

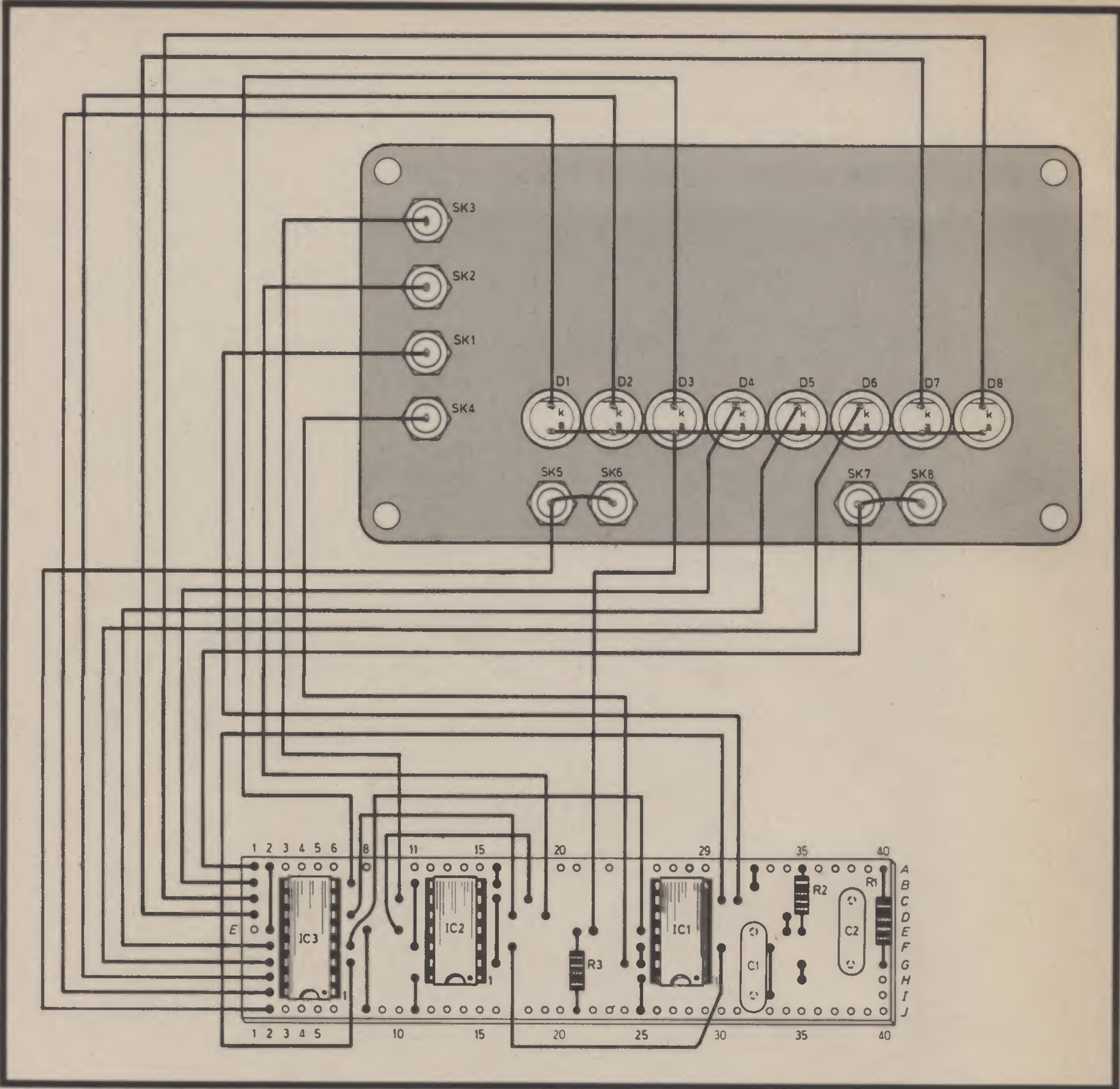


Fig. 8. Wiring diagram and component layout of the Truth Table Display

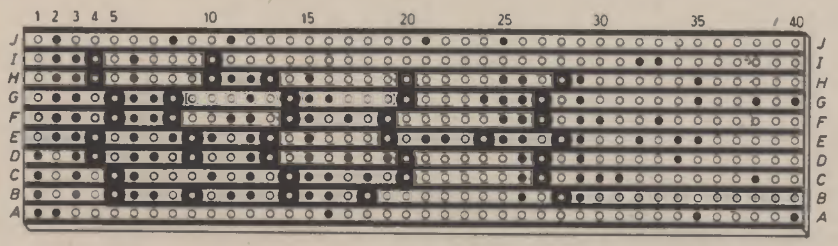


Fig. 7. Truth table display (10 strips x 40 holes)

See **Shop Talk** page 18

NOTE: The same stripboard layout may be used for either of the two units.

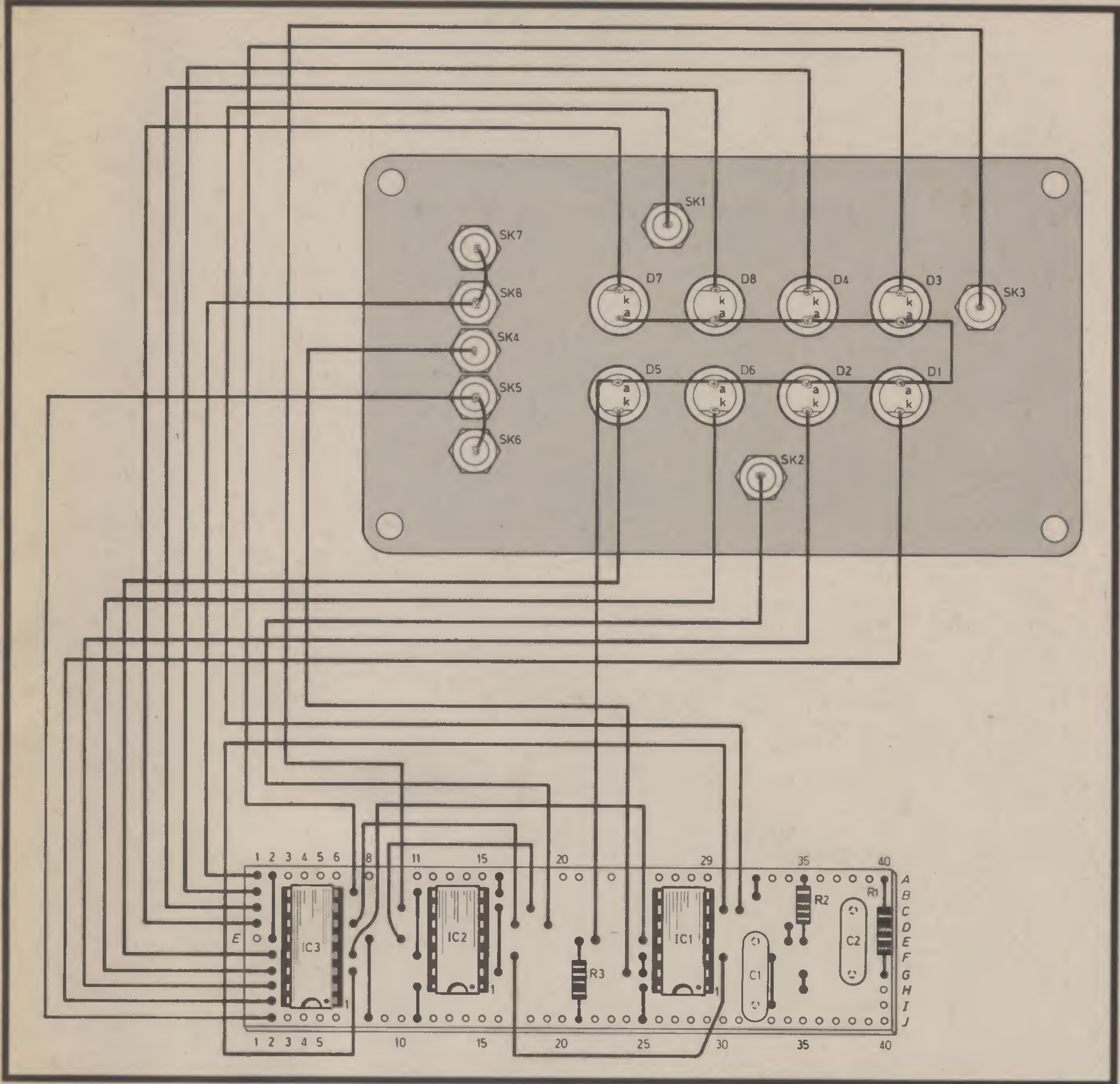


Fig. 9. Wiring diagram and component layout of the Karnaugh Map Display

COMPONENTS

Resistors
R1,2 3k3 (2 off)
R3 180
All $\frac{1}{8}$W carbon ±5%

Capacitors
C1,2 470n polyester (2 off)

Semiconductors
IC1 7400 TTL quad 2-input NAND gate
IC2 7474 TTL dual D-type flip-flop
IC3 74141 TTL b.c.d. to decimal decoder/driver
D1–8 TIL220 0·2in red l.e.d. (8 off)

Miscellaneous
SK1–6 1mm red sockets (6 off)
SK7,8 1mm black sockets (2 off)
PL1–8 1mm plugs
Stripboard, 0·1 inch matrix; 10 strips by 40 holes; plastics case, 114 x 64 x 26mm (Box PB1 white); connecting wire; 14-pin d.i.l. holder (2 off); 16-pin d.i.l. holder.

Approx. cost Guidance only **£8**

USING TRUTH TABLES

A truth table is a systematic way of listing the outputs caused by all the possible combinations of inputs to a logic circuit. If the circuit has "n" inputs there are 2^n different ways of combining them. In order to ensure that no possible states are overlooked, it is customary to list the input states in binary order. A three variable truth table is shown below. The column labelled "*F*" lists the output states of a logic circuit. The positive logic convention is used here, "1" means a positive voltage and "0" means a lower positive or zero voltage.

C	B	A	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

By comparing the output column with the *A*, *B* and *C* columns it can be seen that

i) *F* is "1" whenever *A* is "1";
ii) the output is also "1" if *C* = "1", *B* = "1" and *A* = "0".

Closer inspection shows that *F* = "1" if *C* = "1", *B* = "1" and *A* = "1".

Hence we can describe the behaviour of the circuit as follows:

The output is "1" when *A* = "1" OR when *B* = "1" AND *C* = "1".

Using the symbols "+" for OR and "·" for AND we can abbreviate the above statement as follows:

$$F = A + B.C$$

Expressions like this can be handled very much like ordinary algebraic equations. The dot "·" behaves like a multiplication sign and the "+" behaves almost (but not quite) like an addition sign. The following truth tables should make this clear.

B	A	F
0	0	0
0	1	0
1	0	0
1	1	1

Truth table for *A* AND *B* ($A \cdot B$) "0" and "1" are shorthand symbols

$0 \times 0 = 0$
$0 \times 1 = 0$
$1 \times 0 = 0$
$1 \times 1 = 1$

Multiplication table for the numbers "0" and "1"

B	A	F
0	0	0
0	1	1
1	0	1
1	1	1

Truth table for *A* OR *B* ($A + B$)

$0 + 0 = 0$
$0 + 1 = 1$
$1 + 0 = 1$
$1 + 1 = 2$

Addition table for the numbers "0" and "1"

It will be seen that both processes yield the same pattern.
2 has no meaning in a two-state logic system. We can use the OR sign "+" in the same way as the ADDITION sign "+" except that we must remember that

$$1 + 1 = 1!$$

A bar over a symbol means that it is INVERTED or NEGATED. In this truth table for an inverter *X* is "1" if *A* = "0"

A	X
0	1
1	0

or $X = $ Not A
$X = \overline{A}$

The most common type of TTL gate is the NAND gate and is equivalent to an AND gate followed by an inverter.

B	A	A.B	$\overline{A.B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

$A.B = A$ and B
$\overline{A.B} = $ not (A and B)
$=$ NAND

Any logical function can be rewritten so that it can be implemented using only NAND gates.

Referring back to the three variable truth tables, it can be seen that the expression $F = A + B.C$ can be implemented with an AND gate and an OR gate.

How can the same function be realised with NAND gates?

The original expression can be transformed with the aid of Dé Morgan's Theorem which tells us that:

$$A + X = \overline{\overline{A}.\overline{X}}$$

Writing $B.C$ instead of X yields

$$F = \overline{\overline{A}.(\overline{B.C})}$$

This can be translated into the circuit as shown in Fig. 10.

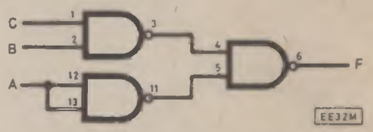


Fig. 10. Translated circuit

The circuit in Fig. 10 can be proved by building up the truth table from scratch, as shown below.

C	B	A	$\overline{A}$	(B.C)	$\overline{B.C}$	$\overline{A}.(\overline{B.C})$	$\overline{\overline{A}.(\overline{B.C})}$
0	0	0	1	0	1	1	0
0	0	1	0	0	1	0	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	0	1
1	1	0	1	1	0	0	1
1	1	1	0	1	0	0	1

THE KARNAUGH MAP

A truth table can be displayed in a different format. As in ordinary maps a point on the map can be specified by "coordinates" (latitude and longitude). As well as being more compact for three or four variables the layout is usually easier to interpret.

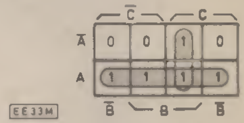
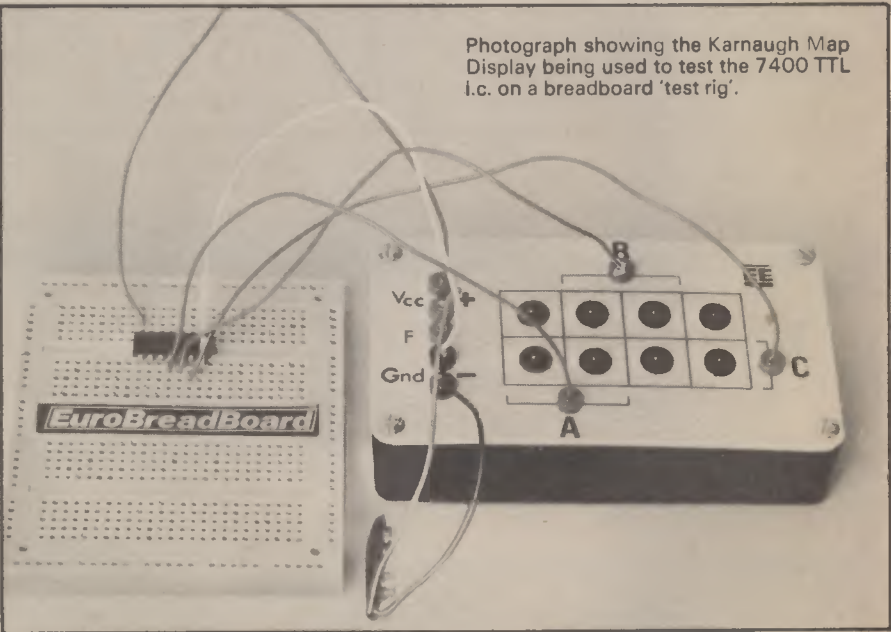


Fig. 11. Karnaugh Map

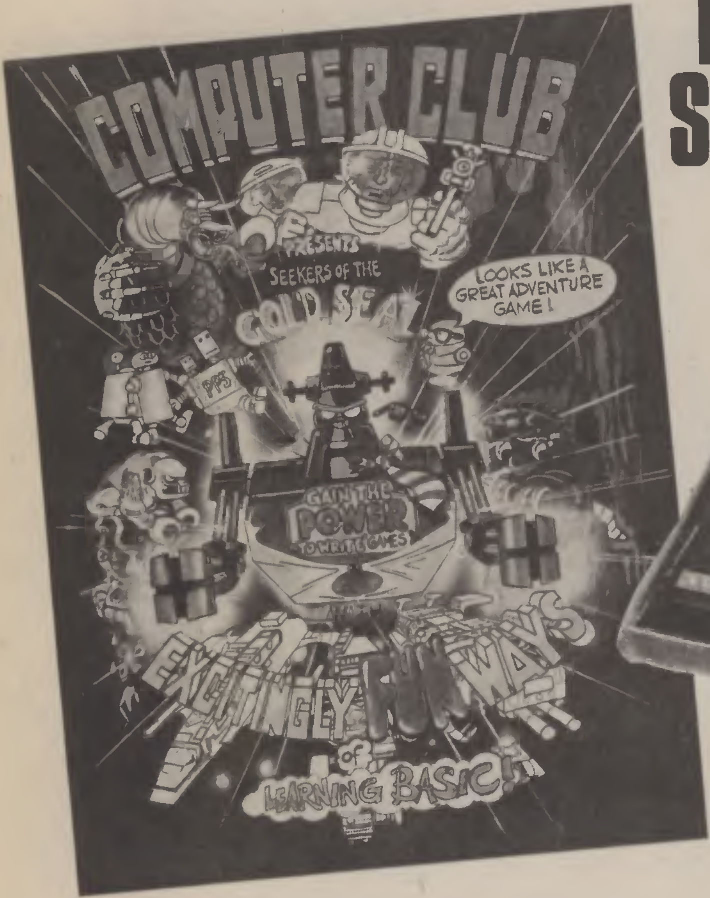
If adjacent cells can be combined in blocks of two or four as shown (Fig. 11) simplification results. □



Photograph showing the Karnaugh Map Display being used to test the 7400 TTL i.c. on a breadboard 'test rig'.

FEBRUARY FEATURES...

8 EXTRA PAGES



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FEBRUARY 1985 ISSUE ON SALE FRIDAY, JANUARY 18

GAMES TIMER

W. ENGLISH

JOINING in various board games with two young grand-children, it became obvious that some method of timing the duration of their turns was necessary to maintain harmony and avoid arguments. Not finding anything suitable on the market, the author devised this unit, employing a 555 i.c. for the timing and an AC128 transistor driving a small buzzer. In the absence of a suitable commercial buzzer, by reason of physical size and current requirements, it was found that by suitably wiring a miniature relay it was possible to achieve the desired note with low battery consumption.

As a spin-off, after the author had completed construction, other applications were found, in the kitchen.

COMPONENTS

Resistors

- R1 18k ¼W
- R2 180k
- R3 330k
- R4 470k
- R5 680k
- R6 390k ¼W

All resistors ½W high stability except R1, R6

Capacitors

- C1 470n polyester
- C2 220µ 16V elect.
- C3* 100n polycarbonate

Semiconductors

- IC1 555 timer
- TR1 AC128

See Shop Talk page 18

Miscellaneous

Printed circuit board 50mm x 35mm
S1 Single-pole 4-way
S2 on/off switch
RLA miniature relay 250Ω–500Ω (see text)
Soldercon sockets (8 off)
Pointer knob
Letraset numbers
PP3 battery.

Approx. cost Guidance only **£5**

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. A 555 i.c. is employed in a standard configuration. Switching on S2, the cycle starts with a build-up of voltage at pin 2 via C1 charging through R1. At this instant, the voltage on the output pin 3 is high, which being applied to the base of TR1 keeps this turned off. The voltage on pins 6 and 7 of the i.c. is zero initially, gradually rising as C2 charges via the selected resistor (R2 through to R5), until the voltage is sufficient to drive the multivibrator in the 555 into operation, when the output at pin 3 becomes low. This turns on TR1 fully, energising the relay coil in the collector circuit. The coil is connected to the relay contacts so that when energised the circuit is repeatedly broken and re-made in very rapid succession, resulting in a satisfactory buzz. The unit is switched off by S2, and after a very short time may be switched on again to repeat the cycle of operation.

SWITCH SETTINGS

Switch S1 connects R2, R3, R4 or R5 to C2 and the 555 timer. The values shown give delays of: one, two, three and four minutes, but if other times are required, suggested resistor values are given in Table 1. It may be found that the times vary from two to seven seconds over the desired time, but as standard resistors are used, it was felt to be acceptable.

CONSTRUCTION

Because of the simplicity of the circuit, a piece of single-sided printed circuit board was marked out and etched. The layout is shown full-size in Fig. 2. (If desired, however, there should be little trouble in assembling the circuit on a piece of stripboard.) The 555 i.c. is mounted in Soldercon sockets to facilitate any changes. To obviate any error, the author used coloured wires from the printed circuit board to S1, following the standard resistor colour code.

THE CASE

A suitable case came to hand with the packaging of a digital watch. The dimensions are: 60mm wide, 110mm deep and

Table 1. Time delay settings.

Time delay required	Suggested resistor value
5 minutes	820k
6 minutes	920k
7 minutes	1M
8 minutes	1M2
10 minutes	1M5
15 minutes	2M2
30 minutes	4M7

60mm high, and the case opens up lengthways. The following photograph shows the position of the switches and the p.c.b. The PP3 battery fits very neatly as shown, and may be secured by winding 3 or 4 turns of Sellotape (reversed) round the battery case, then pressing it to the container.

RELAYS AND BATTERIES

Several relays have been tried, all successfully, so if a miniature type cannot be obtained, then the smallest available type may be used, making alterations to the layout as required.

The current drawn from the PP3 battery in the timing mode is 5mA, rising when the buzzer actuates to an acceptable 25mA, bearing in mind that the buzzer would be switched off in a matter of

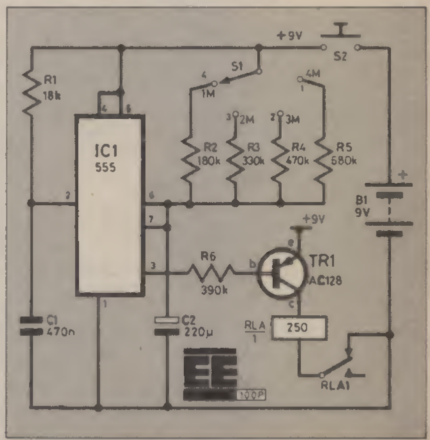
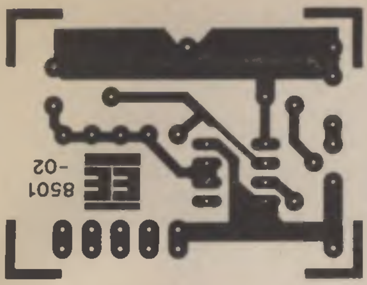


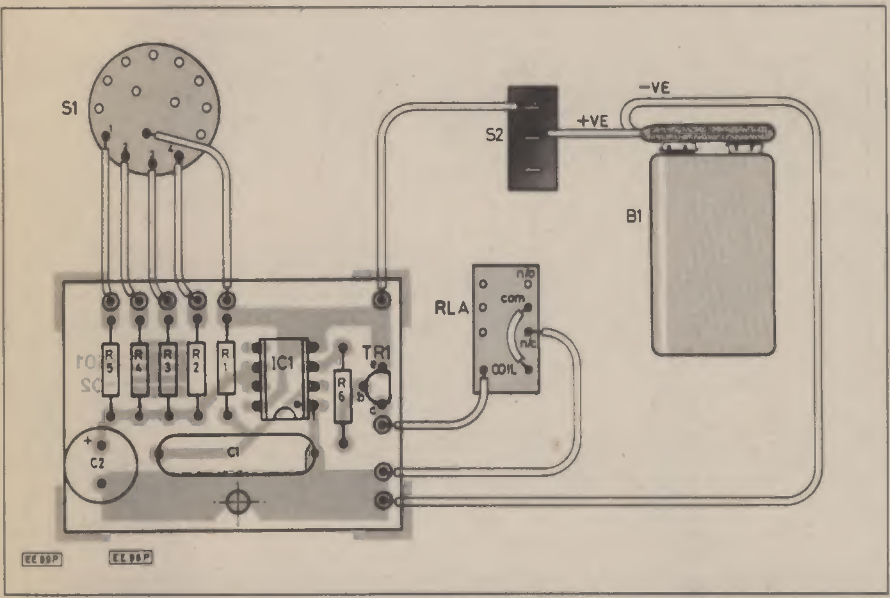
Fig. 1. The complete circuit diagram of the Games Timer.

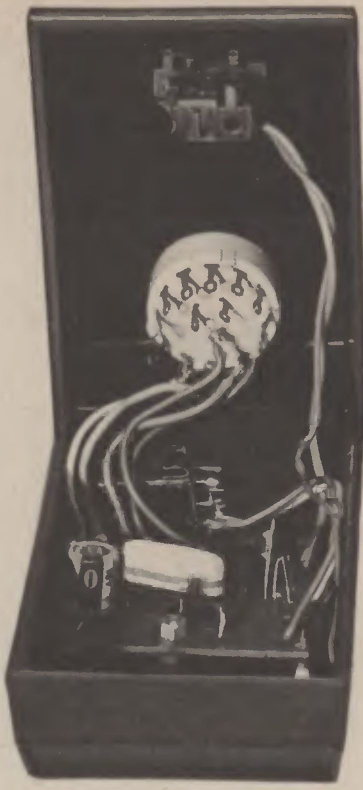


seconds. Reasonable service may be expected from the average PP3, but a high-life type is recommended.

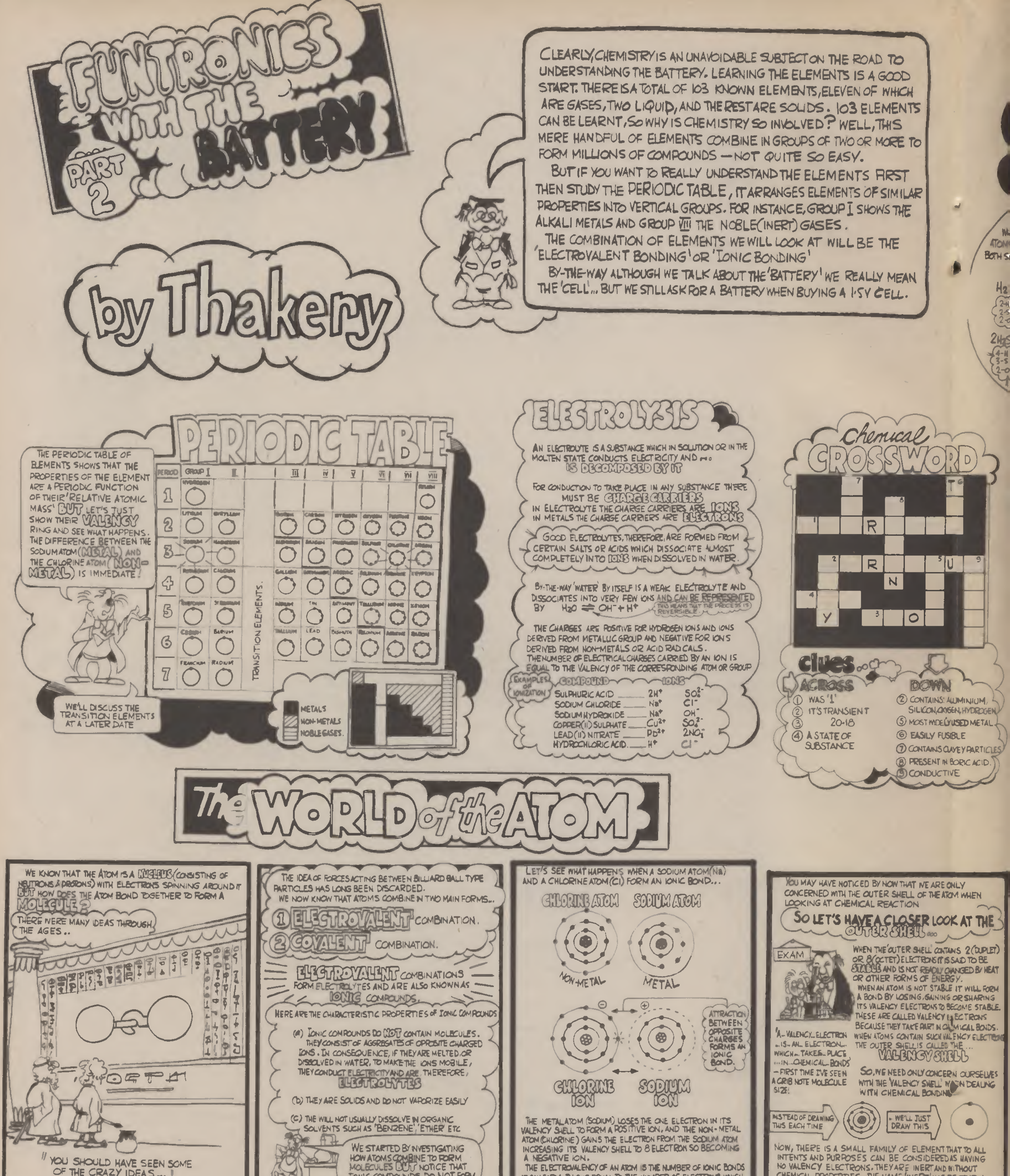
The author required only the four time settings shown, but obviously any further number can be accommodated using a suitable switch for S1 with the resistor values shown in Table 1.

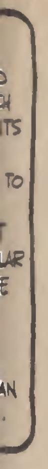
It was found that the prototype was more reliable when an extra capacitor, C3 (100n) was added. This should be connected between pin 5 of IC1 and ground. □

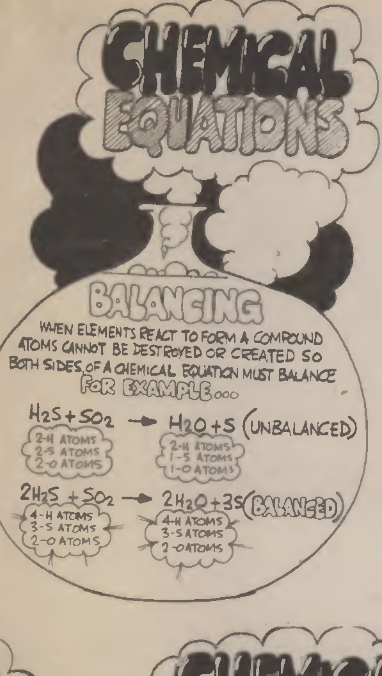


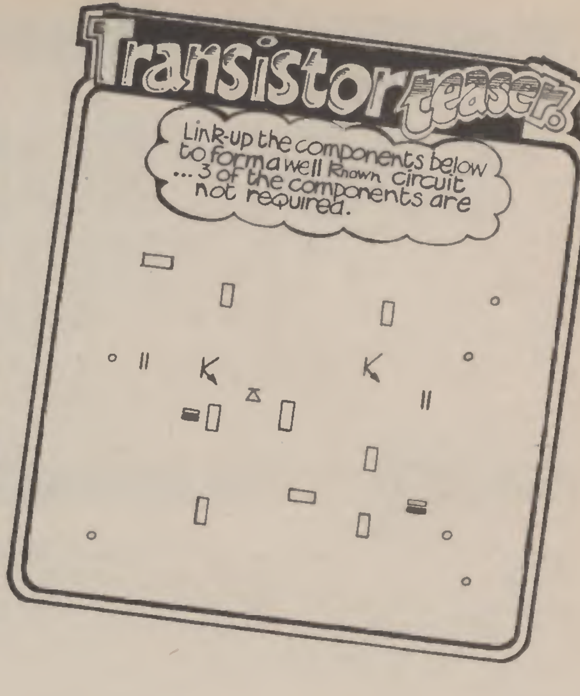


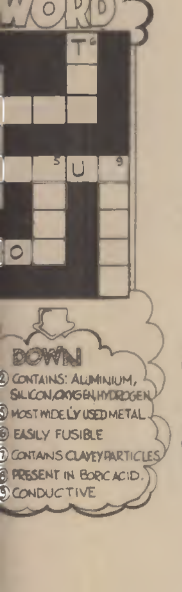
Photograph showing internal view of the Games Timer.

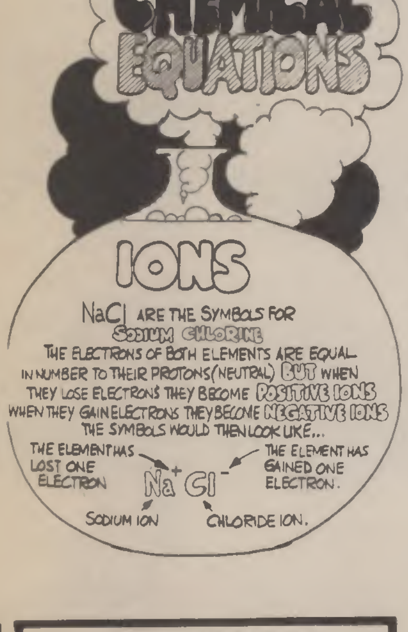

FUNTRONICS WITH THE BATTERY
PART 2
by Thakery
CLEARLY, CHEMISTRY IS AN UNAVOIDABLE SUBJECT ON THE ROAD TO UNDERSTANDING THE BATTERY. LEARNING THE ELEMENTS IS A GOOD START. THERE IS A TOTAL OF 103 KNOWN ELEMENTS, ELEVEN OF WHICH ARE GASES, TWO LIQUID, AND THE REST ARE SOLIDS. 103 ELEMENTS CAN BE LEARNT, SO WHY IS CHEMISTRY SO INVOLVED? WELL, THIS MERE HANDFUL OF ELEMENTS COMBINE IN GROUPS OF TWO OR MORE TO FORM MILLIONS OF COMPOUNDS — NOT QUITE SO EASY.
BUT IF YOU WANT TO REALLY UNDERSTAND THE ELEMENTS FIRST THEN STUDY THE PERIODIC TABLE, IT ARRANGES ELEMENTS OF SIMILAR PROPERTIES INTO VERTICAL GROUPS. FOR INSTANCE, GROUP I SHOWS THE ALKALI METALS AND GROUP VIII THE NOBLE (INERT) GASES.
THE COMBINATION OF ELEMENTS WE WILL LOOK AT WILL BE THE 'ELECTROVALENT BONDING' OR 'IONIC BONDING'
BY-THE-WAY ALTHOUGH WE TALK ABOUT THE 'BATTERY' WE REALLY MEAN THE 'CELL'... BUT WE STILL ASK FOR A BATTERY WHEN BUYING A 1·5V CELL.
PERIODIC TABLE
THE PERIODIC TABLE OF ELEMENTS SHOWS THAT THE PROPERTIES OF THE ELEMENT ARE A PERIODIC FUNCTION OF THEIR 'RELATIVE ATOMIC MASS' BUT LET'S JUST SHOW THEIR VALENCY RING AND SEE WHAT HAPPENS. THE DIFFERENCE BETWEEN THE SODIUM ATOM (METAL) AND THE CHLORINE ATOM (NON-METAL) IS IMMEDIATE!
PERIOD
GROUP I
II
III
IV
V
VI
VII
VIII
1
2
3
4
5
6
7
TIN
LEAD
BISMUTH
BARIUM
FRANCIUM
RADIUM
TRANSITION ELEMENTS.
WE'LL DISCUSS THE TRANSITION ELEMENTS AT A LATER DATE
METALS
NON-METALS
NOBLE GASES.
ELECTROLYSIS
AN ELECTROLYTE IS A SUBSTANCE WHICH IN SOLUTION OR IN THE MOLTEN STATE CONDUCTS ELECTRICITY AND ... IS DECOMPOSED BY IT
FOR CONDUCTION TO TAKE PLACE IN ANY SUBSTANCE THERE MUST BE CHARGE CARRIERS
IN ELECTROLYTE THE CHARGE CARRIERS ARE IONS
IN METALS THE CHARGE CARRIERS ARE ELECTRONS
GOOD ELECTROLYTES, THEREFORE, ARE FORMED FROM CERTAIN SALTS OR ACIDS WHICH DISSOCIATE ALMOST COMPLETELY INTO IONS WHEN DISSOLVED IN WATER.
BY-THE-WAY 'WATER' BY ITSELF IS A WEAK ELECTROLYTE AND DISSOCIATES INTO VERY FEW IONS AND CAN BE REPRESENTED BY $H_2O \rightleftharpoons OH^- + H^+$
THIS MEANS THAT THE PROCESS IS REVERSIBLE.
THE CHARGES ARE POSITIVE FOR HYDROGEN IONS AND IONS DERIVED FROM METALLIC GROUP AND NEGATIVE FOR IONS DERIVED FROM NON-METALS OR ACID RADICALS.
THE NUMBER OF ELECTRICAL CHARGES CARRIED BY AN ION IS EQUAL TO THE VALENCY OF THE CORRESPONDING ATOM OR GROUP
EXAMPLES OF IONIZATION
COMPOUND — IONS
SULPHURIC ACID — $2H^+$ SO_4^{2-}
SODIUM CHLORIDE — Na^+ Cl^-
SODIUM HYDROXIDE — Na^+ OH^-
COPPER(II) SULPHATE — Cu^{2+} SO_4^{2-}
LEAD(II) NITRATE — Pb^{2+} $2NO_3^-$
HYDROCHLORIC ACID — H^+ Cl^-
Chemical CROSSWORD
7
T 6
8
1
R
2
R
5 U
9
N
4
Y
3
O
clues
ACROSS
① WAS '1'
② IT'S TRANSIENT
③ 20-18
④ A STATE OF SUBSTANCE
DOWN
② CONTAINS: ALUMINIUM, SILICON, OXYGEN, HYDROGEN
⑤ MOST WIDELY USED METAL
⑥ EASILY FUSIBLE
⑦ CONTAINS CLAYEY PARTICLES
⑧ PRESENT IN BORIC ACID.
⑨ CONDUCTIVE
The WORLD of the ATOM
WE KNOW THAT THE ATOM IS A NUCLEUS (CONSISTING OF NEUTRONS & PROTONS) WITH ELECTRONS SPINNING AROUND IT BUT HOW DOES THE ATOM BOND TOGETHER TO FORM A MOLECULE?
THERE WERE MANY IDEAS THROUGH THE AGES..
"YOU SHOULD HAVE SEEN SOME OF THE CRAZY IDEAS...!
THE IDEA OF FORCES ACTING BETWEEN BILLIARD BALL TYPE PARTICLES HAS LONG BEEN DISCARDED.
WE NOW KNOW THAT ATOMS COMBINE IN TWO MAIN FORMS..
① 'ELECTROVALENT' COMBINATION.
② 'COVALENT' COMBINATION.
ELECTROVALENT COMBINATIONS FORM ELECTROLYTES AND ARE ALSO KNOWN AS IONIC COMPOUNDS.
HERE ARE THE CHARACTERISTIC PROPERTIES OF IONIC COMPOUNDS
(a) IONIC COMPOUNDS DO NOT CONTAIN MOLECULES. THEY CONSIST OF AGGREGATES OF OPPOSITE CHARGED IONS. IN CONSEQUENCE, IF THEY ARE MELTED OR DISSOLVED IN WATER, TO MAKE THE IONS MOBILE, THEY CONDUCT ELECTRICITY AND ARE, THEREFORE, ELECTROLYTES
(b) THEY ARE SOLIDS AND DO NOT VAPORIZE EASILY
(c) THE WILL NOT USUALLY DISSOLVE IN ORGANIC SOLVENTS SUCH AS 'BENZENE', 'ETHER' ETC
WE STARTED BY INVESTIGATING HOW ATOMS COMBINE TO FORM MOLECULES BUT NOTICE THAT IONIC COMPOUNDS DO NOT FORM MOLECULES ... INTERESTING!
LET'S SEE WHAT HAPPENS WHEN A SODIUM ATOM (Na) AND A CHLORINE ATOM (Cl) FORM AN IONIC BOND...
CHLORINE ATOM
SODIUM ATOM
NON-METAL
METAL
ATTRACTION BETWEEN OPPOSITE CHARGES FORMS AN IONIC BOND.
CHLORINE ION
SODIUM ION
THE METAL ATOM (SODIUM) LOSES THE ONE ELECTRON IN ITS VALENCY SHELL TO FORM A POSITIVE ION, AND THE NON-METAL ATOM (CHLORINE) GAINS THE ELECTRON FROM THE SODIUM ATOM INCREASING ITS VALENCY SHELL TO 8 ELECTRON SO BECOMING A NEGATIVE ION.
THE ELECTROVALENCY OF AN ATOM IS THE NUMBER OF IONIC BONDS IT CAN FORM. THIS IS EQUAL TO THE NUMBER OF ELECTRONS WHICH IT CAN LOSE OR GAIN IN ITS VALENCY SHELL.
YOU MAY HAVE NOTICED BY NOW THAT WE ARE ONLY CONCERNED WITH THE OUTER SHELL OF THE ATOM WHEN LOOKING AT CHEMICAL REACTION
SO LET'S HAVE A CLOSER LOOK AT THE OUTER SHELL...
EXAM
WHEN THE 'OUTER SHELL' CONTAINS 2 (DUPLET) OR 8 (OCTET) ELECTRONS IT IS SAID TO BE STABLE AND IS NOT READILY CHANGED BY HEAT OR OTHER FORMS OF ENERGY.
WHEN AN ATOM IS NOT STABLE IT WILL FORM A BOND BY LOSING, GAINING OR SHARING ITS VALENCY ELECTRONS TO BECOME STABLE. THESE ARE CALLED VALENCY ELECTRONS BECAUSE THEY TAKE PART IN CHEMICAL BONDS. WHEN ATOMS CONTAIN SUCH VALENCY ELECTRONS THE OUTER SHELL IS CALLED THE ... VALENCY SHELL
'A-VALENCY-ELECTRON-IS-AN-ELECTRON-WHICH-TAKES-PLACE-IN-CHEMICAL-BONDS' — FIRST TIME I'VE SEEN A CRIB NOTE MOLECULE SIZE!
SO, WE NEED ONLY CONCERN OURSELVES WITH THE 'VALENCY SHELL' WHEN DEALING WITH CHEMICAL BONDING
INSTEAD OF DRAWING THIS EACH TIME
... WE'LL JUST DRAW THIS
NOW, THERE IS A SMALL FAMILY OF ELEMENT THAT TO ALL INTENTS AND PURPOSES CAN BE CONSIDERED AS HAVING NO VALENCY ELECTRONS. THEY ARE INERT AND WITHOUT CHEMICAL PROPERTIES. THE NAME 'INERT' HAS RECENTLY BEEN REPLACED BY 'NOBLE'. SO WE HAVE 'NOBLE GASES' AND 'NOBLE METALS'

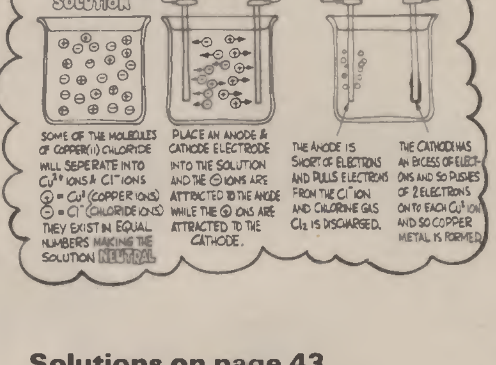


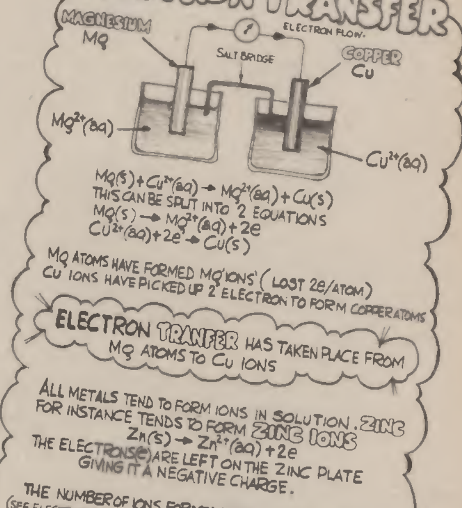












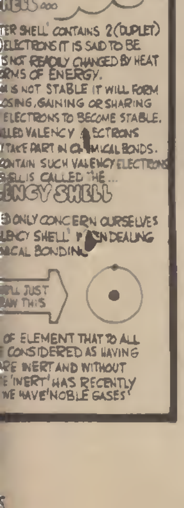
Solutions on page 43

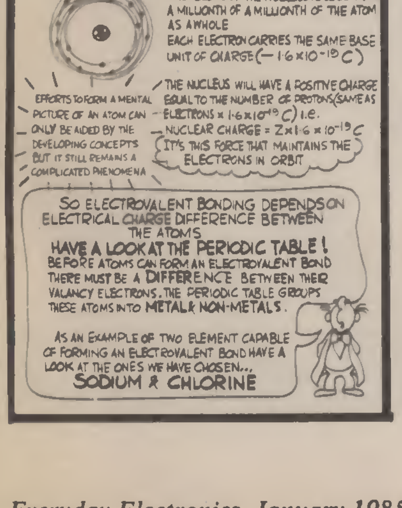
LINK-UP.

Start at [R] and form a chain of words related to electronics

R	O	E	N	T	G	E	N	F
E	R	■	■	D	C	G	A	E
M	R	O	F	A	I	N	M	R
H	O	T	O	S	T	E	O	R
P	R	O	T	H	P	O	T	T
M	U	T	A	O	R	A	H	I
M	O	S	I	N	T	R	M	T
■	C	T	R	F	O	M	U	A
■	R	O	R	E	D	O	I	N

WORD	CLUE
1 .OE....N	UNIT OF EXPOSURE DOSE OF X-RAY
2 ..BB..........	PARAMAGNETIC MATERIAL
3 .A....I	PREVENTS SUDDEN MOTION.
4 ..I....M	METALLIC ELEMENT
5 ..B.Q...B.N	USES HIGH ENERGY ELECTRON BEAM
6 ..BB.....	ACTS AS FERROSONANT AMPLIFIER
7 ..N....R	ASSEMBLY OF CONDUCTORS
8 ..Q.Q.......	A CATHODE RAY TUBE.





SPECTRUM AMPLIFIER

MARK STUART

MOST people who have used the Sinclair Spectrum computer will be aware of the low level of the 'Beep' signal. This project was designed to raise the level to something more suitable for use when playing games in a noisy family house.

In order to avoid having to make power supply connections, the amplifier contains its own PP3 type battery. The only connection required is a link from the computer 'EAR' socket. The amplifier is switched on by insertion of the input lead.

CIRCUIT

The circuit diagram is shown in Fig. 1. As the output from the Spectrum consists only of square waves it is not necessary to use a conventional audio amplifier. Instead a switching amplifier circuit is used. This means that a very simple circuit which uses very little quiescent current can be used.

The input signal is coupled via R1 to the base of TR1 which is connected as a common emitter amplifier stage, but is biased by R2 and R3 so that in the absence of an input signal it is cut off. When TR1 is cut off its collector voltage rises to 9V and this ensures that TR2 and TR3 are also turned off. The only current drawn in this state is via R3 and R2 in series. With a 9V battery this is 9/(R2 + R3) or 18μA.

When an input signal is applied TR1 turns on during positive half cycles and off during negative half cycles. When TR1 is on its collector voltage falls to almost zero and TR2 receives base current via R5. TR2 and TR3 are connected as a 'Darlington' pair. In this arrangement they work as a single emitter follower stage. This has a voltage gain of only 1 but a very high current gain.

The small input current from R5 turns TR2 and TR3 fully on, delivering nearly the full supply voltage across VR1. During negative input half cycles TR1, TR2 and TR3 are turned off and the voltage across VR1 falls to zero. The signal across VR1 thus appears as a much amplified version of the input signal. VR1 acts as a high level volume control directly feeding the speaker. A reverse log potentiometer must be used because of the unconventional arrangement. If a standard log or linear potentiometer were used the control would be very abrupt, and concentrated at one end of the track.

CONSTRUCTION

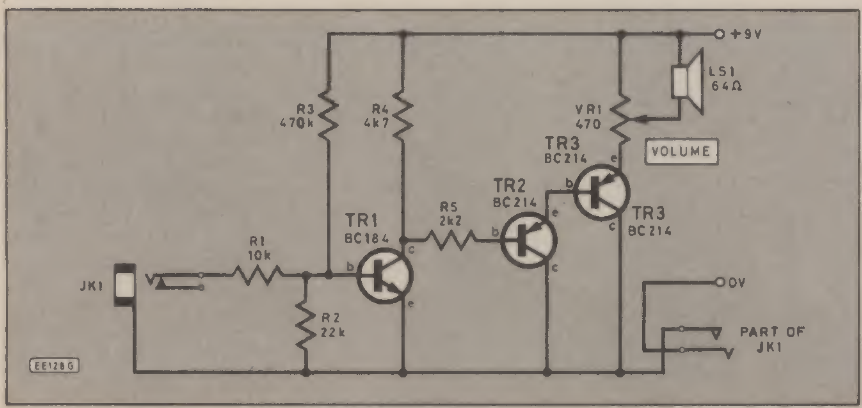
The whole circuit is built on a small printed circuit board. Fig. 2 shows the printed circuit board design and Fig. 3 the component layout. Take care to get the transistors in the correct positions. When the board assembly is complete drill the front panel to take SK1 and VR1, and drill a pattern of holes for the speaker. The printed circuit board is mounted simply by being soldered to the pins of VR1.

When all the components have been fitted to the case lid complete the wiring as shown in Fig. 4. The connections to the printed circuit board are made by stripping 5mm of insulation from each wire, passing the bare end through the board and soldering on the track side. SK1 must be connected exactly as shown to ensure correct switch action.

TESTING

After checking the assembly and wiring, connect a battery, plug or suitable 3·5mm lead into the amplifier (the lead supplied by Sinclair for connecting a cassette recorder is suitable). If you have

Fig. 1. Circuit diagram of the Spectrum Amplifier.



COMPONENTS

See Shop Talk page 18

Resistors

R1	10k
R2	22k
R3	470k
R4	4k7
R5	2k2
VR1	470 reverse log potentiometer

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

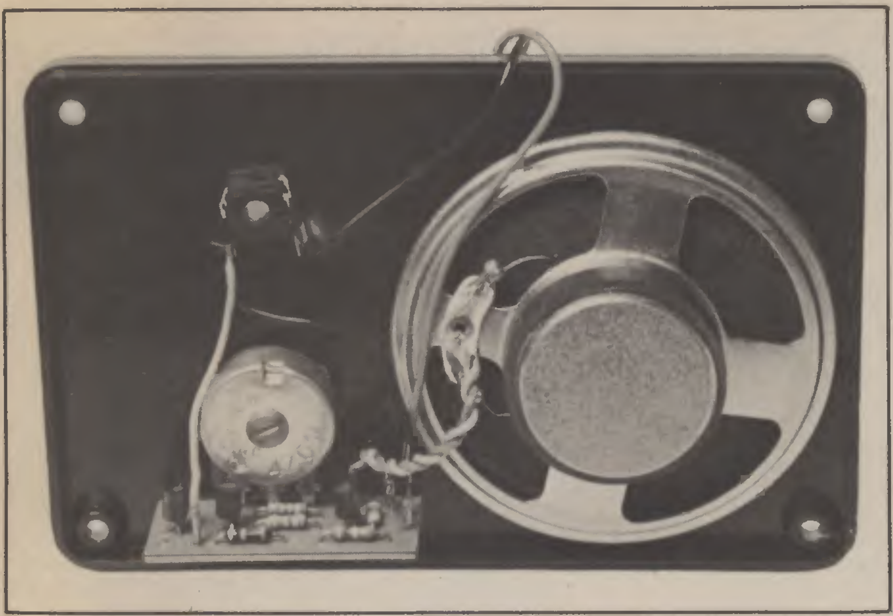
Semiconductors

TR1	BC184
TR2, TR3	BC214 (2 off)

Miscellaneous

PP3 battery clip
64 ohm miniature speaker
S1.SK1 3·5mm make break jack socket
Knob, feet, wire
Plastic case approx. 120 x 80 x 35mm
Printed circuit board

Approx. cost Guidance only **£6.50**



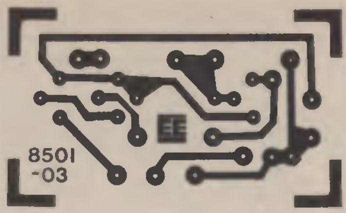


Fig. 2. Printed circuit board design.

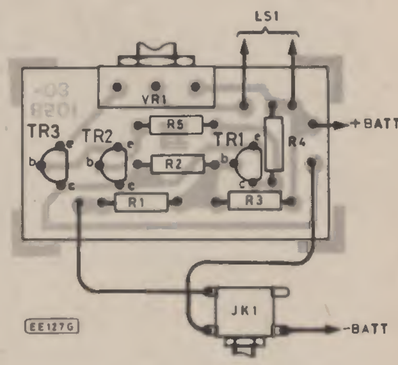


Fig. 3. Component layout.

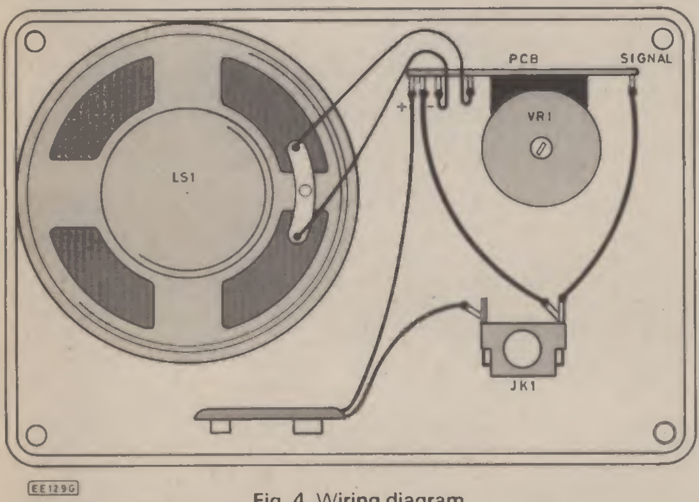
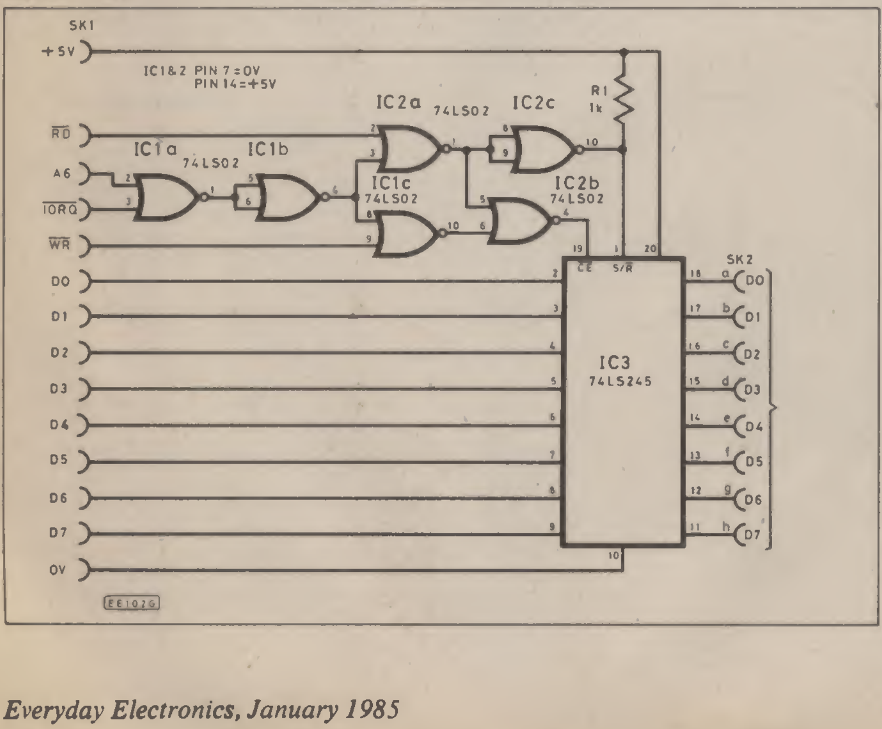


Fig. 4. Wiring diagram.

a multimeter you can check that the battery current is about 20μA. If not connect the other end of the lead into your Spectrum and issue a 'Beep' command. Check that the amplifier output is present and that the volume control works correctly. If all is well fix the battery inside the case using double sided adhesive tape, and fit the case lid. The battery life will be very long even with regular use because current drain is only significant when sound is present. Current drain during beeps is reduced at lower volume settings. Most of the time that the amplifier is connected it will be silent and the current drain will be very low. Remember to disconnect the lead from the amplifier before putting it away. □



ZX81 INPUT/OUTPUT

THIS 8-bit port is designed for use with the ZX81 or the ZX Spectrum home computer. It uses just three low cost and readily available TTL i.c.s, two 74LS02's and a 74LS245. The mapping is very straightforward as it only requires A6 to be low during an input-output operation.

The decoding is performed by the two quad 2-input OR gates which determine the state of the chip enable and the S/$\overline{R}$ pins of the bi-directional port i.c. For an output operation the $\overline{CE}$ and the S/$\overline{R}$ pin is low and for an input operation the $\overline{CE}$ is low and the S/$\overline{R}$ is high.

When using this circuit it must be noted that the address of the port is "echoed" throughout the memory map. Also when an output operation is performed it may be necessary to include another device for latching the data output.

A. Moran,
Reading,
Berks.

EVERYDAY news ... from the world of

TV COLOUR VIDEO PRINTER

THE world's first printer for instantaneous print-out of pictures on a television screen was introduced by Mitsubishi Electric last year. Now comes news that they have unveiled a NTSC Colour version.

The colour printer can be broken down into five major blocks: a block where the incoming National Television System Committee (NTSC) composite video signals are demodulated to obtain red, green, and blue (RGB) signals; an A-to-D converter for processing each colour signal into a digital sequence; a field memory for storing digital colour signals for a frame of picture; a block where the colour signals read from the field memory are converted into the three colours—yellow, magenta and cyan—of the subtractive colour process to obtain the necessary graduation colour signals; and finally a block where a colour print is obtained by a thermal transfer system.

Once the print button is pressed, it takes about one minute to produce a colour print. The paper is stored in cassette form, each "cartridge" holding sheets for 100 pictures.

At present there are no plans for a European standards version.

EDUCATED ROBOT

THE Nottingham based company TecQuipment International has won an order from the Open University for 150 of its new educational robots, type MA2000.

The MA2000 was developed in response to the Open University's requirement for an educational robot which would be capable of being programmed to perform a wide range of scaled down industrial tasks. The robots are wanted for use in two new OU courses; "Robots in Manufacturing" and "Robotics and Computing", which form part of the two modular M.Sc. degree programmes *Manufacturing* and *Industrial Applications of Computers*.

The price of the MA2000 Robot is £3,400.

Radio Kuma

Kuma Computers developed the Basicode 2+ translator for MSX microcomputers in advance of the two new "Radio Chip Shop" series on *Radios 1* and *4*.

Now, all users who purchase one of the MSX micros currently appearing in the shops will be able to take advantage of the free software offered by the BBC for downloading every week.

Bank Calls in Telecom

British Telecom's London City Area has signed a 12-month agreement with the Midland Bank relating to future orders of switching systems for branches of the bank throughout England and Wales.

The agreement, representing a special discount arrangement, covers BT's Herald, Monarch and S6022 business switchboards. All Midland Bank orders for those systems in the next year will be placed with the City Area.

AWARDS

The 1984 British Computer Society award for technical achievement has been won by Inmos for its development of Occam, a new porgramming language. It was given for the simplicity of the language and its high performance when used with the Inmos transputer.

A microcomputer system which can be operated by the eye movement of disabled patients won the Social Benefit class for St George's Hospital, Lincoln.

As part of its continuing initiative in the education sector Commodore has announced that it will be sponsoring the 1985 British Computer Society *Schools' Computer Quiz*.

CELLNET DRIVE

Initial orders for the much heralded cellular radio telephones have far exceeded Securicor's expectations. Already, they have all but reached their pre-launch sales targets with orders of £4.6 million.

Securicor is in partnership with British Telecom in setting up the CELLNET service.

Says Peter Towle, Securicor's Managing Director: "We are already pushing the manufacturers of the 'Go-Phone' mobile radios to their maximum production capacity, but it looks as though we may be unable to meet the demand until April 1985."

TALKING COMPUTERS

The country's first computer information service is being provided by British Telecom, Bradford. The Bradford area has been selected for the first "field trials" of a new Guideline Service *Home Computer Line*.

Callers dialling Bradford (0274) 722622 will hear a three minute tape giving all aspects of computer ownership. The contents will initially be about hardware, software and peripherals; what's new in the computer world, new concepts and new ideas.

The message is updated twice weekly and is claimed to cater for all needs, such as tips on programming, games and so on. The information is supplied by a Hebden Bridge company, Information Unlimited.

Akadimias Program

Academic staff at the University College of North Wales, Bangor, have established a small educational software house. Known as the Akadimias Project it is funded by the College and run on a commercial basis with all profits, after payment of royalties, management fees and running costs, to be devoted to the uses of the College.

Memorex's 5.25in, 0.25 Mbyte, single-sided, double density flexible disks are now available from selected branches of Currys. They join Boots and Dixons in stocking the Memorex disks.

WELSH BASIC

The development of XBasic in Welsh is announced by Xitan. This version is syntactically the same as XBasic except that all keywords and messages are in Welsh. For example the equivalent of LOAD is LLWYTH and RUN is RHEDEG.

Geoff Lynch, Managing Director of Xitan, admitted that Welsh XBasic was a means of testing the firm's capability to provide XBasic in other languages, and that Welsh was chosen for a number of reasons—not the least was the "ability to get the product checked out by people in the same country", and its "high levels of real use in the Welsh academic community."

The Civil Aviation Authority has published the second edition of its *Radiotelephony Manual* (£2.90 including UK postage) to reflect the recent changes to the phraseology used in aviation radiotelephony.

The general philosophy behind the phraseology changes is an attempt to remove the ambiguity in messages. Wherever possible the concept is "one word—one meaning".

High Speed ROMs

Hitachi are now accepting orders for 1Mbit Mask programmed ROMs with access time of 250ns (max), compatible with most microprocessor based systems.

All signals are TTL compatible, and the data output lines have three-state operation for wired-OR connection to bus lines. A Chip Enable input deselects the device and puts the chip in power down mode.

Dr Peter Troughton has been appointed Managing Director of British Telecom Enterprises.

SPEECH RECOGNITION

Computers that recognise the human voice are to be developed in a £2 million research project headed by British Telecom's Research Laboratories at Martlesham Heath, Ipswich.

The study, which will run for three years, will be undertaken in collaboration with Logica and Cambridge University. It is being funded by the Alvey Directorate.

Soft Touch for BT

A new range of home computer games costing £2.50 each, and backed by a British Telecom guarantee of value for money and honest packaging, are now on sale through High-street shops.

Published by British Telecom's new software house, under the label Firebird, the cassettes are available for the most popular machines, including the Sinclair Spectrum, Commodore 64 and the BBC Micro. A full colour picture of what the players will actually see on their TV screen or monitor appears on the cassette pack, enabling customers to judge the games from their covers.

Announcing the new venture, Mr. Richard Hooper, Chief Executive of British Telecom's Value Added Systems and Services, said: "You can now judge a game by its cover. In a market where quality and prices tend to be variable and complaints of misrepresentation frequent, Firebird software is setting new standards . . ."

"Our first releases are all games but we shall be offering educational software and other types of programs."

CLEAN CUT

THE ART of controlling a metal turning lathe using the BBC Microcomputer, was ably demonstrated at the recent Design & Technology Exhibition, Wembley, by Shesto-Tech of London.

The system, known as CoNeCt 121, is a reasonably priced (about £3,600–4,000) interface plus software for the BBC model B micro to control a modified Myford ML10 precision lathe, enabling students to learn Computer Numerical Control (CNC), as used in industrial engineering control systems.

Programming can take place on any BBC B Micro, leaving the lathe free for the use of others. The graphics package allows a complete run through of the program showing each machine tool movement. Students can therefore check and change their programs before running them on the lathe, either as a straight through sequence, or one line of program at a time to double check the cutting tool actions.

The electronic interface unit controls the lathe movements. Two high quality precision d.c. stepper motors are used to move and position the cutting tool using X and Z axes information. The spindle drive motor receives d.c. power drive signals to provide a stepless range of speeds from 150 to 1200 r.p.m. continuously variable.

The ability to run the program in the graphics mode, allowing a visual check on the VDU before using the lathe, is a major safety feature which, it is claimed, effectively removes any possibility of a collision during a machine action program run.

NEW · NEW · NEW · NEW PRODUCTS NEW · NEW · NEW · NEW CHRISTMAS

STILL HAVING PROBLEMS SELECTING A SUITABLE GIFT? WE OFFER OUR SMALL CONTRIBUTION (INCLUDING TELEPHONE NUMBER) TO THIS ANNUAL DILEMMA!

1

2

VIDEO STAR—1

FOR the whole family we have gone for the luxury of the Ferguson Video Star C In-Camera Recorder Model 3V41. This latest concept in "electronic photography", which combines a video camera and recorder in one unit, will find equal appeal from the lady of the house; especially for holiday and "new baby" growing up sequences.

The package includes a single unit camera and recorder, slimline rechargeable battery, battery charger, r.f. converter, detachable microphone, carrying handle, VHS C EC30 video cassette and instruction book. Developed from VHS technology it is completely compatible with all VHS video cassette recorders.

Supplied in an executive style carrying case, the Ferguson Video Star C is a truly portable home video system that includes everything needed to make home videos in colour and with sound, and to immediately replay them on the TV screen. The anticipated retail price for the Ferguson Video Star C In-Camera Recorder Model 3V41 is £995: **Thorn EMI Ferguson Ltd., Dept EE, Cambridge House, Great Cambridge Road, Enfield, Middlesex EN1 1UL.** ***Tel: 01-363 5353.***

NURSERY CALL—4

WHILST big brother (or sister) is busy playing video games or writing programs for their home computer, the younger members of the family can enjoy their very first introduction into the world of the microchip with the Phillip Phone, an addition to the Milton Bradley range of Playskool products.

Designed for the 3 to 6 year olds, the Phillip Phone is an electronic musical phone with a flip-down front to reveal a 12-note touch sensitive keyboard which is easy to play by colours or numbers.

The "nerve centre" of the phone is an SGS processor chip, type 884024Y, battery operated it features an automatic on/off to conserve battery life. It comes complete with a coded music book, containing eight different tunes of old favourites, and budding young composers can write their own tunes. The usual retail price for the Phillip Phone is between £6 and £8: **Milton Bradley Ltd., Dept EE, Spencer House, 23 Sheen Road, Richmond upon Thames, Surrey TW9 1AL.** ***Tel: 01-940 6069.***

ENGLISH SPEAKING—5

A NEW complete O-level English Language course for BBC Model B and Electron micros would make an interesting present for the teenager approaching exam year.

Developed by **LCL** and called Micro English, it consists of 24 easy-to-use programs on either disc or cassette that, it is claimed, was field tested in schools under normal learning conditions. A feature of the course is an accompanying audio cassette, controlled by the computer, which it is claimed enables the computer to "talk" sensibly to the student in a conventional teacher-pupil manner.

The Micro English program is priced at £24.50 and consists of either 2 discs plus audio cassette or program and audio cassette in tape version. A comprehensive manual, with step-by-step instructions is included with both packages: **LCL, Dept EE, 26 Avondale Avenue, Staines, Middlesex.** ***Tel: 0784 58771.***

TALKING TAPE—2

FOR the busy executive or the overworked student, Panasonic have marketed the voice activated microcassette tape recorder, type RN-Z109.

Ideal for meetings and in the classroom, it features a voice activated system which eliminates the need for a manual on/off operation and keeps tape usage to a minimum. When speaking finishes, the recorder automatically pauses, and when the sound continues so does the recording.

A digital tape counter enables the user to note important sections on the tape. The recorder automatically turns off when the tape has finished.

Two-speed switching provides one hour recording at standard speed and up to two hours playing time at low speed. Other features include: one-touch recording, follow-up recording, pause control and l.e.d. record/battery indicator.

Powered from the mains, with an optional a.c. adaptor, or by batteries, the RN-Z109 has a suggested retail price of £66.50 through authorised dealers: **Panasonic UK Ltd., Dept EE, 300/318 Bath Road, Slough, Berkshire SL1 6JB.** ***Tel: 0753 34522.***

CHOICE

We would like to point out that readers buying from these pages are not protected by the Mail Order Protection Scheme unless the company concerned have advertised the product in a display advertisement in this issue.

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COMPUTER AID—3

IDEAL for younger children, adults and those who would like to attempt some of today's more complex games but have not yet acquired the necessary skills or reaction levels, we offer the Slomo from **Cambridge Computing Research Ltd.**

This little gadget will prove an invaluable gift to the newcomer to the Spectrum, BBC, Electron and Commodore 64 home computers. It provides slow motion and freeze frame facilities for most games or programs.

It accomplishes this by setting a "Bus Request" signal on the system bus. This is acknowledged by the main processor and causes a "high impedance" or hold state until the signal is called off.

The two front panel push-button switches provide either instant freeze frame, for as long as the switch is held down, or slow motion mode. The rate of viewing in the slow motion mode is set by the Speed control knob.

The Slomo, micro VDU slow motion and freeze frame controller, is available by mail order (state which micro used) for the sum of £14.95, inclusive of VAT and postage. Cheques should be made payable to Nidd Valley Micro Products. For more details contact: **Cambridge Computing Research Ltd., Dept EE, 61 Ditton Walk, Cambridge CB5 8QD. *Tel: 0223 214451.***

SOUND STUDIO—6

THE Porta One Ministudio from Tascam, marketed by **Harman (Audio)**, will appeal to the professional musician. It is a high quality portable 4 x 2 mixer and 4-channel multi-track cassette recorder, with switchable dBx noise reduction.

Each input channel of the built-in mixer can accept a microphone, musical instrument, line level source or playback from the built-in recorder. You can preset the sensitivity with a Trim control and adjust the channel level with a Fader. Because there are Record Function switches as well as Pan Pot, you can assign each input to any of the four tracks for recording—or all four inputs to one track.

The Ministudio's system includes cue capability. This means you can mix all four tracks plus "live" inputs onto an independently controlled headphone output so you can hear what you are doing while recording and over-dubbing. Four VU meters provide a visual monitoring of any recorded or reproduced signals.

Available from the specialist music shop, the Porta One Ministudio is expected to retail for around £429: **Harman (Audio) UK Ltd., Dept EE, Professional Products Division, Mill Street, Slough, Berks SL2 5DD. *Tel: 0753 76911.***

RADIO WORLD

BY PAT HAWKER G3VA

Ham or Experimenter?

On both sides of the Atlantic there is a continuing debate on what the activities carried out by radio amateurs should be called. Some British enthusiasts complain that the term "ham radio" is derogatory and is frequently applied indiscriminately by the media to both amateur radio licencees and c.b. enthusiasts. Some even object to being called "amateurs" on the grounds that this may be taken to imply "amateurish".

The origins of the term "ham radio", as applied to the hobby, are lost in time, although that does not prevent writers from presenting highly speculative accounts, including the rather far-fetched story that the names of three young enthusiasts who appeared before a 1912 Congressional Committee in the USA had surnames beginning H, A and M and were in the habit of using these letters as a callsign in the period before any official amateur licences were issued in the States.

Others suggest it may have derived from the derogatory term "ham actor", but far more plausible is the belief that it stems—as do other terms such as "73"—from maritime radio and land-line telegraphy. In the days when all telegrams and American railroad messages were sent in Morse by skilled telegraphists, the "professionals" became very proud of their "fists" or in other words their manual dexterity and precision in manipulating morse keys.

When the often very young and inexperienced amateur enthusiasts began to venture on air with crude spark transmitters, based on vehicle ignition coils, their morse must have been pretty poor. So the old pro's dismissed them as "ham-fisted" from which it was a short step to the collective title of hams.

Today, with most traffic sent by machine-telegraphy or data communications there are far fewer professional telegraphists—and the morse heard on amateur bands is often very far from being "ham-fisted". There is, however, a word that is almost identical with what may have been the original: "hamfest", applied to a large meeting or convention of radio amateurs.

Talking To Ships

One of the services that still depend on manual morse rather than machine telegraphy (r.t.t.y.) and electronic data transmission systems is the maritime service, although increasingly the requirement is for Radio and Electronics Officers, trained to cope with radio and radar navigational equipment, etc, as well as acting as "Sparks". The continued decline in the size of the merchant fleets has dramatically reduced the number of sea-going jobs, and many radio officers have taken up shore jobs.

Telephony on m.f., h.f. and v.h.f. has also drastically reduced the amount of "brass-pounding" and this will increase as more satellite terminals are fitted to ships, providing high-quality voice circuits through the *Inmarsat* satellite system which is also planning to introduce automatic distress systems, including search and rescue systems. The latest Marconi Marine satellite communications terminal, *Oceanray* is priced at under £20,000 and is claimed to be the smallest and cheapest system suitable for fitting on all kinds of vessels, from luxury yacht to passenger liner or supertanker. It has been designed to make long or medium distance communication as easy as using an STD telephone or telex machine.

Sir Martin Ryle

Radio-astronomy has lost one of its most distinguished pioneers with the death of Professor Sir Martin Ryle, the former Astronomer-Royal and former director of the Mullard Space Observatory at Cambridge.

He was one of the few eminent British scientists who kept his amateur radio licence, G3CY, issued while he was still at university. I still have his QSL card for a 7MHz contact in 1939 although he was apparently not active as an amateur in the post-war period.

What he retained was an ability to make use of odd pieces of equipment—his early studies of signals from the Sun and beyond were largely based on surplus British and German radar equipment with which he became familiar during six years of wartime work on airborne radar at T.R.E. at Malvern and elsewhere. But Ryle disliked the idea of a career designing military radars just as in recent years he became an outspoken critic of nuclear energy for both civilian or military applications.

A great scientist with tremendous enthusiasm for radioastronomy to which he contributed so much.

When the telephone handset is lifted a synthesised voice gives instruction on how to use the system. For incoming calls, the Oceanray terminal remains switched on with its 3ft diameter dish aerial locked on to the nearest *Inmarsat* satellite, automatically searching for another satellite should the signal become too weak.

Defence Radio

Oceanray is much less complex than the type of enhanced shipborne communications terminals ("Scot 1A") now being fitted to 19 more Royal Navy frigates under a £40-million contract. These latest digital-communications terminals now cover a much wider tuning range permitting their use with American, NATO and the British *Skynet* military satellites.

But this does not mean that naval vessels can now dispense with long-distance h.f. equipment since there still remains the possibility that in a major conflict it would be possible to put communications satellites out of action, either with anti-satellite systems or by jamming from ground-based terminals.

Recently, for example, the American services have begun modernising their h.f. facilities, resulting in a number of orders for British companies who have long recognised the continued value of h.f., even while stressing the advantages of satellites in overcoming the problems of the constantly changing h.f. propagation conditions.

Military radio systems seem to present a picture of ever-increasing complexity as the implications of electronic warfare sink in. First you need a basic system, then a counter-measures system, then a counter-counter-measures system, a computer to crack codes, a bigger computer to design unbreakable codes, a still bigger computer to try to break them . . . You need surveillance equipment, you need jammers, you need sensors that detect movement, that detect heat, that one day may even detect the brain waves of your enemy!

DBS Radio

The ambitious British plans for early installation of fully interactive, star-switched 30-channel television networks seem recently to have gone into reverse, as the early euphoria evaporates. The City has added up the costs and taken fright. This may or may not leave the way clearer for 12GHz direct television broadcasting from satellites, though there is now no chance of this happening in 1986 as originally forecast, and even 1987 or 1988 still have question marks against them.

More promising is that the European countries seem close to agreement on a compatible transmission system based on both C-MAC/packet with a digital high-capacity binary sound/data system and D2-MAC which has slower-rate duobinary digital sound system. Both could use a common set of i.c. devices and countries could then choose which to use without upsetting the entire apple-cart.

In fact most people agree that the main problem for DBS is more a question of how to provide programmes at low cost sufficiently attractive to encourage viewers to subscribe to yet another new service of home entertainment. For many of us four programme channels of television are quite sufficient.

In the USA a problem is that many viewers have found that by installing their own C-band dishes directed at low-point distribution satellites they can receive the cable programmes without paying for them, although over 43 per cent of U.S. homes are now cabled, and still increasing at almost 10 per cent per year.

The American United States Information Agency has funded a feasibility study for a DBS sound broadcasting system that would be operated by "Voice of America". It will study how such satellite radio would be powered from solar or nuclear sources, what type of orbit would be most suitable, and what would be a suitable frequency, from h.f. at about 26MHz up to 12GHz.

The whole system would have to be suitable for launching from the Space Shuttle. There is however virtually no likelihood of VOA using DBS until the mid-1990s.

SQUARE one FOR BEGINNERS

ELECTRONICS is a young science: only a hundred years ago, Edison in America and Swan in Britain were struggling to develop the first electric light bulb. Now, it seems there is almost no area of life which is unaffected by electronics. Our understanding of the phenomenon we call electricity has increased steadily since then, though even today it cannot be said to be complete.

ATOMS

All matter is made up of atoms, or compounds of atoms, of which there are only around one hundred which occur naturally. Any atom can be imagined as comprising a very small nucleus, and orbiting that nucleus, a number of particles—electrons—rather as the planets orbit our sun.

The simplest atom is that of hydrogen, which is made up of one proton and one orbiting electron. It should be pointed out here that it is believed at present that an atom is actually made up of many different kinds of elementary particles; however, the ones which are of particular interest here are protons and electrons.

Protons each have a small charge, which is balanced by the charge on the electrons. It is conventional to consider the charge on the proton as being "positive", and the charge on the electron, "negative". Since there are as many orbiting electrons as there are protons in the nucleus, the atom as a whole is electrically neutral.

This model is a simplified one, but is useful in explaining the connection between simple chemical processes and the generation of electricity. This "planetary" model is shown in Fig. 1, with similar models for the atoms of Neon and Argon. Although the total number of electrons is the same in each case as the number of protons in the nucleus, it will be seen that the electrons orbit the nucleus in different numbers at different distances.

These precise orbits, or "shells", can accommodate fixed numbers of electrons—two, in the innermost orbit, eight in the next two orbits. When the maximum number of electrons exists in the outermost shell, the atom is chemically stable. Neon and Argon, for example, are "inert" gases: they will combine with no other elements.

Similar models are shown in Fig. 2a for sodium and chlorine. Sodium, with a total of eleven electrons, has one in its outermost orbit, while chlorine, with a total of seventeen, has seven. As shown in Fig. 2b, the naturally stable state of eight electrons in the outermost orbit is achieved by the movement of the single electron from the outermost orbit of the sodium atom into the orbit of the chlorine atom. The sodium atom, which has now lost an electron, is left with a net positive charge, while the chlorine atom gains one negative charge (due to the electron).

Both atoms are now said to be *ionised*—an *ion* is an atom which has lost or gained one or more electrons. Further, the ions—one negative and the other positive—attract each other very strongly, and form a rigid crystal structure known as sodium chloride, or table salt.

CONDUCTION

Copper, like sodium, has one electron in its outermost orbit. This outermost electron is easily dislodged, and in any piece of pure copper, one can imagine a "sea" of electrons, moving randomly from atom to atom, the whole piece meanwhile remaining electrically neutral. In an insulator, the electrons are not free to move easily, as the outermost shells are full.

The flow of electrons—electricity—is the result of chemical action: energy, of course, cannot be created or destroyed, but by choosing appropriate materials, chemical energy can be converted into electrical energy.

SIMPLE CELL

The simple cell shown in Fig. 3 will produce electricity, and was first demonstrated by the Italian scientist Volta, in 1799. The zinc plate dissolves in the dilute sulphuric acid (H_2SO_4), forming zinc sulphate, and this simple process transforms chemical energy into electrical energy. This happens because, chemically, it is positive zinc ions which combine with negative "sulphate" ions, displacing positive hydrogen ions. These hydrogen ions become atoms again by taking the weakly-held electrons from the outermost orbits of the copper atoms in the other plate—and in practice, bubbles of hydrogen gas collect on the plate.

The net effect of this chemical reaction is to leave the zinc plate with extra electrons, while the copper plate is deficient. When a conductor is placed between the two plates, electric current flows, and can be measured.

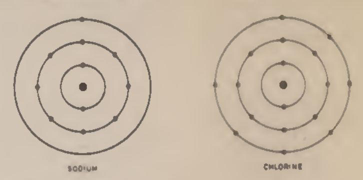


Fig. 2a. Sodium and chlorine atoms.

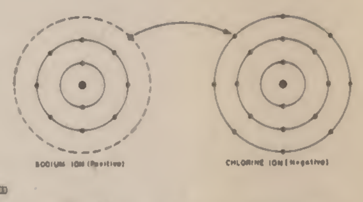


Fig. 2b. Movement of electron to create a sodium-chlorine ion pair.

This flow of electric current is a movement of electrons from the zinc plate, through the copper wire, to the copper plate. The movement appears to be almost instantaneous, because of the millions of electrons free to move in the copper wire. The electrons in the conductor behave like a long line of snooker balls which are all touching—if a ball at one end is moved forward, the ball at the other end moves forward at almost the same time.

This electron flow is sustained for as long as the chemical reaction continues; after that, no more current flows, and the battery is "flat."

DRY CELLS

An improvement on the simple wet cell described above is one which makes use of carbon, rather than copper, and ammonium chloride instead of sulphuric acid. This type of cell produces a higher voltage for a longer time than the wet cell. However, eventually, it will also become "flat", and it is not possible to easily reverse the chemical processes that have taken place; the cell has to be replaced. This type of cell is the one in most common use today.

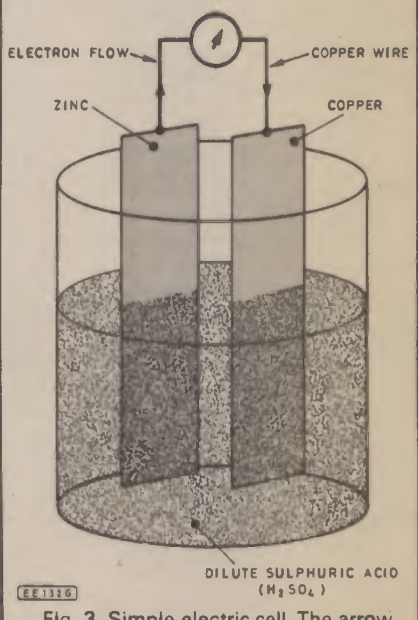


Fig. 3. Simple electric cell. The arrow shows the direction of electron flow.

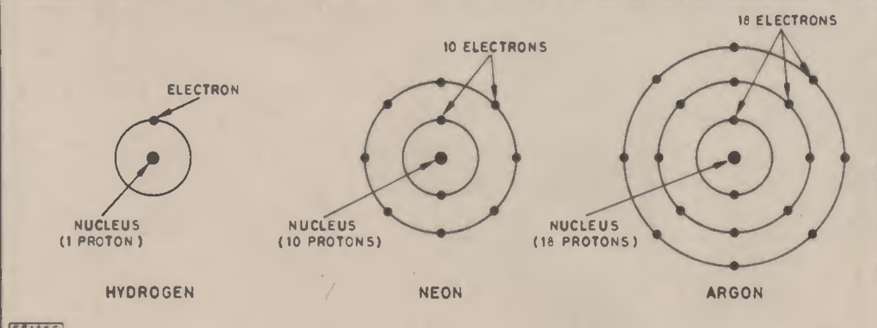
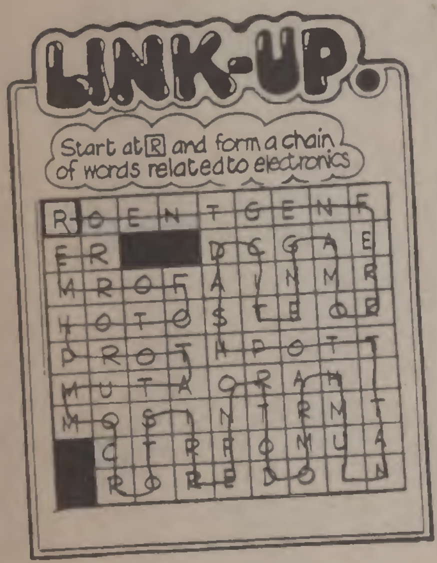
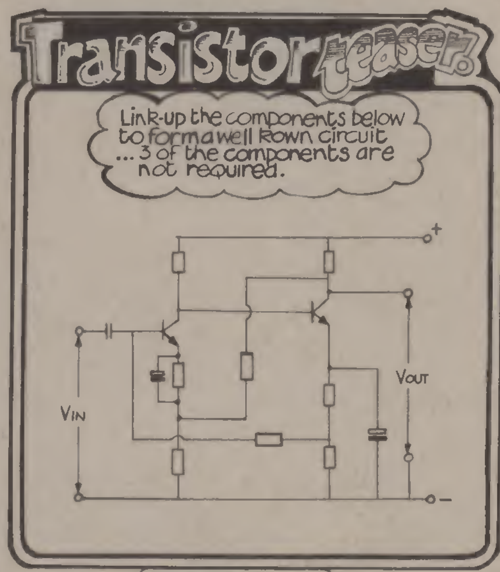


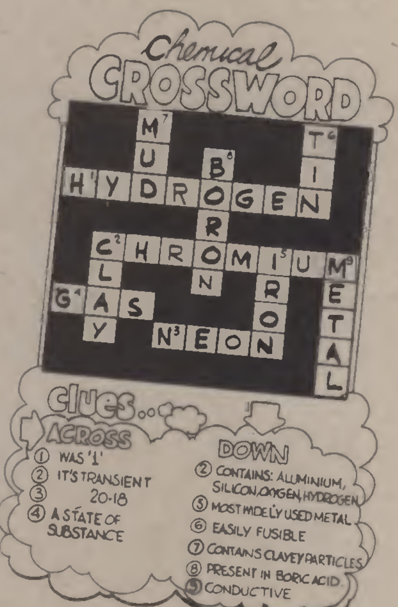
Fig. 1. Models of Hydrogen, Neon and Argon atoms.

FUNTRONICS Solutions...





2-STAGE AMPLIFIER



ALFRED

ALAN GREEN PART THREE

IN the previous two parts of this series we concentrated on the hardware construction details of friend Alfred. To fully explore Alfred's ability to educate and entertain this month (the final part) we take a look at software; in particular a program which allows the robot to learn, store and then replay a series of movements.

WHAT DO YOU THINK, ALFRED?

There are two versions of the software available. The more sophisticated version is a comprehensive package including a demonstration routine. This is supplied as a standard item in the Alfred kit as available from RCT.

To save a few trees from the paper mill we have shown a simplified version of the software in Table 3.1. Alfred may be controlled directly using this program.

SIMULATED PENDANT

In industry an increasingly popular method of operating robots is that of using a control box linked via an umbilical cable, and which is often referred to as a 'pendant' control. This has specific buttons on it which relate to axes or preset movement sequences of the robot.

Alfred's software is extremely easy to use, and mimics the pendant by setting up certain keys on the computer's keyboard to activate individual axes on the robot.

The software described is written for the BBC microcomputer, although programs that replicate the same functions, which will run on other popular machines, are available. Unfortunately some microcomputers such as the ZX Spectrum and the ZX81 require a parallel port adaptor, as only the bus lines are available for this kind of system expansion.

USING THE SOFTWARE

Immediately the program has been loaded and run a menu of options appears on the screen. Of the options displayed the user makes his choice by tapping the Tab key until the appropriate selection is highlighted. The program allows the motors to be frozen, or de-energised, by pressing the 'F' key, and energised again by pressing the 'E' key. All motors are automatically frozen when the program is first run.

The centre position of any motor is numerically 128, and by selecting 'C' on the keyboard each motor may be driven to centre position directly. Positional data is displayed to the right of the menu. See Fig. 3.1 which shows the display format.

One built-in safety precaution is a software flag to limit the motor positions to within certain extremes so that mechanical damage to Alfred cannot occur.

On the BBC micro the 'Copy' key is used to memorise the selected position of a particular axis. The 'arrow' keys are used to enter the numerical position of an axis. The 'up arrow' increases the number displayed, and the 'down arrow' decreases the number. The amount by which the number you are adjusting is incremented by each push of the 'arrow' key will depend upon the Increment selected beforehand. The Increment is selected by pressing the 'S' key and then entering a number between one and nine. Although when expressed in words this may sound complicated the practice is simple, and the logic of operation quickly becomes self-evident.

Fig. 3.1. A typical screen display using the full length software. The alternative topline would read: ENERGISED 'F' TO FREEZE SERVOS.

FROZEN 'E' TO ENERGISE SERVOS

MOVEMENT	<TAB>	POSITION	No.
Waist	←	*120*	1
Upper Arm	↑	*15*	2
Forearm	↑	*105*	3
Wrist UP/DOWN	↑	*75*	4
Wrist rotate	←	*10*	5
Gripper	↑	*220*	6

STEP SIZE = 'S' TO CHANGE

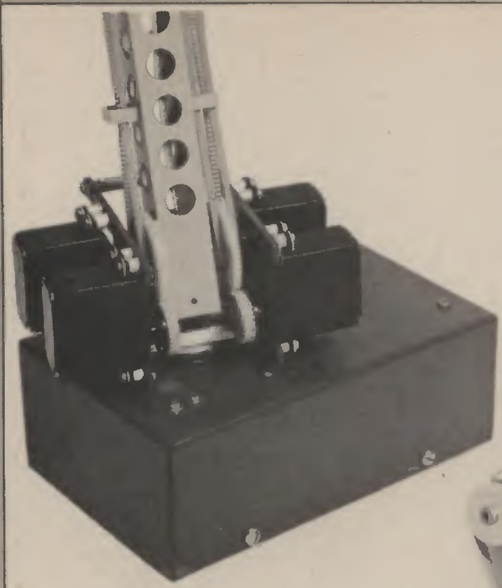
C Centralise Position (Position 128)
RET Return Menu
COPY Store Sequence
Current Sequence No. *13*

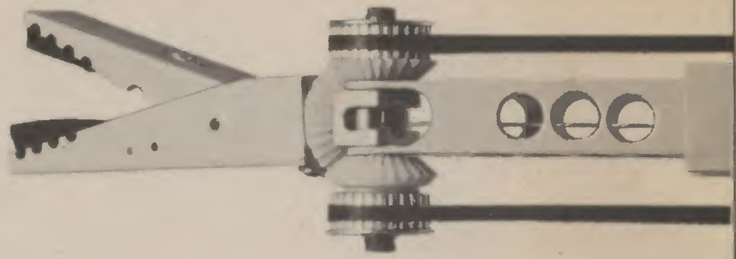
```
1000 REM * ALFRED DRIVE
     PROGRAMME *
1010 REM 30/10/84
1020 REM COPYRIGHT ROBOT CITY
     TECHNOLOGY LTD. 1984
1030 REM AUTHOR A. J. CAVES
1040
1050 DIM PV%(7):DIM OV%(7)
1060 P%=&FE60
1070 *FX229,1
1080 *FX12,15
1090 MO%=1
1100 *FX229,1
1110 VDU23,1,0;0;0;0;
1120 *FXx4,1
1130
1140 PROCwelcome
1150 PROCinit
1160 PROCmanual
1170 *FX4,0
1180 VDU23,1,1;0;0;0;
1190 PROCenable(0)
1200 CLS
1210 *FX12,0
1220 *FX229,0
1230 END
1240
1250 DEFPROCmanual
1260 PROCman_disp
1270  REPEAT
1280   K$=GET$
1290   KEY%=ASC(K$)
1300   IF KEY%=9 PROCmovement
1310   IF KEY%>135 AND KEY%<140
       PROCstep
1320   IF K$="E" THEN
       PROCenable(1):PRINT
       TAB(0,1);H7$
1330   IF K$="F" THEN
       PROCenable(0):PRINT
       TAB(0,1);H6$
1340   IF K$="S" THEN PROCsize
1350   IF K$="C" THEN PROCcent
1360    UNTIL KEY%=13
1370 PROCenable(0)
1380 ENDPROC
1390
1400 REM Sets up data so that all servos are
     centralised when energised.
1410 DEF PROCinit
1420 *FX151,98,127
1430 FOR J%=0 TO 7
1440   PV%(J%)=128
1450   OV%(J%)=234
1460   NEXT
1470 FORJ%=0 TO 7
1480   PROCdata(J%,8,OV%(J%))
1490   PROCdata(J%,0,PV%(J%))
1500   NEXT
1510 M1$="Waist                    ["
1520 M2$="Upper Arm                ^ "
1530 M3$="Forearm                  ^ "
1540 M4$="Wrist Rotate             ["
1550 M5$="Wrist Up/Dn              ^"
1560 M6$="Gripper                  ^"
1570 P4$=" C      Centralise (Position=128)"
1580 P5$="RET       Exit from Programme"
1590 H2$="Movement <TAB>"
1600 H3$="Position"
1610 H4$="No."
1620 H5$="STEP SIZE= 'S' to change"
1630 H6$=FROZEN 'E' to energise servos"
1640 H7$=" ENERGISED  'F' to freeze
     servos "
1650 H8$="ROBOT CITY
     TECHNOLOGY"
1660 ENDPROC
1670
1680 REM Selects servo number and loads
     new position data
1690 DEFPROCdata(cn%,off%,d%)
1700
1710 REM cn% is servo number 1 to 6
1720 REM off% should be 0
1730 REM d% is the position data 0 to 255
1740
1750 Un%=d%DIV 16
1760 Ln%=d% MOD 16
1770 x%=128+cn%+off%
1780 ?P%=128+Un%
1790 ?P%=144+Un%
1800 ?P%=144+Ln%
1810 ?P%=128+Ln%
1820 ?P%=x%
1830 ?P%=x%+32
1840 FOR j%=1 TO 38:NEXT:REM
     Approx. 8mS delay
1850 ?P%=x%
1860 ENDPROC
1870
1880 DEFPROCenable(en)
1890
1900 REM en=0 freezes all servos
1910 REM en=1 energises all servos
1920
1930 ?P%=128+en
1940 ?P%=192+en
1950 ?P%=128+en
1960 ENDPROC
1970
1980 DEFPROCwelcome
1990 CLS:PRINT'''
2000 VDU141:PRINTTAB(10);
     "WELCOME TO"
2010 VDU141:PRINTTAB(10);
     "WELCOME TO"
2020 PRINT'''
2030 VDU141,136:PRINTTAB(4);
     "ROBOT CITY TECHNOLOGY"
2040 VDU141,136:PRINTTAB(4);
     "ROBOT CITY TECHNOLOGY"
2050 PRINT''''''"Press any key to continue"
2060 REPEAT UNTIL GET
2070 ENDPROC
2080
2090 REM Display Form
2100
2110 DEFPROCman_disp
2120 CLS
2130 VDU31,2,3:PRINTH2$
2140 VDU31,19,3:PRINT H3$;"    ";H4$
2150 PRINT'TAB(2);M1$
2160 PRINTTAB(2);M2$
2170 PRINTTAB(2);M3$
2180 PRINTTAB(2);M5$
2190 PRINTTAB(2);M4$
2200 PRINTTAB(2);M6$
2210 FOR J=1 TO 6:VDU31,30,4+J,
     48+J,31,16,4+J,135,156,31,25,4+J,
     135,156,31,32,4+J,135,156:NEXT
2220 FOR J=1 TO 6:VDU31,21,4+J:
     PRINT RIGHT$!("    "+STR$
     (PV%(J)),3):NEXT
2230 PRINT TAB(0,1);H6$
2240 PRINT TAB(0,15);H5$
2250 PRINT"P4$"P5$
2260 SS%=0:PROCsize
2270 MO%=6:PROCmovement
2280 ENDPROC
2290
2300 DEPROCmovement
2310 VDU31,0,MO%+4,32,32
2320 IF MO%<4 OR MO%>4 THEN
     VDU31,19,MO%+4,32,32,31,28,
     MO%+4,32,32
2330 MO%=MO%+1:IF MO%=7 THEN
     MO%=1
2340 VDU31,0,MO%+4,157,132,31,
     19,MO%+4,157,132,31,28,
     MO%+4,157,132
2350 IF MO%=4 THEN
     VDU31,19,MO%+5,157,132,31,28,
     MO%+5,157,132
2360 IF MO%=6 THEN
     VDU31,19,MO%+2,
     32,32,31,28,
     MO%+2,32,32
2370 ENDPROC
2380
2390 DEFPROCstep
2400 CN%=MO%
2410 IF MO%=4 OR MO%=5 THEN
     V1%=PV%(4) ELSE
     V1%=PV%(CN%)
2420 V2%=PV%(5)
2430 IF MO%=1 AND KEY%=136 THEN
     V1%=V1%+SS%
2440 IF MO%=1 AND KEY%=137 THEN
     V1%=V1%-SS%
2450 IF MO%=2 AND KEY%=138 THEN
     V1%=V1%+SS%
2460 IF MO%=2 AND KEY%=139 THEN
     V1%=V1%-SS%
2470 IF MO%=3 AND KEY%=138 THEN
     V1%=V1%-SS%
2480 IF MO%=3 AND KEY%=139 THEN
     V1%=V1%+SS%
2490 IF MO%=4 AND KEY%=138 THEN
     V1%=V1%-SS%:V2%=V2%+SS%
2500 IF MO%=4 AND KEY%=139 THEN
     V1%=V1%+SS%:V2%=V2%-SS%
2510 IF MO%=5 AND KEY%=136 THEN
     V1%=V1%-SS%:V2%=V2%-SS%
2520 IF MO%=5 AND KEY%=137 THEN
     V1%=V1%+SS%:V2%=V2%+SS%
2530 IF MO%=6 AND KEY%=138 THEN
     V1%=V1%+SS%
2540 IF MO%=6 AND KEY%=139 THEN
     V1%=V1%-SS%
2550 IF V1%<0 OR V1%>255 THEN
     ENDPROC
2560 IF V2%<0 OR V2%>255 ENDPROC
2570 IF MO%=5 THEN PV%(4)=V1%
     ELSE PV%(CN%)=V1%
2580 PV%(5)=V2%
2590 PROCstep_disp
2600 ENDPROC
2610
2620 DEFPROCstep_disp
2630 D1$=RIGHT$("    "+STR$(V1%),3)
```

Table 3.1. Shortened version of the program supplied with Alfred.

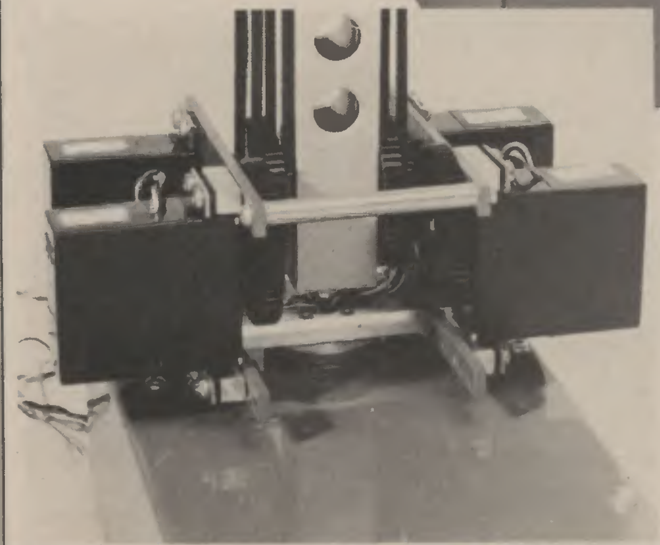
Continued

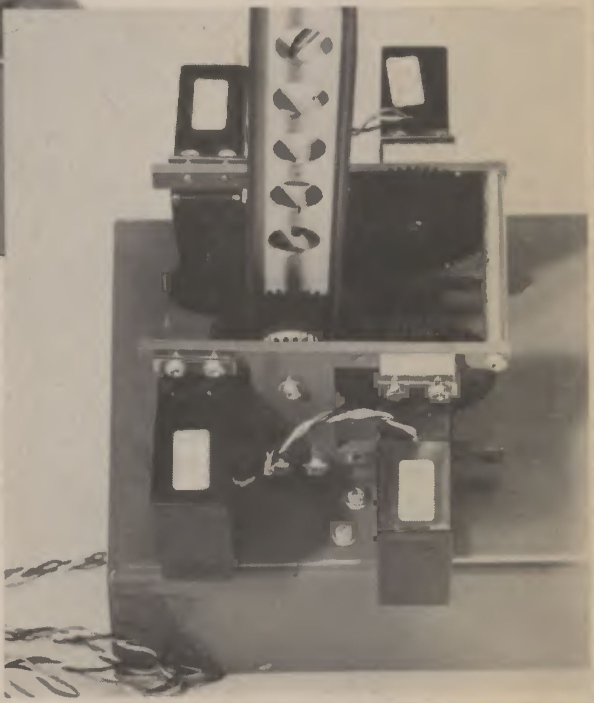
ALFRED CARRIAGE





Various views of Alfred. Above: Frontal view of the carriage and servos. Below: Close-up of the same servos and carriage gearing. Carriage rotate servo is mounted inside the base. Right: Alfred's gripper servo is mounted on the forearm. Top Right: Wrist. Bottom Right: Top view of the Carriage.

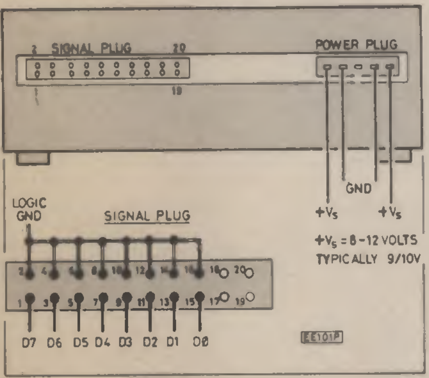




```
2640 IF MO%=5 THEN VDU31,21,8
     ELSE VDU31,21, MO%+4
2650 PRINTD1$
2660 D2$=RIGHT$("  "+STR$(V2%),3)
2670 IF MO%=4 OR MO%=5
     VDU31,21,9:PRINT D2$
2680 PROCdata(CN%,0,PV%(CN%))
2690 IF MO%=4 THEN
     PROCdata(5,0,PV%(5))
2700 IF MO%=5 THEN
     PROCdata(4,0, PV%(4))
2710 ENDPROC
2720
2730 DEFPROCsize
2740 SS%=SS%+1
2750 IF SS%=10 THEN SS%=1
2760 PRINT TAB(10,15);SS%
2770 ENDPROC
2780
2790 DEFPROCcent
2800 CN%=MO%:V1%=128:V2%=128
2810 IF MO%=4 OR MO%=5 THEN
     PV%(4)=V1%:PV%(5)=V2% ELSE
     PV%(CN%)=V1%
2820 PROCstep_disp
2830 ENDPROC
```

See Shop Talk page 18

Fig. 3.2. Alfred's connectors.



NOTE: IC19 is now an 8 × 47k package with Common to +5V. R1 is deleted. Also, on IC8 pin 15 does not now go to 0V but to pin 11 of IC13.

After entering each position number the program will ask you to enter a 'Pause' number (in seconds). It is important to remember that as there is no feedback to the computer to tell it when an axis position has been reached during a run, the pause must be long enough to cover this running time as well as any further wait before moving on to the next instruction.

Once a sequence of positional instructions has been stored the menu may be exited by pressing Return.

The second page to appear on the screen consists of a choice of replay possibilities. This choice is: Single Step and Continuous Movement; and through stopping a replay it is possible to edit functions.

Alfred is a fundamental building block comprising parts which may be used to build other mechanisms including a fun robot. He has two bigger brothers which are capable of lifting 1kg and 3kg objects and therefore capable of being used in light industrial situations.

Individual parts of Alfred are available from RCT, such as servo motors and mechanical parts and the interface board, but it is recommended that procurement of sub-assemblies is adhered to, such as the waist, carriage and upper arm. Alfred's big brothers and expansion systems will be described in *EE* as they become available, probably in early 1985. We hope you have a great deal of fun and reward in pursuing this project, which we expect to be the most cost effective introduction to robotics available to the hobbyist and student. □

MICROPHONE PREAMPLIFIER

BY R.A. PENFOLD

IT IS often necessary to use a microphone with a piece of audio equipment that has a high level input, probably requiring an input signal of around 200 to 900mV r.m.s.

This gives a slight matching problem since the output level of the popular high impedance dynamic and electret microphones (which have a built-in step-up transformer) is typically only a few millivolts r.m.s. or less. In order to obtain usable results it is therefore necessary to use a high gain amplifier between the microphone and the item of audio equipment.

OPERATIONAL AMPLIFIER

This simple design uses a dual BIFET operational amplifier to give the high gain required plus low levels of noise and distortion. The voltage gain of the unit is continuously variable from about 40dB (100 times) to approximately 66dB (2000 times), and this should enable any high impedance dynamic or electret microphone to be matched properly to any high level audio input.

The unit is not recommended for use with low impedance dynamic microphones or with crystal types. The circuit is powered from a 9-volt battery which gives many hours of use as the current consumption is only about 4mA.

CIRCUIT DESCRIPTION

The circuit diagram of the preamplifier appears in Fig. 1. IC1a is used as an input stage having a fixed voltage gain of about 26dB (20 times), while IC1b is the output stage having a voltage gain which is adjustable from about 14dB (5 times) to 40dB (100 times).

IC1a is used as a straightforward inverting amplifier having the non-inverting input biased by R2 and R3. C2 prevents stray feedback to the non-inverting input which would otherwise almost certainly cause instability. R1 and R4 is the negative feedback network which sets the input impedance and voltage gain of the input stage.

What is termed a "virtual earth" is formed at the inverting input due to the stabilising effect the negative feedback has on the voltage. Thus the input impedance is equal to the value of R1, and this gives a figure of 47 kilohms which is ideal for this application. The purpose of C1 is simply to provide d.c. blocking at the input. The voltage gain of the input stage is equal to the value of R4 divided by the value of R1.

VOLTAGE GAIN

The output amplifier uses IC1b in the non-inverting mode and it is direct coupled to the output of IC1a. This gives the required quiescent bias voltage of about half the supply voltage at the non-inverting input of IC1b. The voltage gain of the output amplifier is determined by the negative feedback network which consists of VR1, R5 and R6.

The gain is equal to the sum of these three resistances divided by the sum of VR1 and R5. By adjusting VR1 it is therefore possible to vary the gain of the amplifier, with maximum resistance giving maximum gain. C3 provides d.c. blocking so that there is virtually 100 per cent negative feedback through R6 at d.c. and only about unity voltage gain so that the output of the unit is biased to the required level of about half the supply potential. C4 provides d.c. blocking at the output of the unit.

The integrated circuit used in the prototype is a TL082CP but similar devices such as the LF353 and TL072CP are also suitable; the TL072CP having the lowest noise level.

CASE

With a sensitive piece of audio equipment such as this it is advisable to house the circuitry in a metal case so that it is screened from mains leads and r.f. interference. A diecast aluminium box measuring approximately 120 × 65 × 38mm is used as the housing for the prototype, but any metal box having similar dimensions should be suitable.

Sockets SK1 and SK2 are mounted at opposite ends of the case with S1 positioned next to SK1. The sockets are 3·5mm jacks or any preferred type of audio connector.

COMPONENT BOARD

The components are assembled on a 0·1 inch matrix stripboard which has 10 strips by 24 holes and this is a standard size in which the board is sold. However, it is of course possible to use an offcut trimmed to the right size or to cut a suitable piece from a larger board using a hacksaw.

Fig. 2 shows the component layout and other details of the board and wiring. The two mounting holes in the board are drilled for 6BA clearance (3·2mm diameter). All 14 breaks in the copper strips should be made before soldering the components and link wires into place.

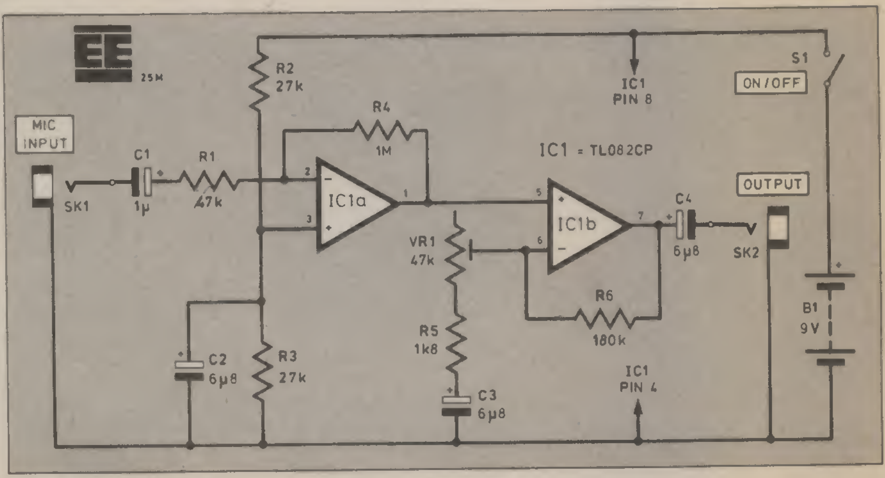


Fig. 1. Circuit diagram of the Microphone Preamplifier.

COMPONENTS approximate cost £6.00

See Shop Talk page 18

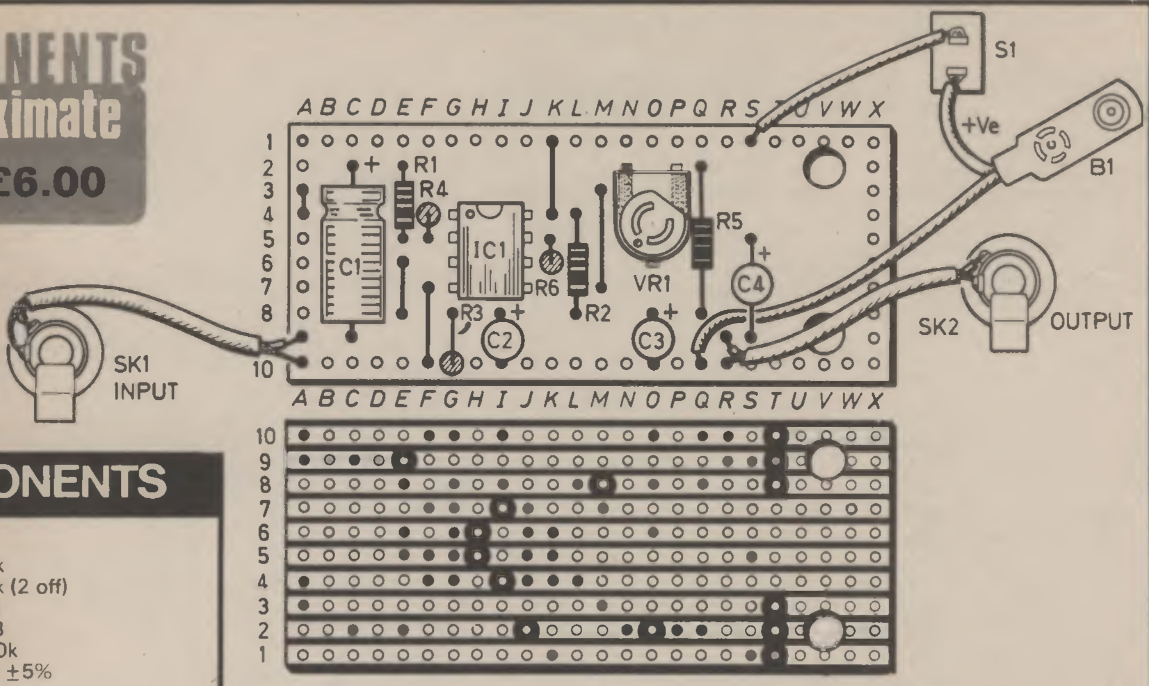


Fig. 2. Stripboard and component layout of the Microphone Preamplifier.

COMPONENTS

Resistors

R1	47k
R2,3	27k (2 off)
R4	1M
R5	1k8
R6	180k

All ⅓W carbon ±5%

Capacitors

C1	1µ 63V elect.
C2,3,4	6µ8 16V tantalum (3 off)

Semiconductors

IC1	TL082CP dual BIFET op-amp

Miscellaneous

VR1	47k miniature horizontal preset
S1	s.p.s.t. miniature toggle
SK1,2	3·5mm jack sockets (2 off)

Aluminium cast housing, 120 × 65 × 38mm; 0·1 inch matrix stripboard, 24 holes × 10 strips; battery connector; connecting wire.

The board is then wired to S1, SK1, SK2, and the battery clip (as shown in the diagram), and it is not necessary to use screened leads to carry the connections from the board to the two sockets. The case provides screening from external signals, and as the input and output of the circuit are out-of-phase, any slight stray feedback between the two will not cause instability.

The component panel is then bolted to the base panel of the case, and spacers are used to ensure that the underside of the board does not short circuit against the metal case. Leave sufficient space for the battery to one side of the board and use foam to keep it in place.

In use the microphone is plugged into SK1 and an ordinary screened audio lead fitted with the appropriate type of plug, is used to couple the output to the mixer or amplifier. VR1 is set for the lowest gain level that gives good results.

A higher level of gain is inadvisable since it could lead to overloading of the unit, although an output signal of up to about 2V r.m.s. can be handled before the onset of clipping and severe distortion. Maximum gain is produced with VR1 set fully clockwise. □

BOOK REVIEWS

THE FIFTH GENERATION

Author	Edward A. Feigenbaum and Pamela McCorduck
Price	£2.95 limp
Size	378 pages
Publisher	Pan Books Ltd.
ISBN	0330 284 703

THE first generation of computers were thermionic, the second were transistorised, the third consisted of integrated circuits, the fourth were super-integrated miniaturised circuits, and the fifth generation deals with Artificial Intelligence and Knowledge Engineering.

When you pause to consider how vast the concept is that these two authors have tackled, you begin to appreciate what a splendid job they have carried out and how engrossed they are in their subject. I have no doubt, that this book will be the first of many covering this aspect of computers, and we should bear in mind that this may prove to be the most important one of all, yet you would find it difficult to find one that gives you a better introduction.

Although I use the word "Introduction", I do not wish to imply that this book in any way gives a superficial account, on the contrary, they deal with the subject in great detail and I feel with authority. One difficulty they are up against is this, many of the results of the fifth generation may not be apparent for one or two decades. While I found it necessary to read this book slowly and carefully, in no way did I find it difficult, and due to Pamela McCorduck's delightful touches of humour, it was also an enjoyable experience.

Edward A. Feigenbaum is Professor of Computer Science at Stamford University. Pamela McCorduck is a New York writer who became interested in Artificial Intelligence in 1960 and has already written books on the subject.

Finally, I strongly recommend this book to everyone who is interested to know which way the computer world is heading, and learning how it will effect our lives. A.S.

PLEASE TAKE NOTE

Doorchime *(Dec. '84)*

On page 760, IC1 is shown the wrong way round on the component layout. Pin one (indicated by black dot) should be in the bottom-right position, not the top-left, as shown.

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FOR YOUR ENTERTAINMENT

BY BARRY FOX

Flight Path

Different airlines have different policies over the use of electronic equipment on board. Almost without exception the cabin crew will stop passengers running a portable TV set. In fact there's not much point in even trying, because it will usually pick up a mish-mash of channels on the same frequency.

The whole theory of u.h.f. TV cover relies on the limited transmission distance of u.h.f. signals so that different stations can operate on the same frequency in different parts of the country. At 35,000 feet you pick them all up!

Airlines don't like radios much either, but will usually now let passengers use tape recorders, personal stereos, calculators and portable computers. Why, you may well ask, should there be any problem? I found out recently, when I had the opportunity to travel on the flight deck of a Boeing 757.

Forget the fiction idea of a distraught passenger trying to land an aircraft after the captain and his co-pilot have both fallen ill. For one thing they eat different food, to avoid the risk of food poisoning. For another modern aircraft, like the 757 and the Trident, fly by computer.

Once the aircraft has taken off it can fly across Europe, land, taxi down the runway and even switch off its own engines, all without any pilot action! Of course, this isn't how flights normally run. The pilots handle a lot of tasks like landing, with the controls. "We do it for practice," one of them told me.

It's also quite clear that they do it because they want to, and to stop getting bored. But the extent of electronic automation now found on the flight deck of a modern airliner is quite extraordinary.

Before taking off, the captain keys the departure and destination into an onboard computer. He also keys in the number of the air-lane route to be taken, rather like a bus route. The computer then displays the flight path on a cathode ray tube (c.r.t.). It shows up as a white line with landmark names, like towns, along the route. The aircraft shows up on the screen as a triangle. The "auto pilot" computer then continually adjusts the direction controls to keep the aircraft on the computer route.

But how does the onboard computer know where it is with relation to the ground? Contrary to public misconception, this need not rely on radio signals from ground beacons or space satellites. On board there are three crossed gyroscopes which continually sense any change of direction and feed an appropriate signal into the computer.

The c.r.t. map is backed with a radar display showing any clouds ahead, with colours geared to the likelihood of a bumpy ride, for instance, red for the most bumpy weather.

This on-board radar is not much use in preventing collisions. Most small aircraft would produce too small a blip on the screen. Collisions are avoided partly by eye, but mainly by ground control which by voice radio warns any aircraft that another is getting too close.

The ground radar system has enough resolution to pick up small aircraft. Also all aircraft are required by law to carry a transponder; that is a transmitter which sends out an identification signal when interrogated by a signal sent out by ground or another aircraft. The one thing the law can't do, however, is ensure that small aircraft with casual pilots switch on their transponders.

There is one type of dangerous weather which the radar cannot show. That is clear air turbulence or CAT. It's invisible, just an up or down draft that bumps the aircraft like mad. CAT is at best a nuisance, because it can throw crew and passengers around the cabin without any warning. This happens a lot over the Pacific. At worst it is dangerous, because the aircraft may fall thousands of feet through an air pocket.

There are now attempts at detecting CAT, by beaming lasers out onto the sky ahead and picking up a return signal caused by the differences in refractive index. But so far it has not proved a reliable technique.

All the other controls on board are now c.r.t. displays, which show engine or oil temperature, brake temperature, air speed and so on. They can be switched out but come back automatically if there is an alarm condition. At the same time an alarm buzzer sounds.

Touch-Down

As the aircraft approaches its British landing strip, it flies into British air traffic control space. The ground controller tells the captain either to go into a holding pattern or fly on into the Instrument Landing System. This is a radio pattern beamed up from the ground which is sensed by onboard equipment to create a spot to the centre of another c.r.t.

When the 'plane is directly on course for landing the spot is dead centre. Air traffic control simply radios up a bearing number, which the pilot keys into another computer. This alters the craft bearing either to put it into a holding pattern or latch onto ILS.

For manual landing the pilot moves the joystick control to keep the spot in the centre of the ILS display c.r.t. and stop it moving sideways or up or down. But the onboard computer could do this equally well. It is a remarkable sight to fly through cloud, with the invisible ground somewhere below and then suddenly break through to see the runway ahead, lined up purely by electronics on-board reading directional beam signals from the ground.

The ban on some electronic equipment is necessary because it generates spurious signals that are close in frequency to those used by the ILS system. In a worst case situation, the pilot could be flying through cloud, lining up the ILS spot with the dial centre and then find the runway not dead ahead after all!

There are a few other questions you might like answered. What happens for instance if the onboard computer crashes? What happens if the c.r.t. displays fail?

There is a small bank of duplicate equipment, with air speed, altitude, gyro, compass and ILS display which are purely mechanical. The altimeter works as a barometer, the air-speed indicator works with a piece of pipe sensing air pressure and the gyro is battery operated. Every six months pilots have to prove on a ground simulator that they can still use the old equipment.

What happens in foreign countries, where English language isn't spoken? How does air traffic control communicate?

Britain and America have exported English as the international language at air traffic control. Every controller must learn to speak enough basic English to bring down an aircraft. But quite often French pilots jabber to their ATC in French, which is confusing for other pilots trying to listen in.

Also, as often happens in obscure African states, the controllers may speak only a very limited vocabulary of English. Any question outside that limited vocabulary isn't understood. So all verbal ATC communication has to be in common jargon.

Cellular Radio

For my sins, I like to have things straight, and for the record. I am not interested in folklore facts that everyone knows to be true, simply because enough people say so. That's the way journalists get sued. And it's no defence.

Recently I have been looking at the coming, next month (Jan '85), of Cellular Radio. That's the technique of dividing a country up into hexagonal cells which re-use the same radio frequencies over and over again, at low power.

The trick is for no cell in a natural cluster of seven, to use the same frequency as any other cell with an adjoining boundary. Several dozen frequencies, around 900MHz in the u.h.f. band, are used in each cell. A mobile and fixed transmitter keep tabs on each other, switching frequencies as the signal strength fades when a mobile moves out of one cell and into another.

In country areas, where radio traffic is light, the cells can be 20 or 30 miles across, because only 20 or 30 people will be using the system at any one time. In cities, where radio traffic is heavy, the cells can be down to less than a mile across.

It's a clever idea, dreamed up by Bell Labs of America in 1947. But at that time the computers necessary to juggle and switch frequencies weren't available. Working systems were put together in the 70's, and a full scale test started in Chicago in 1978.

After a five year trial, the system went commercial, in October 1983. Now Britain is getting a similar system, using the US technology.

In keeping with present Government policy, aimed at stimulating free market competition, two different consortia have been given 25 year licences to run cellular radio in Britain. One is TSCR, Telecom Securicor Cellular Radio Ltd., which as the name implies is a joint venture between British Telecom and Securicor. Their service will be called Cellnet.

The other operator is Racal, which has connections with the US radio firm Millicom. The Racal service will be called

Vodafone. Both services will cost the same, around £20 a week for moderate telephone use. It's clear that the government's enthusiasm for free market competition has actually put the price up. Both consortia have had to install their own network of computers and transmitters, to cover the same area twice over. Also the available frequencies, (600 channels now with 400 available when the rest of Europe decides which system to use) have been split down the middle, with a 17 per cent loss of air space because both services need their own separate switching control channels.

The American experience is that businessmen who have been waiting for a car telephone, or using one on the presently over-crowded v.h.f. spectrum, will jump at the chance of subscribing to cellular radio. This pent up demand is there for the taking by whichever service gets into business first. After that it gets harder to sell the system.

Not surprisingly, therefore, both Cellnet and Vodafone are struggling to get their services up and running at the same time. To date Vodafone has not even demonstrated its system yet, but hope to be ready for tests this month (December). Heaven knows how ready they will be. I also wonder about Cellnet. Here's why.

Cellnet got under way faster than Vodafone, thanks largely to the chance of providing a 3000 sq. km pilot cellular radio service for the Economic Summit Conference held in London in June. The idea was to give all world leaders a mobile phone. But the press demonstration given soon after was a sloppy affair, with the press coach simply driven round a single transmitter tower so that journalists did not have a chance to witness the all-important "hand off". This is the channel switch which takes place when a vehicle moves from one cell to another and the receiver has to change frequencies to pick up another cell's transmitter.

After making myself a thorough nuisance, I was offered the chance for a separate demonstration a week or so later. We drove round London, to check hand off and it worked perfectly well. But in the meantime Cellnet pulled an extraordinary publicity stunt, most uncharacteristic of a business venture incorporating British Telecom.

Hands Off The President

On Thursday, 14 June 1984, *The Times* carried a full page advertisement, showing an enormous picture of President Reagan using Cellnet radio, at the Summit meeting. But had President Reagan really allowed his photograph to be taken, and used in a full page advertisement for a commercial product?

I tried telephoning Cellnet to ask these questions. I couldn't get through on the numbers Cellnet had given me. So I tried British Telecom and they gave me another number for Cellnet. Still no joy. It turned out that Cellnet, part-owned by British Telecom, had changed its telephone numbers. There was no system working to re-direct calls!

Finally, I found a working number for Cellnet and asked my questions. Rather sheepishly, Cellnet admitted that the full page picture of President Reagan, wasn't of President Reagan. It was a male model with Reagan's face grafted on from another photograph!

So did the White House approve? "Our advertising agency got permission from the American Embassy" said Cellnet. I don't believe it, I said, and checked with the American Embassy in Grosvenor Square.

The Embassy checked with the White House, right up to the lawyer who represents the President. "Under no circumstances and in no way do we approve advertisements that use the President's photograph and appear to endorse a product" said Reagan's lawyer. "We have seen the phoney photograph. We weren't asked for permission and wouldn't have given it".

By this time Cellnet had decided to come clean. "Our advertising agency sought legal advice and were told that they did not need to get the President's permission" Cellnet told me, "but knowing that journalists were looking at the story they checked with the Advertising Standards Authority and the ASA checked with the Embassy. In any case there haven't been any formal complaints from the Embassy". I checked with the Embassy but they could recall no approach from the ASA.

I'm laying bets that if President Reagan comes to Britain again and needs cellular radio, it will be Vodafone who get the contract next time, not Cellnet.

FAULT FINDING

E.A.Rule Part 3

CONTINUING with our look at faults found on newly built equipment, we will now take a look at some actual faults found on kits returned for service in the authors workshop. The first of these is an example of how an incorrectly specified component can cause mystifying symptoms. The unit in question was a tuner which covered the Long and Medium wave bands as well as VHF, FM and TV.

The symptoms were that a fault on the TV band only was causing extremely erratic tuning and large jumps in the frequency tuned to. The VHF and AM bands were seemingly OK. Tests showed that tuning on the AM and VHF bands did *appear* normal but the TV stations tended to 'jump' off tune. All circuits were tuned by varicap diodes. As the television RF unit was a sealed-unit it was decided to replace this as a reasonable starting point with a known good unit. The fault remained. We now have a situation where we know that the RF unit was OK, so that the fault must be external to it. This was at first confusing because the only other circuits involved were common to the FM and AM bands and these were found to be OK.

CAREFUL AND DETAILED

It was obvious now that a very careful and detailed check would have to be made and the varicap tuning circuit was a good place to start. The basic circuit used is shown in Fig. 1. The d.c. supply is stabilised by the Zener diode D1 and fixed at approx 30 volts, this then goes to either the pre-set tuning pots or the manual pot.

As the fault appeared on both pre-sets and manual tuning it was felt that these could be ruled out. This left the varicap supply or the circuits leading to the various tuning units. At this stage it was decided to use a signal generator to provide the input signal, at which point it was found that the signal was completely stable.

UNLIKELY

Now to say the least it would be unlikely that the actual TV stations were jumping in frequency but when tuned to local TV, the frequency jumped about and when tuned to the signal generator, it did not. But, we were injecting our generator signal at the low frequency end of the TV band, whereas our local signal is at the high frequency end, was there a clue here? Injecting a signal at the high frequency end produced the jumping in frequency. In other words, the fault only happened at the high frequency end of the TV band. We already know that the RF unit is OK so what could cause a fault to only happen at the high frequency end that was external to the RF unit and yet not effect the low frequency end or the other wave bands?

FURTHER TEST

A further test was made at the high frequency end of the FM band and a jumping in frequency was detected there also, but, nothing like as much. Now the varicap tuning voltage swings from 3 volts to 30 volts to cover each band. The FM band covers 88 to 108 a total of 20MHz which works out at 1·35MHz per volt of tuning. On TV the coverage is from about 440MHz to 900MHz or 460MHz total which works out at 17MHz per volt of tuning. Here was our first clue, a small variation in tuning voltage would have a larger effect on the TV band than on the VHF band, so it seemed we had to look for very small variations in tuning voltage.

Now the TV signals were jumping from the correct tuning position to just outside the IF pass band, or about 200kHz. At a tuning rate of 17MHz per volt, a 0·2MHz jump meant we were looking for a change in tuning voltage of only about 12 millivolts. It was felt that a possible leakage current in one of the decoupling capacitors might be the problem and these were checked out. The reason for the fault turned out to be C1, the 0·01 microfarad capacitor decoupling the varicap feed to the TV tuner. It had only a 12 volt rating and its leakage became excessive as the varicap supply voltage went above this. This was why

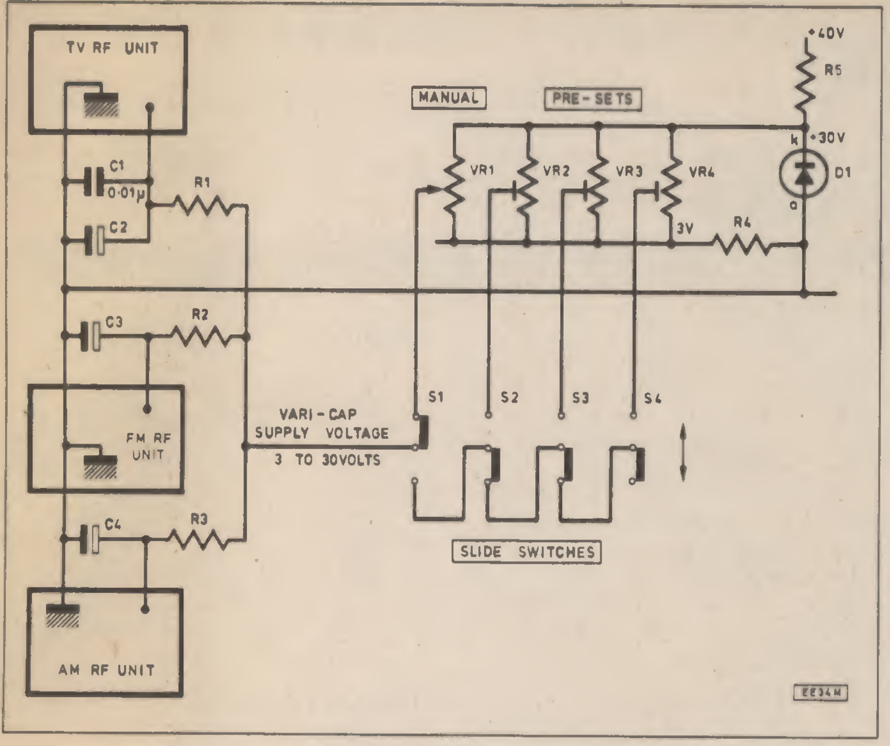


Fig. 1. Basic varicap supply voltage and tuning system.

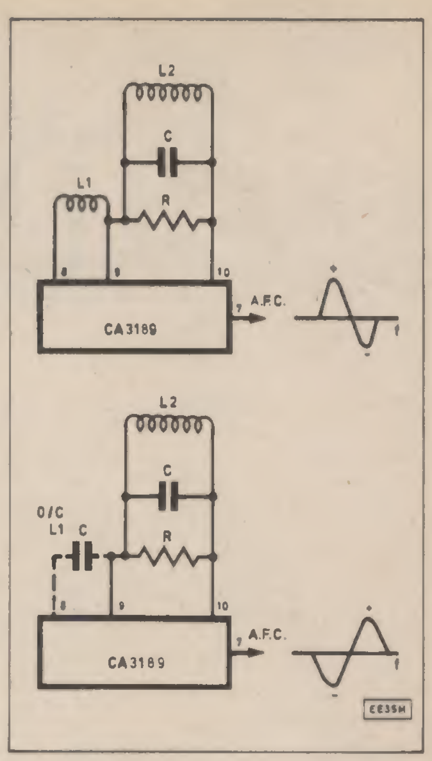


Fig. 2. Capacitive effect with LI o/c.

the tuning behaved normally at the lower frequencies, the voltage across this capacitor then was within its rating. The reason for the fault was simple enough, but over two hours were spent in tracking it down. In the parts-list it simply said 0·01 disc, no mention of working voltage at all. The constructor had ordered 0·01 disc and been sent a 12 volt component. Changing this 0·01 to a 63 volt version completely cured the problem.

CHECK THE RATINGS

The important point about this case is that the clue came when a *careful* check was made, and a similar effect, although less, was found on another waveband. This clue gave positive evidence that the fault was common to all sections. The moral is to check that the voltage ratings of capacitors is *higher* than the maximum voltage expected in a circuit.

MEDIUM WAVE RECEIVER

Now for a less complicated story. This concerns a medium wave only receiver which used a gang capacitor for tuning. This was returned with the complaint that it would not align and that if the slugs in the coils were adjusted at the low frequency end and then the trimmers at the high end (the correct way) it always finished up with the tuning slugs right out of the tops of the coils and the trimmers screwed up tight but without the correct alignment.

The first thing was to return all the trimmers and tuning slugs to their midway positions and then inject 600kHz from a signal generator with the receiver tuned to 600kHz on its scale. The slugs were tuned for maximum signal. Then both generator and receiver were tuned to 1·4MHz and the trimmers adjusted. Using the normal technique of backwards and forwards across the band until no improvement can be found, it was in fact found that the slugs were wound right out and the trimmers screwed up tight, exactly as stated by the constructor.

The fault turned out to be the fact that the tuning gang capacitor was not wired up at all. When the generator was set to 600kHz and supposedly the receiver was tuned to the same frequency, it was in fact tuned to the third harmonic of the generator on 1·8MHz. The generator was then changed to 1·4MHz and the trimmers adjusted, of course the set tuning had not changed due to the unwired gang, no wonder the trimmers had to be screwed tight to bring the tuning down to 1·4MHz!, the slugs then had to be unwound to take them back to 1·8MHz etc.

WORKING BACKWARDS

As stated right at the beginning of this series, the most complicated faults often turn out to be a simple mistake or component failure. Another example of this was found in an FM tuner which used a quadrature detector circuit (Fig. 2). The tuner was fitted with AFC (Automatic Frequency Control) which was working backwards. In other words it was pushing the stations off-tune instead of pulling them into tune. The reason for this was that L1 was open circuit, it was acting as a capacitor instead of an inductance and this reversed the phase of the detected signal (polarity) making the AFC control voltage reversed to normal.

Not an easy fault to locate because the voltage on the i.c. pins is the same at each end of the coil and an open circuit coil makes no change. In this particular instance it was the author's experience which enabled the fault to be found quickly as the same fault has happened several times before. However, finding it for the first time was not so easy and a number of wrong roads were first explored. The original clue came when the detector curve was displayed on an oscilloscope and the reverse phase noted. Another clue was that the detector coil L2 was critical in its tuning whereas it is normally fairly broad.

MAKE NOTES

The clues mentioned above are very important, always note anything that appears to be different to normal, however slight, and consider if it could have a bearing on the problem in hand. Try to work out what could happen in a circuit if various things went wrong, would that same fault affect other circuits and if so what type of result could be expected?

Next month we will look at faults on equipment that has been working satisfactorily to date, and has now failed. The methods covered will assume that the test equipment is limited to a multimeter and a signal generator. Oscilloscope techniques will also be looked at.

CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

MAINS FAILURE EMERGENCY LAMP

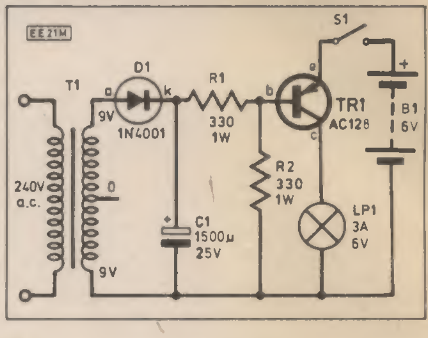
THIS lamp illuminates your room in the event of a power failure. The circuit uses only one transistor and the whole unit is very cheap.

When there is mains power, the current from the transformer is half-wave rectified by D1 and smoothed by C1: The voltage divider resistors, R1 and R2, holds the transistor's base at a greater voltage than its emitter and hence the emitter base junction is reverse biased. So no current flows through the transistor and the lamp.

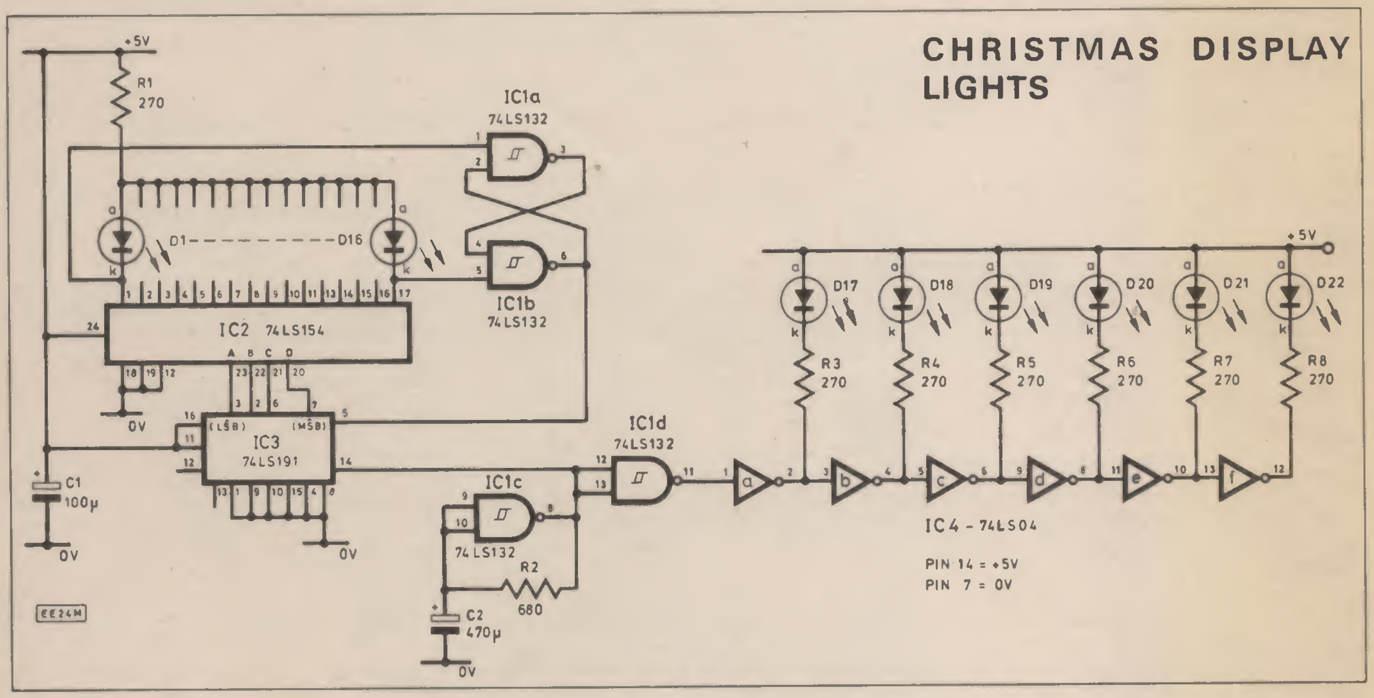
In the event of a power failure, the voltage across the resistor R2 drops and the transistor begins to conduct and the bulb will be illuminated. When the mains power is resumed, the light is again switched off.

Current consumption from the batteries is zero when the mains power is present. The circuit is very useful in situations where a coin operated electricity meter is used.

J. Streekumar,
Cochin, India.



CHRISTMAS DISPLAY LIGHTS



ALTHOUGH Christmas is usually the period when we think of getting out the fairy lights and despite the above title, this project can be put to use at any time, for example, bringing attention to an advertisement.

This circuit offers something a bit different from fairy lights in that the l.e.d.s, D1 to D16, light up one at a time in an "upwards" direction. When D16 is reached the reverse procedure takes place in sequence, down to D1. This pattern is then repeated, at the same time D17 to D22 flash on and off. The oscillator, IC1c, and associated R/C network determine the frequency of operation of all the l.e.d.s.

The oscillator that brings the circuit into motion, consisting of IC1c, R2 and C2, operates in the following manner. C2 will in the first place be uncharged, so when the circuit is switched on the input will be low and the output will be high, current will then flow through R2, and C2 will charge up. When the voltage reaches the upper Schmitt trigger point, pins 9 and 10 will be high and pin 8 will now be low and the capacitor now discharges via R2 till the lower Schmitt trigger point is reached at pins 9 and 10. Now the input will again be low and pin 8 (output) will invert back to the high position. This action then repeats, the frequency of oscillation being just a few hertz, using the C/R network as in the diagram. To alter the frequency to a higher rate, change C2 to a lower capacitance, or higher for a slower rate.

As each l.e.d. in sequence lights up, the voltage on that pin will drop low, so when D16 (pin 17) is reached, pin 17 along with pin 5, IC1b will become low. The output pin 6 will go high along with pin 2, and pin 3 will invert to become low. With pin 6 high, pin 5 of IC3 will also be high by which the count will now be down. When D1 is reached pin 1 along with pin 1 of IC1 will go low.

R1 and R3–R8 are current limiting resistors to prevent the l.e.d.s from overheating, and C1 is the decoupling capacitor that prevents stray spikes from upsetting the proper function of the circuit.

G. A. Hewes,
Syston,
Leics.

CAR BURGLAR ALARM

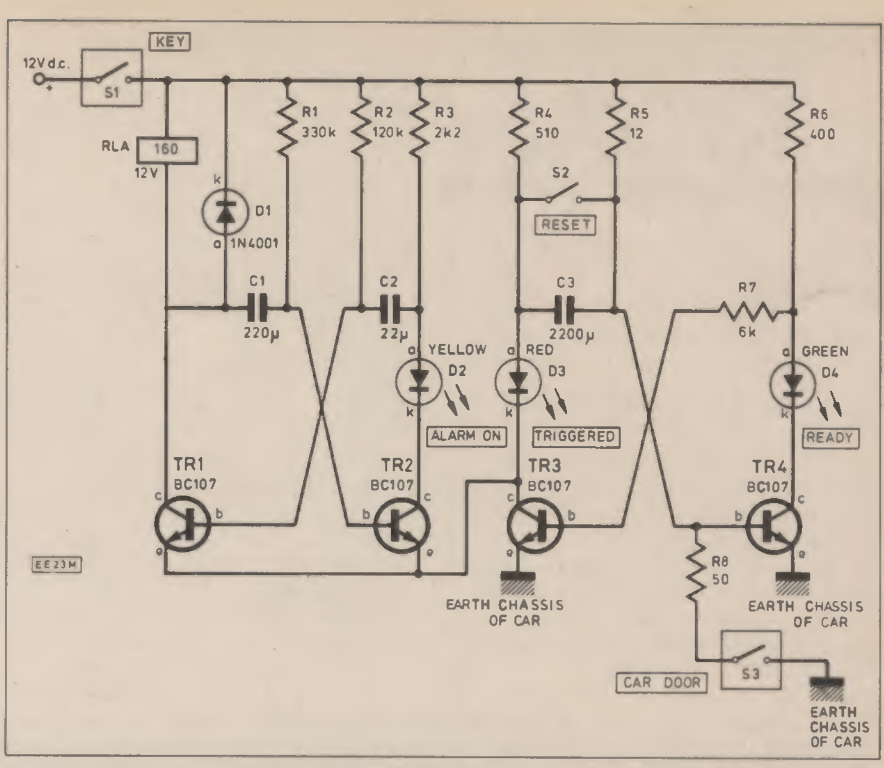
This circuit is designed to pulse a relay on and off, which in turn will sound the horn of a car, when the alarm is triggered. Once a car door has been opened, the alarm will switch for approximately 20 seconds and then stop, even if the car door remains open. This will prevent the battery from going flat.

The circuit is a monostable configuration connected to an astable. The monstable acts as the delay circuit, and the astable controls the alarm switching circuit.

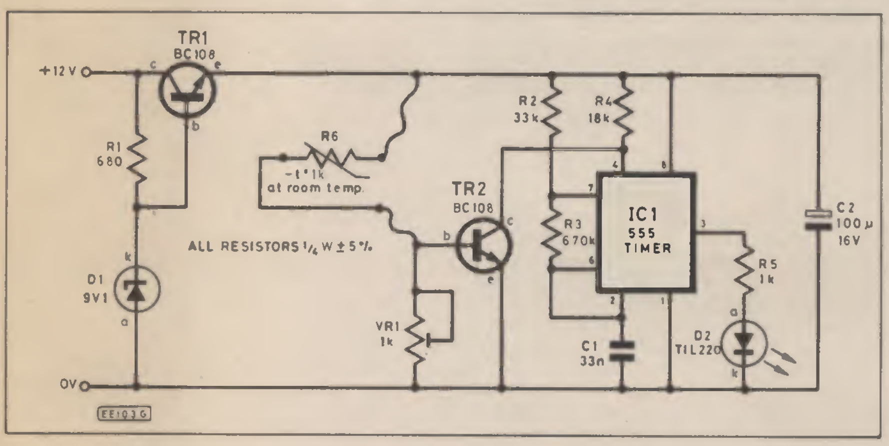
Capacitor C3 controls the time delay, which for the value shown will give a delay of 20 seconds. Before switching the alarm on the reset button should be operated to discharge C3, thus enabling the green l.e.d. D4 to light when the key switch S1 is operated. This will indicate that the alarm is ready, and the doors should now be kept closed.

The display (l.e.d.s) should be mounted in a suitable place on the outside of the car. The green l.e.d. should be near to the door lock to remind you that the alarm is switched on.

S. S. Palin,
Amington,
Staffs.



ICE WARNING FOR CARS



This is a very useful device, especially in the winter, as it gives a visual warning of icy conditions. The unit should be placed at the front of the car in a position best suited for exposure to the elements. When the circuit is built it can be calibrated by placing the thermistor, R6, in a bucket of icy water and the l.e.d. can be made to light by adjusting VR1.

The circuit consists of a 555 timer, IC1, which is prevented from operating because TR1 is normally conducting taking pin 4 low. When the temperature drops sufficiently the resistance of R6 increases causing the voltage on the base of TR2 to decrease which will switch off TR1 thus taking pin 4 high. The 555 which is configured as an astable will flash the l.e.d., D2, until the temperature rises.

Gordon Bamford,
Cleckheaton,
West Yorks.

TTL LOGIC PROBE

This is a simple, yet very useful circuit for checking TTL logic levels. It can distinguish between four conditions; high/low, rapid switching between high and low, or undefined.

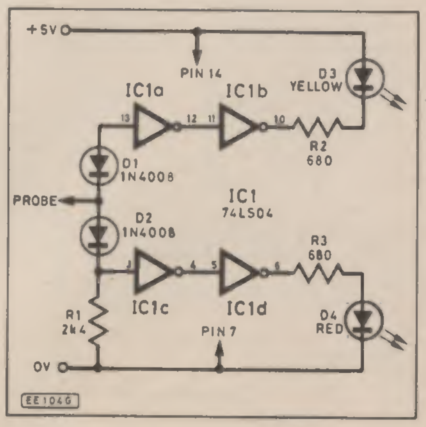
The main component is a 74LS04 hex inverter i.c. Two inverters are used to drive each l.e.d. With the probe not connected, the input to IC1c is held low by R1 so that D4 does not light. Because of the forward voltage drop by D1 and D2 the input to IC1a remains high, so D3 does not light.

When the probe is taken to 0 volts, the input to IC1a is pulled low so D3 lights. If the probe is taken to +5 volts, the input to IC1c is taken high so D4 lights. Where the logic level is switching rapidly from one level to the other, then both l.e.d.s will appear to light.

The circuit can be built on a piece of stripboard 11 strips by 6 holes which is then mounted in the body of a steel nibbed pen, with the nib acting as the probe. The power supply is taken from the circuit under test via two leads fitted with crocodile clips.

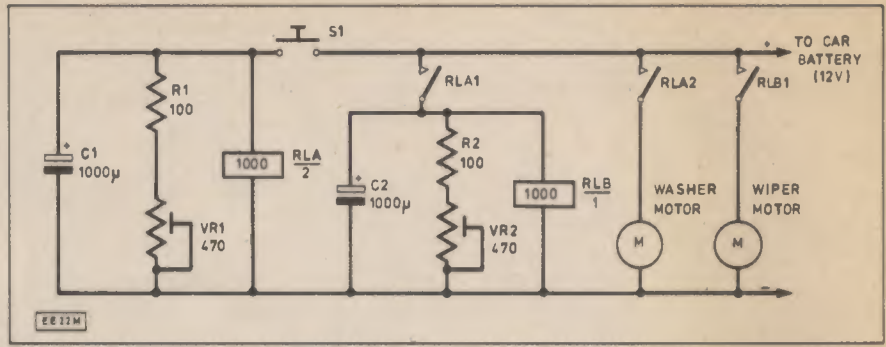
The circuit will work well under most conditions, but because of the low impedance input it may cause problems in some applications. These problems may be overcome by adding an op-amp to the input.

Mark Adams,
Selby,
N. Yorks.



CIRCUIT EXCHANGE

WASH AND WIPE CONTROLLER FOR CARS



For some old cars, operating the windscreen washer and wipers simultaneously while still remaining in perfect control is not easy. The unit described here washes the screen and then wipes it clear, having switched off the washer; all at the touch of a button.

The circuit for the wash and wipe controller is shown above. When S1 is depressed C1 charges up almost instantaneously and the relay contacts close. When S1 is released C1 discharges slowly through the relay, RLA and the resistors R1 and VR1. During this time (variable up to about 10 seconds by the pre-set VR1) the relay RLA is "on" and the washer motor will be in action.

When RLA1 is closed, the capacitor C2 charges and the relay RLB is energised. Hence the wiper motor will also be in action simultaneously with the washer motor. When finally the contacts RLA1 become open and the washer motor ceases working, the relay RLB will still be on because of the stored charge in C2. The charge in C2 leaks through R2 and VR2 and when the voltage in C2 is insufficient, the contacts RLB1 will be open and the wiper motor stops working. The time for which the wiper should work, after the washing operation is over, can be controlled by the pre-set resistance VR2 (up to about 10 seconds).

A convenient position for the switch S1 is on the steering column. The whole unit should be mounted in a dry place away from exhaust fumes and extreme temperatures.

J. Sreekumar,
Cochin, India.

COUNTER INTELLIGENCE

BY PAUL YOUNG

A Moving Story

I recently came across a list of things that should be avoided, as they tend to increase blood pressure. Near the top of the list was one that caught my eye "Moving House". It goes on to say that sufferers from hypertension should avoid it at all costs. I can endorse that. The tension builds up over a period of six to seven months, while you are trying to sell your house and buy another, and reaches its climax when the moving men arrive. When you arrive at "Chez Nous" or "Shangri La" you may be greeted by a crowd of friendly relatives, anxious to help, or in my case it was a swarm of hostile wasps who decided they liked the look of the joint and took possession of the garage roof.

Even the friendly relatives may bring additional problems as they expect to be fed and this is difficult without crocks or cooking utensils. After all this, you spend the next six months trying to find out where you have put everything, having distributed your belongings among twenty tea chests.

What's all this to do with electronics ask our puzzled readers. Nothing, for which please accept my sincere apologies. I have only mentioned it in case you are wondering why Young has not written his usual scintillating article. I am sure you will be understanding. I just hope it arrives in time for the January issue, because just at the moment I am trying to find my typewriter!

Inventing

I can never remember how the well known saying goes. Is it:

"Necessity is the Mother of Invention"? or,
"Mother is the necessity of Invention"?

I rather feel that in an age where anything goes, it must be the former. Unquestionably we all feel the urge to invent from time to time. Who, in his youth, hasn't invented "perpetual motion", usually consisting of an electric motor turning a dynamo and the resulting current driving the motor.

Luckily we grow out of it, without any lasting ill effects. The difficulty is, that electronics offers such a large scope to the would-be inventor that it becomes very tempting to indulge.

Since the would-be inventor is seldom discouraged by anything or anybody I can safely mention some of the pitfalls. To begin with the cost of taking out a provisional patent is quite high unless you can do it yourself. It is possible to do this and the Patent Office and HM Stationery Office would be good places to visit as a preliminary exercise. The big firms are always on the look out for new patents, to see if they can use the idea and get round the patent.

However, I suppose the first question you should ask yourself is, why you are doing it and there could be several answers. The most likely one is that it is something you need for yourself.

It may even be altruistic or more likely along with the rest of us, the idea is to make money. If money is the ultimate aim, then some market research is necessary. It is essential to find out if thousands of people will be queuing up to buy it.

I was amused to read in Arthur Koestler's biography how his father brought home a machine that was going to make the family fortune. It was large, noisy and clattered away interminably and in the end, its sole achievement was to open a few envelopes, and very slowly at that. I need hardly add that it was not a commercial success.

For my money I prefer the simpler inventions. Take for example the invention of Raymond Joseph. You have never heard of him. I am not surprised and yet his invention literally lightened the burden of hundreds of thousands of people. He invented the Super Market Trolley.

Finally, the inventor (and I admit I don't know his name) who will get my accolade, I shall even put up a statue to him when I am Prime Minister, is the man who invented the Electric Blanket.

I have no doubt, by this admission, readers will be able to place me in my correct age group; the younger generation have found more exciting ways of keeping their beds warm.

Computers Blameless!

I see I haven't mentioned computers once, so to finish up with here is a recent experience of mine. Thinking that after 30 years, new carpets to go with the new house might be advisable, we hurried to the nearest carpet shop and made our selection.

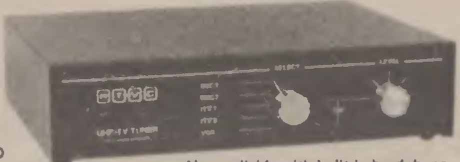
We naturally asked about availability. After a few bouts with her computer, the young lady returned and told us, "Ex-Stock". The house was duly measured and we received an estimate.

Returning to the shop to accept the estimate, we were greeted by another salesman who insisted on re-checking the stock position. He returned with the unwelcome news, "No stock, and no more until next year"!!

The computers had not been regularly updated. Which reaffirms what I have said for years. "A computer is only as good as its programmer".

T.V. SOUND TUNER

SERIES II BUILT AND TESTED Complete with case. £26.50 + £2.00 p&p.



TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your HI-FI is a must for quality reproduction. The unit is mains-operated. This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls.

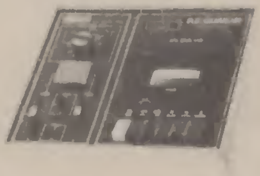
Also available with built-in headphone amp. ONLY £32.50 + £2.00 p&p.

It can also be used in conjunction with your video recorder. Dimensions: 10½"x7½"x2½". E.T.I. kit version of above without chassis, case and hardware £16.20 plus £1.50 p&p.

HI-FI SPEAKER BARGAINS

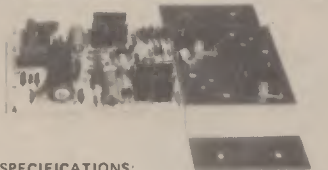
TOKUDEN – 8", 8 ohm full range 7½W twin cone speaker. £3.50 + £1.10 p&p
GOODMANS – 7" 60W Bass/Mid. speaker. 8 ohm impedance. Freq. res.: 40 – 6,000 Hz. 4¼"x½" magnet. £14.95 + £1.75 p&p.
4½" 25W Bass/Mid. speaker. 4 ohm impedance. With rolled surround. £4.95 + £1.50 p&p
Tweeters: 8 ohm soft dome radiator type. (3¾"sq.) For use in systems up to 40 watts. £3.95 ea. + £1 p&p or £6.95 pr. + £1.50 p&p
EAGLE – Full range 8" 20W, 8ohm. Twin cone with rolled surround. £6.95 +£2.20 p&p.
Full range 6½" 15W, 8ohm. Twin cone with rolled surround. £5.95 +£2.20 p&p.
Full range 4"8W, 8 ohm With rolled surround. £4.95 +£1.50 p&p.

PE STEREO CASSETTE RECORDER KIT



Noise Reduction System
Auto Stop Tape Counter Switchable E.Q.
Independent Level Controls Twin V.U. Meter Wow & Flutter 0.1% Record/Playback I.C. with Electronic Switching Fully Variable Recording Bias for Accurate Matching of all Tapes. – Metal, Chrome Dioxide, etc.
Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors capacitors, hardware top cover, printed scale and mains transformer. You only supply solder and hook-up wire.
Featured in April issue P.E. Reprint 50p Free with kit.
£34.50 + £2.75 p&p. Complete with case.

125W HIGH POWER AMP MODULES



The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

Accessories: Stereo mains power supply kit with trans. £10.50 + £2p&p. Mono: £7.50 + £2p&p.

SPECIFICATIONS:
Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4 - 16 ohm. Frequency response measured @ 100 watts: 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%. Dimensions: 205x90 and 190x36mm.

KIT £12.00 +£1.15 p&p. BUILT £17.50 +£1.15 p&p.

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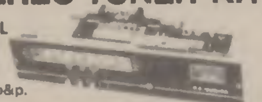

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with PE (July 81) For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System. Front scale size 10½"x 2½" approx. With diagram and instructions.

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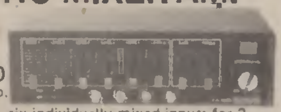

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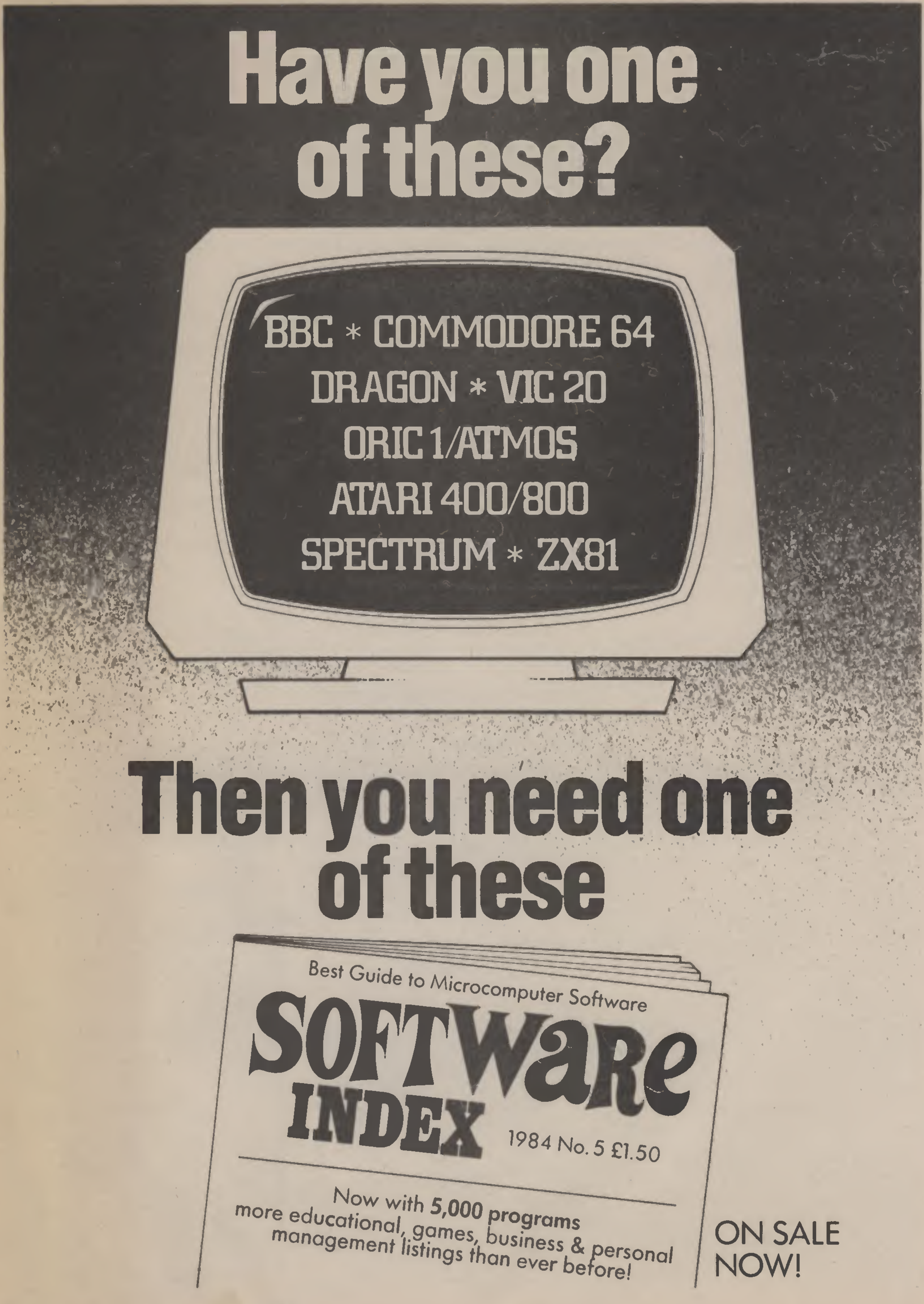
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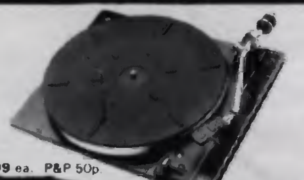

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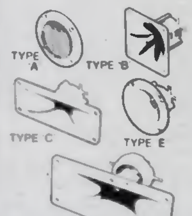
PIEZO ELECTRIC TWEETERS MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 40p P&P.**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.49 each** + 40p P&P.
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.49 each + 40p P&P.**
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £8.99 each** + 40p P&P.
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.49 each + 40p P&P.**
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. **Price £3.99 + 40p P&P.**

PANTEC

HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt) Price: £8.62 + 75p P&P.
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) Price: £13.74 + 75p P&P.
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). Price: £17.82. Transmitter 80 × 50 × 15mm (9/12 volt). Price: £11.27 P&P + 75p each. S.A.E. for complete list.

3 Watt FM Transmitter

STEREO DISCO MIXER

STEREO DISCO MIXER with 7 band graphic equaliser and 10 segment L.E.D. Vu Meters. Many outstanding features.
5 Inputs with individual fader controls:—
2 Mag. turntable, 2 Aux. plus Mic. with talk-over switch. Headphone monitor. Master output control with Hi-Low outputs. Compatible with our OMP Power Amplifiers.
Size: 360 x 200 x 120 mm. Supply 240V/50Hz AC.

PRICE £119.99 + £3.00 P&P

VISA

POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME, SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED.

B. K. ELECTRONICS

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