

Easy to build projects for everyone

# Everyday ELECTRONICS

FEB. 81  
60p

DRIVE UP—LIGHT UP  
WITH OUR  
**CAR-ACTUATED  
DRIVEWAY LIGHT**

**SIMPLE STEREO MIXER  
SIGNAL TRACER  
FOUR BAND RADIO**

# AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

## LINEAR ICs - NUMERIC LISTINGS

TBA1205	1.90	KB4413	1.95
L200	1.00	KB4417	1.80
U237B	1.28	TDA4420	2.25
U247B	1.28	KB4420B	1.09
U257B	1.28	KB4423	2.30
U267B	1.28	KB4424	1.65
LM301H	0.67	KB4431	1.95
LM301N	0.30	KB4432	1.95
LM308H	0.96	KB4433	1.52
LM308N	0.65	KB4436	2.53
LM339N	0.66	KB4437	1.75
LM348N	1.86	KB4438	2.22
LF351N	0.38	KB4441	1.35
LF352N	0.76	KB4445	1.29
LM374N	3.75	KB4446	2.75
LM380N-14	1.00	KB4448	1.65
LM380N-8	1.00	NE5044N	2.26
LM381N	1.81	NE5523N	1.85
ZN419CE	1.95	SD6000	3.75
NE544N	1.80	SL6270	2.03
NE555N	0.30	SL6310	2.03
NE556N	0.50	SL6600	3.75
NE560N	3.50	SL6640	2.75
NE562N	4.05	SL6690	3.20
NE564N	4.29	SL6700	2.35
NE565N	1.00	ICL8038CC	4.50
NE566N	1.60	MSL9362	1.75
NE570N	3.85	MSL9363	1.75
SL624	3.28	HAI1211	1.95
TBA651	1.81	HAI1223	2.15
UA709HC	0.64	HAI1225	1.45
UA709PC	0.36	HAI2002	1.45
UA710HC	0.65	HAI2017	0.80
UA710PC	0.59	HAI2402	1.95
UA741CH	0.66	HAI2411	1.20
UA741CN	0.27	HAI2412	1.55
UA747CN	0.70	LF13741	0.33
UA748CN	0.36	SN76660N	0.80
UA753	2.44		
UA758	2.35		

## FREQUENCY DISPLAY & SYNTHESIZER ICs

TC9A40E	0.75	SAA1056	3.75
TD1028	2.11	SAA1058	3.35
TD1029	2.11	SAA1059	3.35
TD1054	1.45	11C90DC	14.00
TD1062	1.95	LN1232	19.00
TD1072	2.69	LN1242	19.00
TD1074A	5.04	MSL2318	3.84
TD1083	1.95	MSM5223	11.30
TD1090	3.05	MSM5224	11.30
HAI137	1.20	MSM5225	7.85
HAI196	2.00	MSM5226	7.85
HAI197	1.40	MSM5227	9.75
TD1220	1.40	MSM5271	9.75
LM1303	0.99	ICM7106CP	9.55
LM1307	1.55	ICM7107CP	9.55
MCI310P	1.90	ICM7216B	19.25
MCI330	1.20	ICM7217A	9.50
MCI350	1.20	SP8629	3.85
HAI370	1.90	SP8647	6.00
HAI388	2.75	95H90PC	6.00
TD1490	1.86	HDI10551	2.45
MCI496P	1.25	HDI40115	4.45
SL1611P	1.60	HDI2009	6.00
SL1612P	1.60	HD44752	8.00
SL1613P	1.89		
SL1620P	2.17		
SL1621P	2.17		
SL1623P	2.24		
SL624C	1.28		
SL1625P	2.17		
SL1626P	2.44		
SL1630P	1.62		
SL1640P	1.89		
SL1641P	1.89		
TD12002	1.25		
TD12020	3.00		
U1A2242A	3.05		
U1A2283B	1.00		
CA3080E	0.70		
CA3089E	1.84		
CA3090AQ	3.35		
CA3123E	1.40		
CA3130E	0.80		
CA3130T	0.90		
CA3140E	0.46		
CA3189E	2.20		
MC3357P	2.35		
LM3900N	0.60		
LM3909N	0.68		
LM3914N	2.80		
LM3915N	2.80		
KB4400	0.80		
KB4406	0.60		
KB4412	1.95		

## CMOS 4000 SERIES

4001	0.17	4075	0.20
4000	0.17	4076	0.90
4002	0.23	4077	0.20
4008	0.80	4078	0.20
4009	0.58	4082	0.20
4010B	0.58	4093	0.78
4011AE	0.20	4175	0.95
4011B	0.20	4503	0.69
4012	0.55	4506	0.51
4013	0.55	4510	0.99
4015	0.95	4511	1.49
4016	0.52	4512	0.98
4017	0.80	4514	2.55
4019	0.60	4518	1.03
4020B	0.93	4520	1.09
4021	0.82	4521	2.36
4022	0.90	4522	1.49
4023	1.17	4529	1.41
4024	0.76	4539	1.10
4025	0.17	4549	3.50
4026	1.80	4554	1.53
4028	0.72	4560	2.18
4029	1.00	4566	1.59
4030	0.58	4568	2.18
4035	1.20	4569	3.03
4040	0.83	4572	0.30
4042	0.85	4585	1.10

## TTL N and LSN

7400N	0.13	7444N	1.12	74LS112	0.38	74LS169	2.00
74LS00	0.20	7445N	0.94	74LS113	0.38	74LS170	2.30
7401N	0.13	7446N	0.94	74LS114	0.38	74LS171	2.20
74LS01	0.20	7448N	0.56	74LS118	0.83	74LS174	1.20
7402N	0.14	74LS48	0.99	74LS120	1.15	74LS175N	1.10
74LS02	0.20	74LS49	0.99	74LS121N	0.42	74LS175	1.10
7403N	0.14	7451N	0.17	74LS122N	0.46	74LS176N	0.75
74LS03	0.20	74LS51	0.24	74LS124	1.73	74LS177N	0.78
7404N	0.14	7453N	0.17	74LS125	0.44	74LS181N	1.65
74LS04	0.24	7454N	0.17	74LS126N	0.57	74LS181	3.50
7405N	0.18	74LS54	0.24	74LS126	0.44	74LS183	2.10
74LS05	0.26	74LS55	0.24	74LS128N	0.74	74LS190	0.92
7406N	0.28	7460N	0.17	74LS132N	0.73	74LS192	1.05
7407N	0.38	74LS63	1.24	74LS132	0.78	74LS192	1.80
7408N	0.17	7470N	0.28	74LS136	0.40	74LS193	1.05
74LS08	0.24	7472N	0.28	74LS138	0.60	74LS193	1.80
7409N	0.17	7473N	0.32	74LS141N	0.56	74LS194N	1.05
74LS09	0.24	74LS73	0.38	74LS142N	2.65	74LS196N	0.99
7410N	0.15	7474N	0.27	74LS143N	3.12	74LS197	1.10
74LS10	0.24	74LS74	0.28	74LS144N	3.12	74LS198	1.50
7411N	0.20	7475N	0.38	74LS145	0.97	74LS199	1.60
74LS11	0.24	7476N	0.37	74LS145N	1.75	74LS247	0.93
7412N	0.17	74LS76	0.38	74LS147N	1.05	74LS257	1.08
7413N	0.30	74LS78	0.38	74LS148N	1.19	74LS260	1.53
7414N	0.51	7480N	0.46	74LS150N	0.99	74LS270	0.52
74LS15	0.24	7481N	0.88	74LS151	0.55	74LS283	1.20
7416N	0.30	7482N	0.69	74LS151	0.84	74LS293	0.95
7417N	0.30	7483N	1.04	74LS153	0.64	74LS365	0.49
7420N	0.16	74LS85	0.99	74LS153	0.54	74LS366	0.49
74LS20	0.24	74LS86	0.40	74LS154N	0.96	74LS367	0.43
74LS21	0.24	7489N	2.05	74LS155	0.54	74LS368	0.49
7423N	0.27	74LS90	0.90	74LS155	1.10	74LS374	1.80
7425N	0.27	7491N	0.76	74LS156N	0.80	74LS377	1.95
7427N	0.27	74LS91	1.10	74LS157	0.55	74LS379	1.30
74LS27	0.44	7492N	2.38	74LS158	0.60	74LS393	1.40
7428N	0.35	74LS92	0.78	74LS159	2.12		
74LS28	0.32	7493N	0.32	74LS160N	0.80		
7430N	0.17	74LS93	0.99	74LS160	1.30		
74LS30	0.24	7494N	0.78	74LS161N	0.92		
7432N	0.25	7495N	0.65	74LS161	0.78		
74LS32	0.24	74LS95	1.15	74LS162	1.30		
7437N	0.40	7496N	0.58	74LS163	0.92		
7438N	0.33	74LS96	1.20	74LS164	1.04		
74LS38	0.24	7497N	1.85	74LS164N	1.04		
7440N	0.17	74LS107	0.38	74LS164	1.30		
74LS40	0.24	74LS109	0.63	74LS165N	1.05		
7441N	0.74	74LS109	0.70	74LS165	1.04		
7442N	0.70	74110N	0.54	74LS167N	2.50		
74LS42	0.99	74111N	0.68				

## VOLTAGE REGULATORS

4043	0.85	78series	0.95
4044	0.80	79series	1.00
4046	1.30	78series	0.65
4047	0.99	78series	0.35
4049	0.52	79series	0.85
4050	0.55	79series	1.75
4051	0.65	79series	1.75
4052	0.65	79series	1.75
4053	0.65	79series	1.75
4056	1.09	79series	1.75
4066	0.56	79series	1.75
4068	0.25	79series	1.75
4069	0.20	79series	1.75
4070	0.20	79series	1.75
4071	0.20	79series	1.75
4072	0.20	79series	1.75
4073	0.20	79series	1.75

## MICROMARKET

8080A/2	7.50	6800P	7.50
8212	2.30	6810	5.95
8214	3.50	6820	7.45
8216	1.95	6850	4.00
8224	3.50	6852	4.85
8251	6.25		
8255	5.40		
MC2708	7.50		
2114	6.50		
4027	5.78		
2102	1.70		
2112	3.40		
2513	7.54		
HM4716	4.50		
81LS97	1.25		

## CRYSTAL FILTER PRODUCTS

10.7MHZ 2 POLE TYPES:	
10M15A 15KHZ BW	2.49
10.7MHZ 8 POLE TYPES:	
10M4B1 15KHZ BW	14.50
H4402 7.5KHZ BW	15.50
10M22D 2.4KHZ SSB	17.20
HF FIRST FILTER:	
B34FB4 34.5MHz HF	32.00

## RADIO CONTROL CRYSTALS

AM TX:-	
3rd OT 30pf HC25U	1.65
AM/FM RX:-	
3rd OT 30pf HC25U	1.65
FM TX:-	
Fund 20pf HC25U	1.85
Pairs FM	3.25
Pairs AM	3.10

## CRYSTALS

32.768 kHz	2.70
100KHZ	3.85
455KHZ	5.00
1.0MHz	3.00
3.2768MHz	2.70
4.000MHz	2.00
4.19439MHz	2.30
6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

## TOKO COILS AND FILTERS

SEE THE EXTENSIVE SECTION IN OUR NEW PRICE LISTS AND CATALOGUE

## LF/HF FIXED INDUCTORS

-FULL E12 RANGE	
7BA series LuH-LmH	0.16
8RB series	
100uH-3mH	0.19
10RB series	
3mH-120mH	0.33
10RBH series	
120mH-1.5H	0.55

## PIEZO SOUNDER

PB2720	0.44
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## LEDs

5MM RED	0.12
3MM RED CLEAR	0.15

# WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND  
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

**ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O. OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 40p TO ALL ORDERS UNDER £10.00. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. (ACCESS orders by telephone welcome).**

**VAT** Export orders no V.A.T. Applicable to U.K. Customers only. Unless stated otherwise all prices are exclusive of V.A.T. Please add 15% to total cost including P & P.

**We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday 9.00 am-6.00 pm. Ampie Free Car Parking space available.**

**POLYESTER CAPACITORS:** Axial Lead type (Values are in  $\mu F$ )  
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1 $\mu F$  68p; 2 $\mu F$  82p; 4 $\mu F$  85p.  
160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n 38p; 1 $\mu F$  42p; 1 $\mu 5$  45p; 2 $\mu 2$  48p; 4 $\mu 7$  58p.

**POLYESTER RADIAL LEAD CAPACITORS (250V)**  
10nF, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 17p; 680n 19p; 1 $\mu F$  23p; 1 $\mu 5$  23p; 2 $\mu 2$  46p.

We stock most of the parts for projects in this magazine.

**ELECTROLYTIC CAPACITORS:** (Values are in  $\mu F$ ) 500V: 10 52p; 47 78p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 3.3 8p; 4.7 9p; 6.8, 10 10p; 15, 22 12p; 33 15p; 47 16p; 100 19p; 1000 25V: 1.0, 5, 6, 8, 10, 22 8p; 33 9p; 47 9p; 100 11p; 150 12p; 220 15p; 330 22p; 470 25n; 680, 1000 34p; 2200 50p; 3300 70p; 4700 92p. 16V: 40, 47, 100 9p; 125 12p; 220 13p; 470 20p; 680 34p; 1000 27p; 1500 31p; 2200 36p; 3300 44p; 4700 79p.

**TAG-END TYPE:** 450V: 100 $\mu F$  65p; 70V: 4700 $\mu$  245p; 64V: 3300 198p; 2200 139p; 50V: 3300 154p; 2200 110p; 40V: 4700 $\mu$  160p; 25V: 4000 92p; 3300 98p; 2500, 2200 90p; 1500 345p

**TANTALUM Bead Capacitors:**  
35V: 0.1 $\mu$ , 0.2 $\mu$ , 0.33 15p; 0.47, 0.58, 1.0, 1.5 16p; 2.2, 3.3 18p; 4.7, 6.8 22p; 10 28p; 16V: 2.2, 3.3 16p; 4.7, 6.8, 10 18p; 15 26p; 22 30p; 33, 47 40p; 100 75p; 10V: 1.5, 22 26p; 33, 47 30p; 100 55p.

**MYLAR Film Capacitors:**  
100V: 1nF, 2n, 4n, 4n7, 10n 6p; 15nF, 22n, 30n, 40n, 47 7p; 56, 100n, 200 9p; 470n/50V 12p.

**MINIATURE TYPE TRIMMERS**  
4.5pF, 2-10pF 22p; 2-25pF, 5-65pF 30p; 10-88pF 35p.

**COMPRESSION TRIMMERS**  
3-40pF, 10-80pF 20p; 20-250pF 28p; 100-580pF 39p; 400-1250pF 48p.

**POLYSTYRENE CAPACITORS**  
100F to 1nF 8p; 1.5nF to 12nF 10p.  
SILVER MICA: 2pF, 3.3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 75, 82, 85, 100, 120, 150, 180 15p; 200, 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 21p; 1000, 1200, 1800, 2000 30p; 3300, 4700 60p.

**CERAMIC CAPACITORS:** 50V  
0.5pF to 10nF 4p; 22n to 100n 7p.

**EURO SREABOARD £5.20.**

**VOLTAGE REGULATORS\***  
1A TO3 +ve -ve  
5V 7805 145p 7905 220p  
12V 7812 145p 7912 220p  
15V 7815 145p 7915 220p  
18V 7818 145p

**TO220 Plastic Casing**  
1A 7805 80p 7905 85p  
12V 7812 80p 7912 85p  
15V 7815 80p 7915 85p  
18V 7818 80p 7918 85p  
24V 7824 80p 7924 85p

**TO92 Plastic Casing**  
5V 78L05 30p 79L05 65p  
6V 78L02 30p  
8V 78L02 30p  
12V 78L12 30p 79L12 65p  
15V 78L15 30p 79L15 65p

CA3085 95 LM326N 240 78H05+5V/5A 595  
LM300H 170 LM327N 270 78G5.4 +5V 600  
LM3085H 140 LM723 30 78G5.4 +5V 600  
LM309K 135 TAAS50 50 to +25V 800  
LM317K 350 TBA825B 95 79HG 5A -2.25 250  
LM323K 625 TDA1412 150 to -24V 850p

**JACKSONS VARIABLE CAPACITORS**  
Dillon  
100/500pF 195p slow motion  
500pF Drive 450p  
1 1/2 Ball Drive 00 208/176 395p  
4511/DAF 145p 1/2" with slow motion drive 450p  
Dial Drive 4103 208/176 395p  
61/361 1 775p 25.50 pF 278p  
Drum 54mm 525p 100, 150pF 352p  
01-365pF 395p 'L' 3 x 310pF 725p  
00 2 365pF 395p 00-3 x 25pF 550p

**DENCO COILS** RDT2 120p  
"DP" VALVE TYPE RFC7 (10mH) 133p  
Range 1 to 5 Bl. RFC7 (10mH) 133p  
Rd., V. Wht. 106p IFT 13; 14; 15;  
6-Y.B.Y.R. 95p 16; 17; 105p  
1.5 Green 130p IFT 18/16 6 120p  
"T" 1 to 5 Bl., Y.L., IFT 18/465 135p  
Rd., Wht. 130p TOC 105p  
B9A Valve 10p MW/SFR 105p  
3p MW/LW/SFR 136p

**VEROBOARDS 1"**  
2 1/2 x 3 1/2" clad plate 47p  
2 1/2 x 5" 96p 47p  
3 1/2 x 5" 75p  
3 1/2 x 3 1/2" 75p  
3 1/2 x 5" 86p 72p  
3 1/2 x 1 1/2" 296p 192p  
4 1/2 x 1 1/2" 387p  
Pkt. of 36 pins 20p  
Spot Face Cutter 107p  
Pin Insertion Tool 147p

**POTENTIOMETERS (ROTARY)**  
Carbon Track, 0-25W Log & 0-5W Linear Value.  
500 $\Omega$ , 1K & 2K (Lin. only) Single 29p  
5K-2 M $\Omega$  single gang 28p  
5K-2 M $\Omega$  single with DP switch 89p  
5K-2 M $\Omega$  double gang 89p

**SLIDER POTENTIOMETER**  
0-25W log and linear values 60mm  
5K $\Omega$ -500K $\Omega$  single gang 70p  
10K $\Omega$ -500K $\Omega$  dual gang 110p  
Self Stick Graduated Bezels 36p

**PRESET POTENTIOMETERS**  
Vertical & Horizontal  
0-1W 50 $\Omega$ -50 $\Omega$  Miniature 7p  
0-25W 100 $\Omega$ -3.3M $\Omega$  Horiz 10p  
0-25W 200 $\Omega$ -4.7M $\Omega$  Vert 10p

**RESISTORS:** Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.  
Range Val. 1-99 100+  
1W 202-4M7 E12 2p 1p  
1W 202-4M7 E24 2p 1p  
1W 202-10M E12 5p 4p  
2% Metal Film 10 $\Omega$ -1M 5p 4p  
1% Metal Film 50 $\Omega$ -1M 8p 6p  
10% price applies to Resistors of each value not mixed.

TGS 812 or 813 gas and smoke detector 415p. Socket for above 30p.

**SLIDE 250V:**  
1A DPDT 14p  
1A DP C/off. 19p  
1A DPDT 13p  
4 pole c/over 24p  
**PUSH BUTTON**  
Latching or Momentary.  
SPST C/Over 99p  
DPDT C/Over 145p

**SWITCHES Miniature Non-Blocking**  
Push to Make 15p Push to Break 20p  
**ROCKER:** SPST on/off 10A 250V 28p  
**ROCKER:** Illuminated DPST  
Lights when on: 10A 240V 85p  
**ROTARY:** (ADJUSTABLE STOP) 1 pole/  
2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. 45p  
**ROTARY:** Mains 250V AC, 4 Amp 95p

**DIL SOCKETS (Low Profile - Texas)**  
8 pin 10p; 14 pin 10p; 16 pin 10p; 18 pin 43p;  
20 pin 22p; 24 pin 30p; 28 pin 35p; 40 pin 40p.

**DIODES**  
A1A129 22 Range 2V7 to 1A/100V 42p  
BA100 15 1A/100V 40mW 39V 8p each  
BY128 12 Range 3V3 to 33V. 1-3W 8p each  
BY127 12  
CRO33 250  
OA9 40 19p each  
OA47 12  
OA70 12  
OA78 18  
OA81 18  
OA85 15  
OA90 8  
OA91 8  
OA98 8  
OA200 8  
OA202 8  
IN914 4 1A/100V 82  
IN916 5 1A/200V 25  
IN4001/2 5 1A/400V 29  
IN4003 6 1A/600V 34  
IN4004/5 6 2A/50V 38  
IN4006/7 7 2A/200V 40  
IN4148 4 2A/400V 46  
IS44 9 2A/600V 95  
3A/100V 18 6A/100V 83  
3A/400V 17 6A/400V 95  
3A/1000V 30 10A/200V 215  
10A/600V 315 12A/200V 83  
25A/200V 215p 12A/200V 83  
25A/600V 395 16A/100V 105  
BY164 36 25A/400V 185  
VM18 DIL 55

**NOISE**  
Z5J 180

**BRIDGE RECTIFIERS**  
1A (plastic case)  
1A/100V 29  
1A/100V 82  
1A/200V 25  
1A/400V 29  
1A/600V 34  
2A/50V 38  
2A/200V 40  
2A/400V 46  
2A/600V 95

**TRIACS**  
3A/100V 48  
3A/400V 50  
8A/100V 60  
8A/400V 60  
8A/600V 95  
8A/800V 115  
12A/100V 78  
12A/200V 83  
12A/400V 83  
12A/600V 135  
16A/100V 105  
16A/400V 105  
16A/600V 185  
25A/400V 185  
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T28000D 120

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4 Digit 750p  
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TOGGLE 2A 250V  
SPST 33p  
DPDT 44p  
**SUB-MIN TOGGLE**  
SP changeover 88p  
SPST on/off 44p  
DPDT 6 tige 75p  
DPDT C/Over 88p  
DPDT Blased 145p

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AC126 25 BC184 10 BF196 12 MPF106 36 TIP295 60 2N2369A 17  
AC127 25 BC182L 10 BF197 12 MP5A05 25 TIP305 60 2N2646 48  
AC128 25 BC183L 10 BF198 16 MP5A06 25 TIS43 32 2N2904 28  
AC129 25 BC184L 10 BF199 18 MP5A10 32 TIS44 45 2N2905A 26  
AC130 25 BC185 10 BF200 18 MP5A11 32 TIS45 45 2N2906 28  
AC131 25 BC186 10 BF201 22 MP5A12 32 TIS46 50 2N2907A 26  
AC132 25 BC187 10 BF202 24 MP5A13 32 TIS47 50 2N2908 28  
AC133 25 BC188 10 BF203 24 MP5A14 32 TIS48 50 2N2909 26  
AC134 25 BC189 10 BF204 24 MP5A15 32 TIS49 50 2N2910 26  
AC135 25 BC190 10 BF205 24 MP5A16 32 TIS50 32 2N3053 26  
AC136 25 BC191 10 BF206 24 MP5A17 32 TIS51 32 2N3054 26  
AC137 25 BC192 10 BF207 24 MP5A18 32 TIS52 32 2N3055 26  
AC138 25 BC193 10 BF208 24 MP5A19 32 TIS53 32 2N3056 26  
AC139 25 BC194 10 BF209 24 MP5A20 32 TIS54 32 2N3057 26  
AC140 25 BC195 10 BF210 24 MP5A21 32 TIS55 32 2N3058 26  
AC141 25 BC196 10 BF211 24 MP5A22 32 TIS56 32 2N3059 26  
AC142 30 BC197 10 BF212 24 MP5A23 32 TIS57 32 2N3060 26  
AC143 30 BC198 10 BF213 24 MP5A24 32 TIS58 32 2N3061 26  
AC144 30 BC199 10 BF214 24 MP5A25 32 TIS59 32 2N3062 26  
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AC160 30 BC215 10 BF230 24 MP5A41 32 TIS75 32 2N3078 26  
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AC199 30 BC254 10 BF269 24 MP5A80 32 TIS114 32 2N3117 26  
AC200 30 BC255 10 BF270 24 MP5A81 32 TIS115 32 2N3118 26  
AC201 30 BC256 10 BF271 24 MP5A82 32 TIS116 32 2N3119 26  
AC202 30 BC257 10 BF272 24 MP5A83 32 TIS117 32 2N3120 26  
AC203 30 BC258 10 BF273 24 MP5A84 32 TIS118 32 2N3121 26  
AC204 30 BC259 10 BF274 24 MP5A85 32 TIS119 32 2N3122 26  
AC205 30 BC260 10 BF275 24 MP5A86 32 TIS120 32 2N3123 26  
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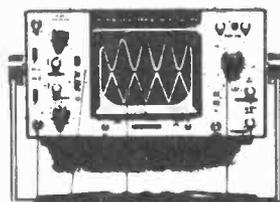
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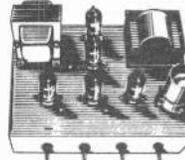
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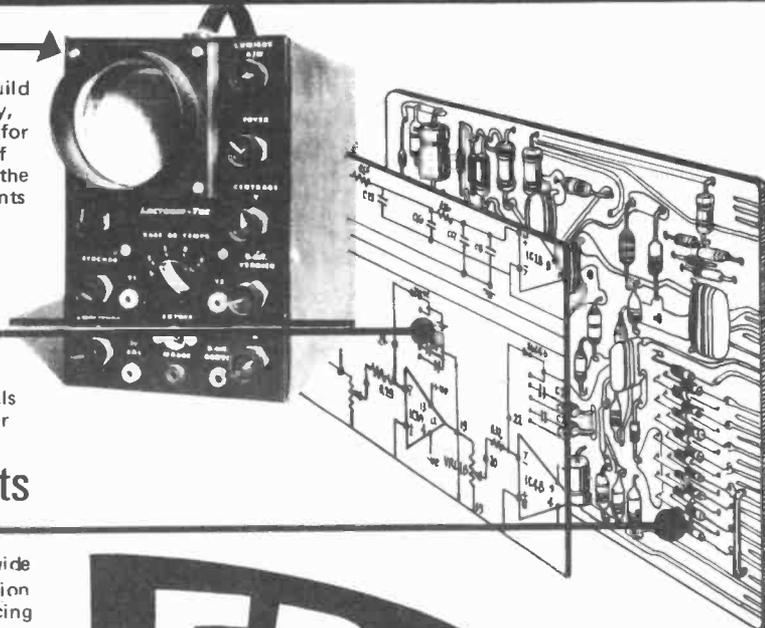
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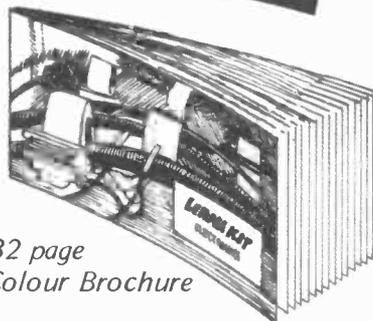
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32 page  
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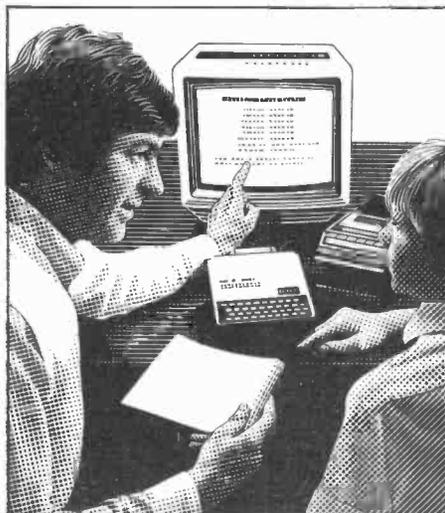
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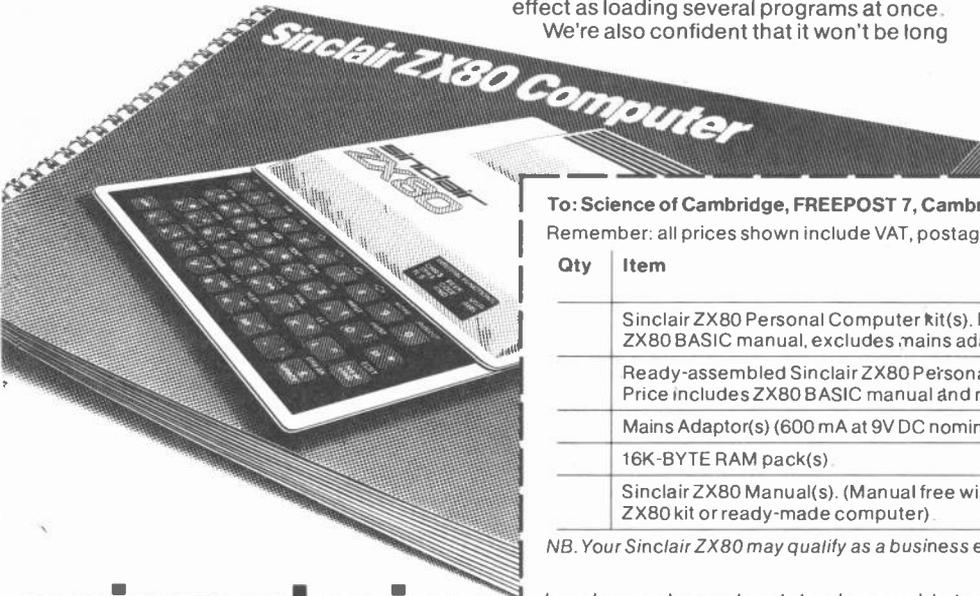
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before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines – and brush up your chess perhaps!

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Gives a brilliant display—psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase-patterns and a strobe effect. Total output power 750 watts per channel. Complete kit. Price £16. Ready made up £4 extra.

**FISH BITE INDICATOR** enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeakers emit a shrill note. Kit. Price £24-90.

### 6 WAVEBAND SHORTWAVE RADIO KIT

Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit. Includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones. Price £11-85.

### SHORT WAVE CRYSTAL RADIO

All the parts to make up the beginner's model. Price £2-30. Crystal earpiece 85p. High resistance headphones (give best results) £3-75. Kit includes chassis and front but not case.

### RADIO STETHOSCOPE

Easy to fault find—start at the aerial and work towards the speaker—when signal stops you have found the fault. Complete kit £4-95.

### INTERRUPTED BEAM KIT

This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components—relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2-30.

**OUR CAR STARTER AND CHARGER KIT** has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11-50 + £2-50 post.

**G.P.O. HIGH GAIN AMP/SIGNAL TRACER.** In case measuring only 5 1/2 in x 3 1/2 in x 1 1/2 in is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4 1/2 battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1-85. Suitable 80 ohm earpiece 69p.

### VU METER

Edgewise mounting, through hole size 1 1/2" x 1" approx. These are 100 micro amp f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price £2-89p.

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Edgewise mounting 100 UA centre zero. Price £2-30p.

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Made for an expensive Hi-Fi outfit—will suit any decor. Resonance free cut-outs for 8" woofer and 4" tweeter. The front material is carved Dacron, which is thick and does not need to be stuck in and the completed unit is most pleasing. Colour black. Supplied in pairs, price £6-90 per pair (this is probably less than the original cost of one cabinet) carriage £3 the pair.



### CHASSIS BARGAIN

3 wave band radio with stereo amplifier. Made for incorporation in a high-class radiogram, this has a quality of output which cannot be described as superb. It is truly hi-fi. The chassis size is approximately 14". Push buttons select long, medium, short and gram. Control are balance, volume, treble and bass. Mains power supply. The output is 6 + 6 watts. Brand new and in perfect working order, offered at less than value of stereo amp alone, namely £8-90. Post £2-00.



### MULLARD UNILEX

A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £18 including V.A.T. and postage. FREE GIFT—Buy this month and you will receive a pair of Goodman's elliptical 8" x 5" speakers to match this amplifier.



## THIS MONTH'S SNIP

**THERMOSTAT ASSORTMENT** 10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc. or when fitted say in front of the element of a boiler heater, the heat would trip the stat if the boiler fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0-100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats would cost round about £15-60—however, you can have the parcel for £2-50.

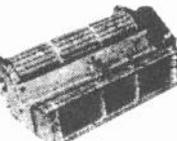
### WALL MOUNTING THERMOSTAT.

Danfoss, a handsome 2 tone, this is intended for living rooms but is just as efficient in a greenhouse or store. It is suitable for normal air temperature range 32F-80F—price £4-60.

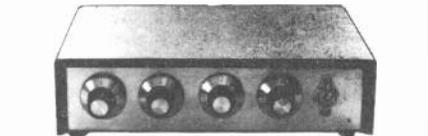


### TANGENTIAL HEATER UNIT

A most efficient and quiet running blower-heater by Solatron—standard replacement in many famous name heaters—comprises mains induction motor—long turbo fan—split heating element and thermostatic safety trip—simply connect to the mains for immediate heat—mount in a simple wooden or metal case or mount direct into base of say kitchen unit. Price £5-95, post £1-50. Control switch to give 2kw, 1kw, cold blow or off available 30p extra. 3kw model £6-95. Control switch 95p.



3 KW Mode  
+ £1.50 P & P



### 3-CHANNEL SOUND TO LIGHT KIT

Complete kit of parts for a three-channel sound to light unit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/2" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14-95 in kit form or £19-95 assembled and tested.

### 8 POWERFUL BATTERY MOTORS

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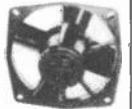
## IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

**DUE TO THE HIGH & RISING PRICES OF FUEL** many companies and probably many householders are looking around for ways of saving some of this cost. One Company bought a number of fans from us and fitted these on the ceiling of their workshops where the hot air tended to collect and they blow this hot air downwards. Another Company has bought fans from us to suck the exhaust from their oil fired central heaters through a zig zag of asbestos pipes, the asbestos pipes being in a separate chamber which becomes a hot air chamber, the hot air from this is blown through ducting to where ever it is needed. Basically, they have cut out the normal chimney and replaced this with one of our high power extractor fans. If you have any other good ideas on heat cost saving, let us know and we will pass it on to our readers.

### EXTRACTOR FANS

Ex-Computer made by Woods of Colchester, ideal also as blower; central heating systems, fume extraction etc. Easy fitting through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" £2-50, 6" £6-50; post £1 per fan.



**PING PONG BALL BLOWER-UPPERS** Have you got to organise a Christmas Party or Charity Fund-Raising Event? Then one always popular way is to have ping pong balls going up and down and being caught. We have some powerful blowers and these should be ideal for this, and of course for more serious purposes. They are 4 stage blowers, coupled to synchronised AC mains motors of approximately 1/2 h.p. They have a terrific suction as well as a high velocity blow. Ex-computers, price £26-00.

**TWO MORE BLOWERS** Both 'snail' type, one very small and compact and suitable for cooling projectors or other equipment. Impeller size 2" x 1", coupled to mains voltage induction motor, outlet size approximately 1 1/2" x 1 1/2". Price £3-50 + 60p. The other is a larger FLANGED BLOWER for direct coupling to ducting, outlet size 3 1/2" x 2 1/2" + 1" flange, holed for easy fitting to trunking. Impeller size 5 1/2" x 1 1/2". Powered by 1/12 h.p. mains motor. £11-75.

**RECHARGEABLE SOLID GEL BATTERY** 12v 5 AH new and unused made by or for Epilover Corporation of California. Dimensions 8" long, 3 1/2" high, 2 1/2" wide. Regular price of similar batteries, R.S. Components is £26-00. Limited quantity available at £15-80.

**DUAL DIGITAL TIMER** Short delay, left timer adjustable 0-2 secs, right timer 0-9 secs. Made by Techno Instruments Ltd., catalogue no. 010 1871. We have some powerful ones, these, but they are battery operated, to use you simply set the digital switches in the desired position, turning the rotary indicator to the chosen time. The lamp will light up when the right timer is in operation. Periodic or single action possible. This is a precision instrument 4 1/2" wide, 1 1/2" high and 5 1/2" deep. We understand that these cost over £200-00 from the Makers. Limited quantity only at £23-00.

**SOLID STATE VARIACS** By Lewis and Holtzman Ltd—their "Elixir", 230-240v AC in and out, 10 amp model is cylindrical approximately 3 1/2" diameter 4 1/2" deep. Price £13-80. 5 amp model, again cylindrical, 2 1/2" diameter, 4 1/2" deep. Price £9-20.

**E.H.T. UNITS** One of our specialities has always been E.H.T. transformers, and we probably have bigger stocks than most of our contemporaries. It is surprising what uses these high voltages can be put to—killing flies, weeds, lighting central heating boilers, lifting paper, extracting dust, etc. etc. A new one this month is 14.5 KV. (dc) 0.5mA—made by ADVANCE ELECTRONICS—this unit is completely enclosed and has input and output sockets—size of the unit is approximately 6" x 3" x 3", price £15-30 post £1.

We understand that these cost over £200-00 from the Makers. Limited quantity only at £23-00.

**LEDs** are used increasingly and are now being recommended for nearly all indicators and for games and novelties. Due to a fortunate purchase, this month we are able to offer 10 red led's for £1. These are the small ones equivalent to the TIL 209. Bulk price £60-90 per 1,000 + V.A.T.

**FIG. 8 FLEX** is always in demand, especially when doing the Christmas decorations. We are able to offer white Fig. 8 5 amp type on 50 metre roll for £2-80, ditto but dark grey with tracer lead, suitable for speaker extensions, 50 metres £3-38.

**500 WATT MERCURY VAPOUR LAMP** Mazda, ref. 90-5104 MA/T/V blended. These give a really powerful light, but of course, have to be used with the correct control gear. We are expecting to get this control gear early in the New Year. Price of the lamp is £3-38 + 38p. Post 50p.

**ANTI FROST THERMOSTAT** The normal refrigerator type thermostat, switches off as the temperature falls and so is not suitable for anti-frost devices. However, we have the ice stat—this switches on as the temperature falls and is set to switch on just above freezing point. It is a skeleton stat so would require boxing, but the price is modest at £1-10.

**THIN CONNECTING WIRE** 500 metre drums, 7 stranded copper, core p.v.c. covered available in 10 different colours. Price £7-15.

**OCTOBER/NOVEMBER CONSTRUCTOR'S SNIP.** Here's a super bargain for you. 100 twist drills, regular tool shop price over £50, yours for only £14-50. With these you will be able to drill metal, wood, plastic etc. from the tiniest holes in P.C.B. right up to about 1/2". Don't miss this snip—send your order today.

**SUPER BREAKDOWN PARCEL** with free gift of a desoldering pump, the most useful breakdown parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find: over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensers, multi turn pots, rectifiers, SCR etc. etc. for only £8-50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel, + £1-27 VAT + £2 post (it's a big parcel).



**TIME SWITCH BARGAIN** Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with dials. Complete with knobs £2-50.

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# Projects... Theory...

## and Popular Features ...

**THE (STILL) OPEN CHANNEL**  
The battle for Citizens' Band Radio goes on.

In August last year the Home Office issued a discussion document on "Open Channel". On December 18, Mr William Whitelaw, the Home Secretary, stated in Parliament that a large number of individuals wanted citizens' band radio at 27MHz to be legalised. On the other hand the electronics industry and institutions representing other interests such as broadcasting strongly advocated frequencies higher than 27MHz. The Home Secretary went on to say that he is disposed to allocate frequencies to Open Channel radio in the neighbourhood of 930MHz and that he is considering "whether it would be possible to exempt this facility from licensing if certain conditions are met".

The door has not been completely closed on a personal radio service on 27MHz (which would have a greater range than the proposed Open Channel on 930MHz could provide) for the Home Secretary intends "to continue consultations to examine this question further".

Prior to this official announcement, the Citizens' Band Association had issued its own response to the discussion document. It is critical of the proposals for use of u.h.f. since the cost of equipment would be too high and the range totally inadequate. The C.B.A. calls for a lower frequency (41MHz or 230MHz); failing that

27MHz operation should be legalised at once.

The C.B.A. is also critical of the Home Office concentration on the interference problem. Why? Against the small but well organised and vocal C.B. lobby there is the vast majority of the population which depends upon radio, television, tape and hi-fi for information and pleasure. It would be utterly intolerable were members of one household to be barred from listening to programmes of their choice because of break-through from a C.B. rig in an adjoining house. It is the very nature of C.B. buffs to be garrulous so any such interference is likely to be suffered over long periods.

Naturally C.B. enthusiasts play down this aspect, but the authorities with their responsibilities to the public at large are perfectly right in seeking to keep interference to the absolute minimum. The frequency of 930MHz seems to offer the least danger of break-through on other domestic electronic equipment. If the rights of the majority can be best safeguarded by restricting the range of C.B. operation we think this is the best and fairest solution.



*Our March issue will be published on Friday, February 20. See page 111 for details.*

**Readers' Enquiries**

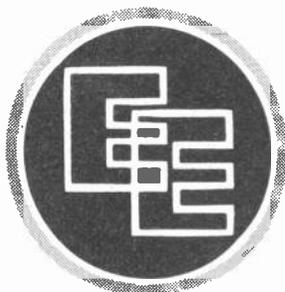
We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

**Component Supplies**

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot however guarantee it, and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.



# Everyday ELECTRONICS

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FEBRUARY 1981

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### Back Issues

Certain back issues\* of EVERYDAY ELECTRONICS are available worldwide price 80p inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.

\* Not available: October 1978 to May 1979.

### Binders

Binders to hold one volume (12 issues) are available from the above address for £4.40 (home and overseas) inclusive of postage and packing. Please state which Volume.

### Subscriptions

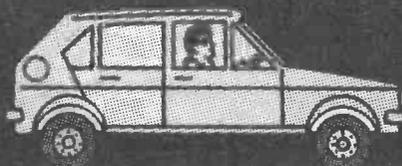
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# CAR - ACTUATED DRIVEWAY LIGHT

BY M. PLANT



**T**HIS optoelectronic project will enable you to switch on an outside light before getting out of your car merely by operating your car main beam switch a preselected number of times. The driveway light remains switched on for a predetermined time, just long enough for you to lock up your car, enter the house and, if necessary, put the cat out with the milk bottles. After closing the door you can be confident that the light will be extinguished automatically.

## LIGHT BEAM

Of course sophisticated remote control systems which make use of ultrasonic or infra-red beams are designed for this purpose, but since a car has powerful headlights why not make use of these beams to control a device at a distance?

However, a simple opto-switch would be very unsatisfactory for this application because a chance illumination of the sensor by a passing car or

a lightning flash would operate the light.

The circuit to be described avoids this possibility by the use of two essential design features: first, a six-position switch which enables you to select the number of flashes of the car head beam required to operate the relay which controls the mains lamp; second, a time delay which can be preset up to a maximum time of 2½ minutes during which the circuit must receive the correct number of light flashes. This is also the time that the mains lamp remains on.

## CIRCUIT DESCRIPTION

The circuit for the Car Actuated Driveway Light is shown in Fig. 1 and derives its 12V d.c. supply from the mains. The supply is stabilised by means of the Zener diode D1 and transistor TR1. The light sensor is a photocell, PCC1 which is coupled to a voltage comparator based on op-amp IC1. The switching action of IC1 is

modified by components D6, R2, C2, R3 and C3 so that it operates as a monostable.

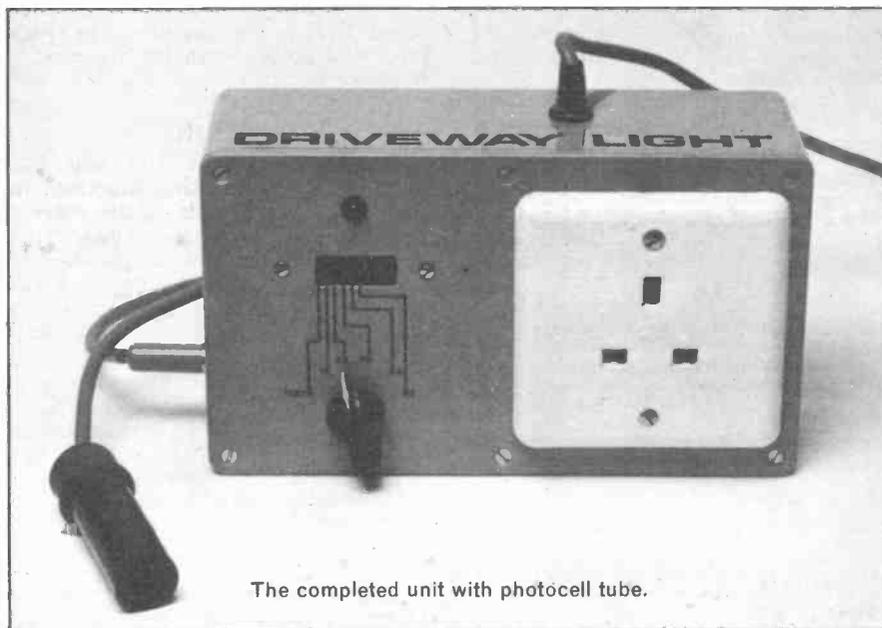
Normally the photocell will be in the dark and its resistance therefore will be high. If VR1 is set so that its resistance is about equal to the photocell "dark resistance", capacitor C4 will be charged to about half the supply voltage. The inverting input of the op-amp will be about 0.6V higher than this due to the action of diode D6. Thus the output voltage of the op-amp is 0V.

If the photocell detects a sudden increase in light intensity, its resistance drops sharply and the voltage on pin 2 falls below that on pin 3 which therefore makes the op amp produce a positive output voltage.

The small amount of positive feedback provided by R3 and C3 ensures that the output voltage changes sharply. This rise in output voltage produces an equivalent rise in the voltage on pin 3 but, since the photocell has returned to its normally "dark" state, capacitor C4 will discharge down through R2. The voltage on pin 3 therefore falls and when it drops below the voltage on pin 2, the output voltage returns to 0V. The time taken for the op-amp to drop out of its monostable state is largely determined by the values of C4 and R2 and is adjusted to be about one second.

The voltage changes on the output and the two inputs of the op amp are shown in Fig. 2. The circuit has the useful feature that, once a flash of light has reached the photocell, it ignores any spurious signals it might be receiving in the time it is in the monostable mode.

Furthermore the op-amp does not respond to slowly changing levels of illumination since its non-inverting input always remains 0.6V below the voltage on its inverting input. So the advent of dawn is ignored by the circuit and it "sleeps" during the day but becomes sensitive again at nightfall.



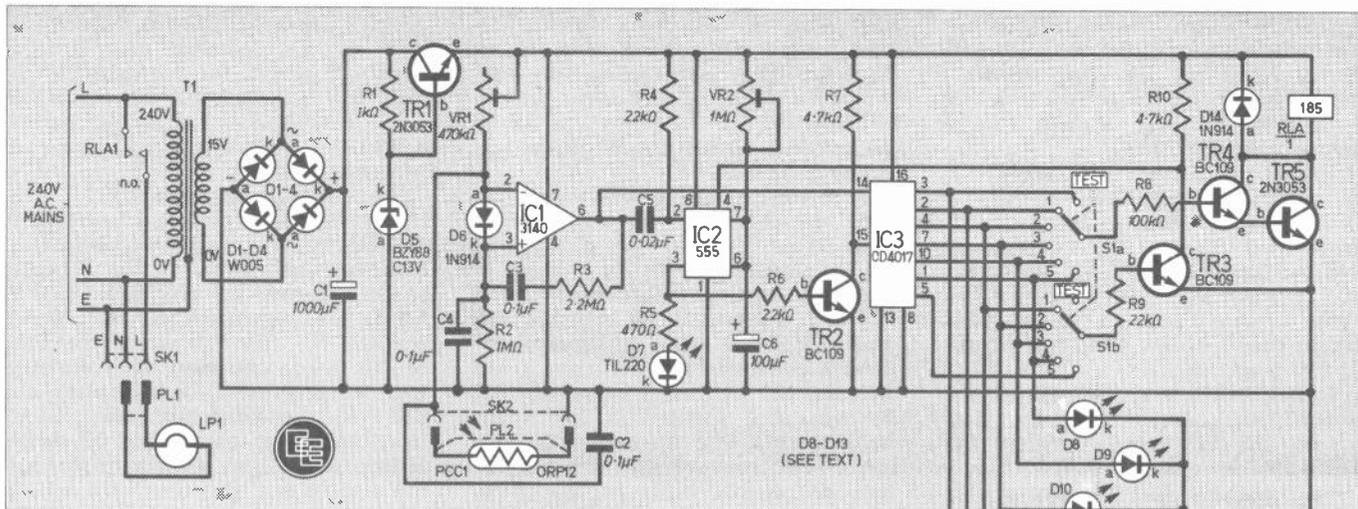
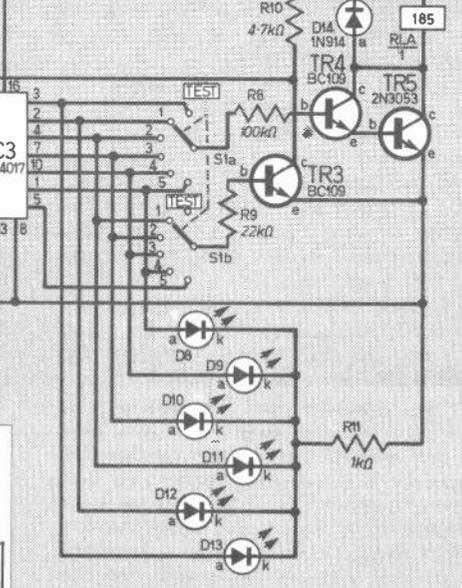


Fig. 1. The complete circuit diagram of the Car Actuated Driveway Light including its mains derived power supply unit.



## COMPONENTS

### Resistors

- |                  |                   |
|------------------|-------------------|
| R1 1k $\Omega$   | R7 4.7k $\Omega$  |
| R2 1M $\Omega$   | R8 100k $\Omega$  |
| R3 2.2M $\Omega$ | R9 22k $\Omega$   |
| R4 22k $\Omega$  | R10 4.7k $\Omega$ |
| R5 470 $\Omega$  | R11 1k $\Omega$   |
| R6 22k $\Omega$  |                   |

All  $\frac{1}{2}$ W carbon  $\pm 10\%$

### Capacitors

- C1 2200 $\mu$ F 16V elect.
- C2 0.1 $\mu$ F polyester
- C3 0.1 $\mu$ F polyester
- C4 0.1 $\mu$ F polyester
- C5 0.022 $\mu$ F polyester
- C6 100 $\mu$ F 16V tantalum bead

### Semiconductors

- D1-D4 1A 50V diode bridge
- D5 BZY88C13V 13V 400mW Zener diode
- D6 1N914 small signal silicon
- D7 TIL220 red l.e.d.
- D8-D13 decade l.e.d. array (d.i.l.) or discrete l.e.d.s, e.g. TIL220 (6 off)
- D14 1N914 small signal silicon
- TR1 2N3053 *n*p*n* silicon
- TR2 BC109 *n*p*n* silicon
- TR3 BC109 *n*p*n* silicon
- TR4 BC109 *n*p*n* silicon
- TR5 2N3053 *n*p*n* silicon
- IC1 CA3140 m.o.s.f.e.t. op-amp (8-pin d.i.l.)
- IC2 555 timer i.c.
- IC3 CD4017B CMOS decade counter
- PCC1 ORP12 or similar light dependent resistor

### Miscellaneous

- VR1 470k $\Omega$  sub-miniature preset
- VR2 1M $\Omega$  sub-miniature preset
- S1 2-pole 6-way rotary switch
- T1 mains primary/15V 200mA secondary
- RLA miniature relay 12V 185 ohms coil with at least one set of mains contacts rated to suit lamp used.
- SK2 3.5mm jack socket
- SK1 3-pin mains socket
- PL1 3-pin mains plug
- PL2 3.5mm jack plug

Stripboard: 0.1 inch matrix, 36 strips  $\times$  34 holes; case, Bimbox type 2006/16 size 190  $\times$  110  $\times$  60mm plastic, or similar; i.c. sockets 8-pin d.i.l. (2 off), 16 pin d.i.l. (1 off); TO-5 heatsink; socket for relay; bush for panel mounted l.e.d.(s) aluminium for relay bracket; 6BA fixings; control knob; three-core mains cable; grommet to suit mains cable; solder tag; short length of plastic tube to act as collimator for PCC1.

**COMPONENTS**  
approximate  
cost **£22**

See  
**Shop  
Talk**  
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PHOTOCELL ILLUMINATED

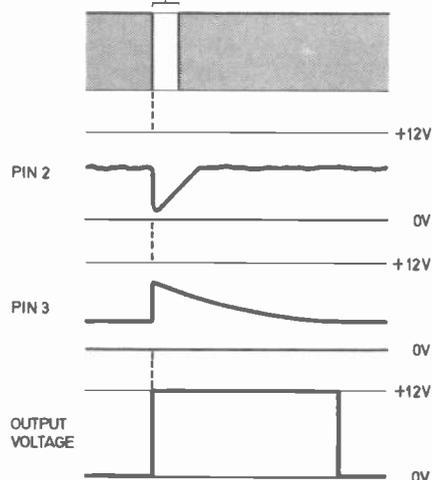


Fig. 2. Voltage changes occurring at IC1 input and output when the photocell is illuminated.

### TIMER AND COUNTER

Integrated circuits IC2 and IC3 have equally interesting functions to perform. IC3 responds to the sharply rising edge of the output voltage from IC1 while IC2 responds to the sharply falling edge of this same voltage change. The 555 timer, IC2 connected as a second monostable, determines whether the decade counter, IC3, should count or not. If its output is at logic low, it switches TR2 off which in turn takes the reset terminal, pin 15, to IC3 to a logic high, i.e. near the supply voltage. A logic high on the reset terminal sets the voltage at IC3 output pin 3 also high, all the other nine outputs of this decade counter being at logic low.

Should the output voltage of IC2 be high, transistor TR2 is switched on

and the reset terminal of IC3 goes to logic low which allows this decade counter to count pulses received at its count input, pin 14. Thus counting takes place when the output of IC2 is at logic high, that is, when it is in its monostable "on" state.

During this period, each rising edge of the pulses from IC1 successively sets the ten decade outputs of IC3 logic high. Thus, after the counter has been reset and pin 3 is high, next pin 2 goes high, all other outputs being low and each successive pulse brings output pins 4, 7, 10 and 1 logic high in turn.

Switch S1a selects any one of the first six outputs of IC3, the other four outputs of this decade counter not being used in this application.

By means of the Darlington pair made up of transistors TR4 and TR5, a mains relay is energised when the switch selects a logic high from IC3. Thus if the switch is in position 1, as shown in the circuit, the relay is energised after the first pulse is received from IC1. Pin 2 remains high and the lamp remains lit for the time that IC2 is in its monostable state. Once pin 3 of IC2 falls to its normal low state at the end of its monostable period, determined by the product of the VR2 and C6 values, pin 15 of IC3 goes high and resets the counter so that its pin 3 is high.

Thus, trigger pulses from IC1 must be passed on to the counter during IC1 monostable on period, which is adjustable up to about 150 seconds, if the lamp is to be switched on. Suppose S1a has been set to its fourth position. The chance that three random flashes of light are received by the photocell in the monostable period is small. However, it is easy to flash the headlamps of your car three times quite rapidly in order to switch on the lamp by bringing the output, pin 7 to logic high. The reason for providing five switch positions in addition to the reset position, is so that user can find the position best suited to their environment. If your house is situated near a busy road junction it might be necessary to select a high number of required flashes while country dwellers might only need to set S1a to position 2 or 3.

### TIMER OVERRIDE

Should you want to switch off the lamp before the termination of IC2 monostable period, S1b which is ganged with S1a allows you to do this. S1b is wired in advance of S1a by one step. So once the light has been turned on by the flashing sequence, the counter high output can be picked up on S1b pole by backstepping S1. This turns on TR3 whose collector drops towards 0V. A low voltage to pin 4 of IC2 resets this i.c. and its output falls to 0V and stays

there. TR2 is thus off resulting in a high level to IC3 reset, setting the first output pin 3 in the high state. This facility is not available for the single flash system, position 1.

Remember to return switch S1 to its original position to maintain the required flash count.

Assembly of the circuitry on 0.1 inch stripboard is shown in Fig. 3. The layout includes the d.c. power supply which uses the large smoothing capacitor C1. A heat sink is essential for transistor TR1. Use of i.c. sockets for the three integrated circuits is recommended, particularly for IC1 and IC3 which are CMOS devices. Do not plug these i.c.s into their holders until you are ready to test the circuit and certainly do not insert or remove them at any time when the circuit is being supplied with power.



### CIRCUIT BOARD

Begin by cutting the board to size, drilling the fixing holes and making the breaks on the underside as shown in Fig. 3. Mount the i.c. sockets followed by the wire links, presets, resistors and capacitors. Leave C1 until last for ease of construction. The semiconductors should be mounted next—remember to fit TR1 heatsink before connecting it to the board.

Finally connect sufficient lengths of flying lead to the circuit board to

reach the case mounted components when positioned. Ribbon cable was used in the prototype but is not essential. In fact this assembly is too rigid and lightweight cable would be better except of course for the mains wiring where heavier duty insulated wiring is essential.

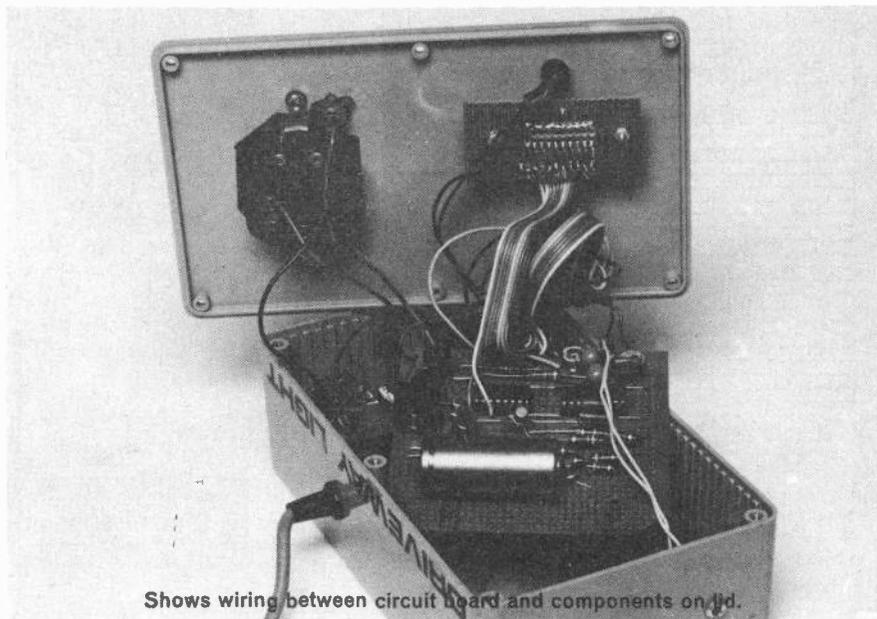
The internal arrangement of the circuit board, switches, transformer and the relay in the prototype unit is also shown in Fig. 3. Decide whether to use a decade bar display for i.e.d.s D8 to D13 or individual i.e.d.s and prepare the front panel of the box to suit. As can be seen the prototype used a bar type of i.e.d. display and this for convenience has been mounted on a small piece of stripboard. A d.i.l. socket for mounting the display was also used. The board was bolted to the front panel below a suitable rectangular cut-out.

Note that a relay is mounted in a suitable socket and held in place on a small aluminium bracket in a corner of the box adjacent to the transformer and near to the three-pin socket which accepts the connection to the mains lamp. Connect the flying leads to the relay base and fit all the case mounted components in position and wire up to the circuit board.

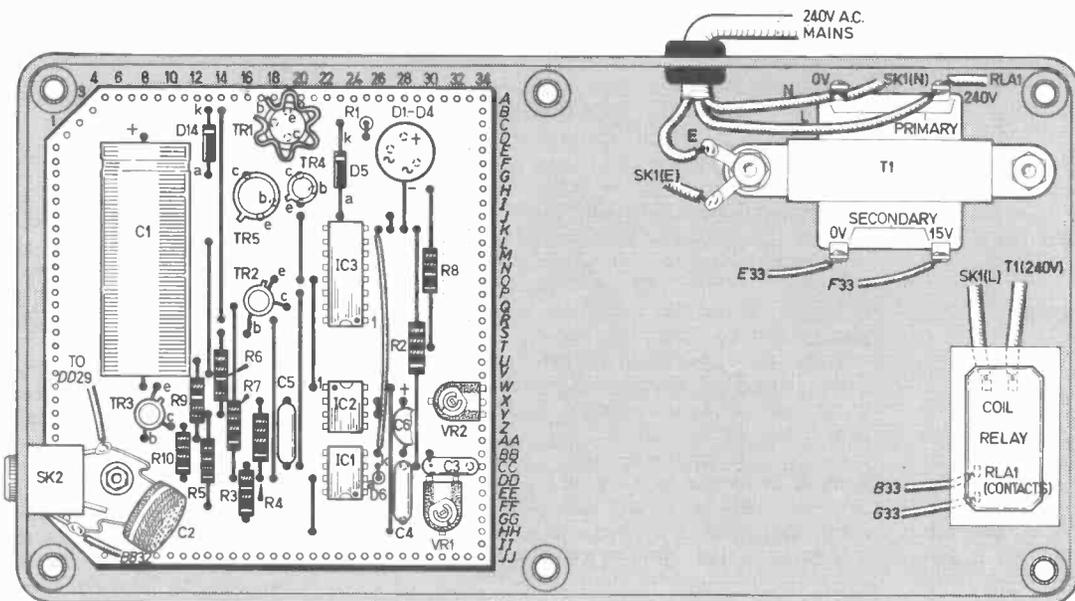
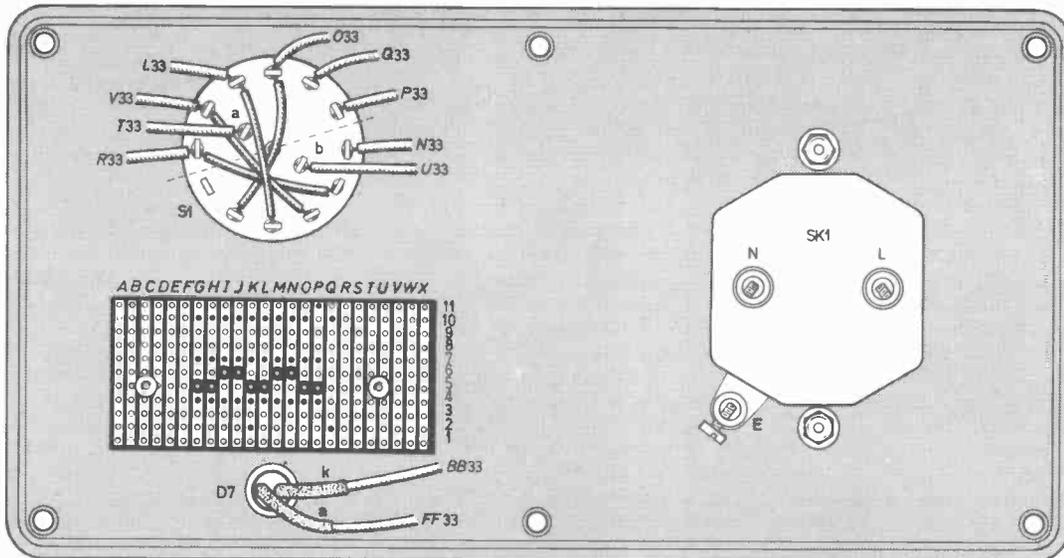
The circuit board should be mounted firmly just off the bottom of the box on short stand-off pillars or similar.

### PHOTOCELL TUBE

The photocell was situated in a short length of plastic tube so that in operation it can be lined up with the headlights of your car. The tube limits the angle of view of the photocell and reduces the chance that the circuit is operated by chance flashes of light, for only light directed along the axis of the tube will be effective, see Fig. 4.



Shows wiring between circuit board and components on lid.



RELAY SOCKET MOUNTED ON 'L' SHAPED BRACKET

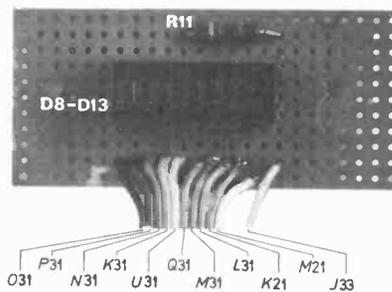
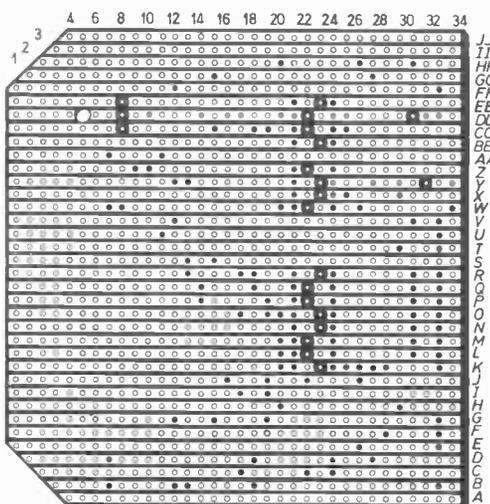


Fig. 4 (below). The photo-cell collimator construction details.

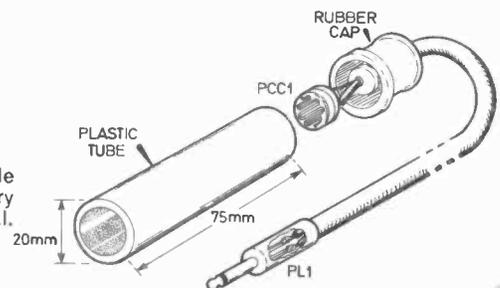
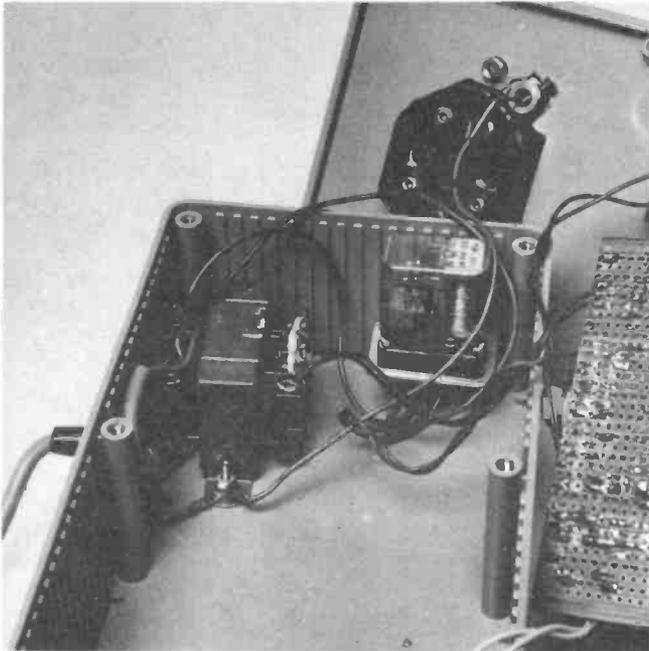
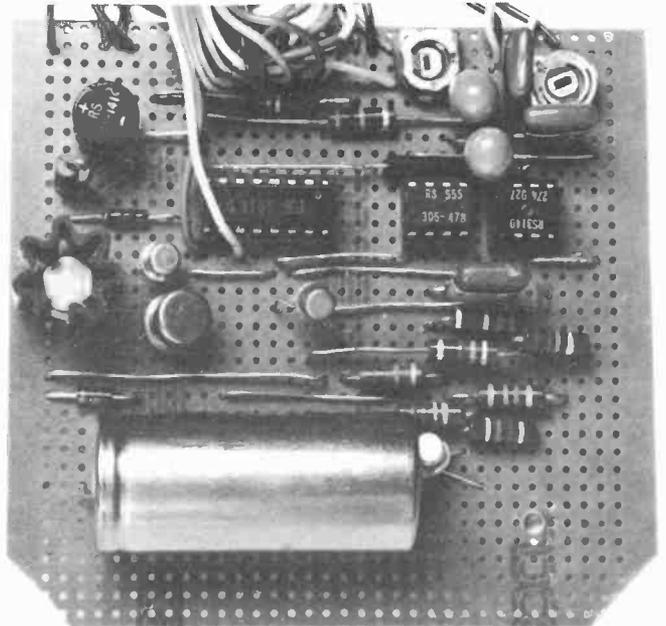


Fig. 3. The layout of the components on the stripboard and the breaks to be made on the underside. The two chamfered corners on the larger board are necessary to clear the mounting pillars in the specified case. The bar l.e.d. fitted in a d.i.l. socket on the smaller board is seen in the photograph.



Position and wiring of transformer and relay fitted in the case.



The completed prototype circuit board. Here C6 is constructed from two 47 $\mu$ F capacitors wired in parallel.

Provide the photocell with two to three metres of connecting wire so that it can be mounted in a position suitable for receiving light from your car headlamps. The photocell is plugged into the unit via a 3.5mm jackplug/socket arrangement.

#### SETTING UP

The operation of the unit can be checked out either by using a torch in a darkened room or merely by using the light from a window. The only adjustment which is necessary is to VR1 so, with the lid of the box carefully supported, make sure you can gain access to this component with a small screwdriver or the correct adjustment tool. Take care that you do not inadvertently touch any bare mains connections, especially those on the transformer, when you are making this adjustment.

First set switch S1 to the TEST position and plug a lamp into the socket on the front panel, e.g. a table lamp which is terminated with a three pin plug. When the unit itself is plugged

into a mains socket, the lamp should light. Now set S1 to position 1 and the lamp should turn off. Cover the tube of the photocell with your thumb and quickly uncover it and cover it up again. Adjust VR1 until the mains relay is heard to click on accompanied by the lamp turning on. Now expose the photocell to one more brief period of illumination and the lamp will be extinguished and the first l.e.d. in the chain will relight. Note that D7 comes on after the first flash of light and sets the start of the first monostable period and will also light up after the lamp has been switched off by the second flash of light. However, if the lamp is allowed to continue alight until the end of the delay period, D7 will go out.

Check the operation of the circuit for the other positions of S1 and adjust the value of VR2 until the required time delay is obtained. Note that you can increase the value of C6 to increase the maximum time delay in the circuit but make sure that you use a tantalum type capacitor for reliable results.

#### INSTALLATION

When the circuit is working correctly, the unit needs to be installed in a suitable position. It is a good idea to mount the photocell just inside a window at a height which can be illuminated by your car headlights when you enter your drive. If the photocell has to be mounted on a wall, make sure you protect it from the effects of the weather. Similarly, just behind a window is a good position for the unit itself so that you can see the l.e.d.s at night. An existing outside light will need to be adapted so that it can be plugged into the unit's three-pin socket. ✧



1981

## New Year's Resolution~

*I will place a firm order  
with my newsagent for Everyday Electronics  
Every Month*



# 3-CHANNEL STEREO MIXER

by D. J. EDWARDS

SIMPLE TRANSISTOR CIRCUIT  
IDEAL FOR HOME RECORDING OR DISCOS

**T**HE AUDIO mixer is an essential part of any recording or P.A. installation. To the professional this means row upon row of knobs and sliders and of course enormous expense.

However, there are often cases when a simple unit is required to mix two or three inputs perhaps for home recordings or disco use and the unit described here is designed to fill such a function.

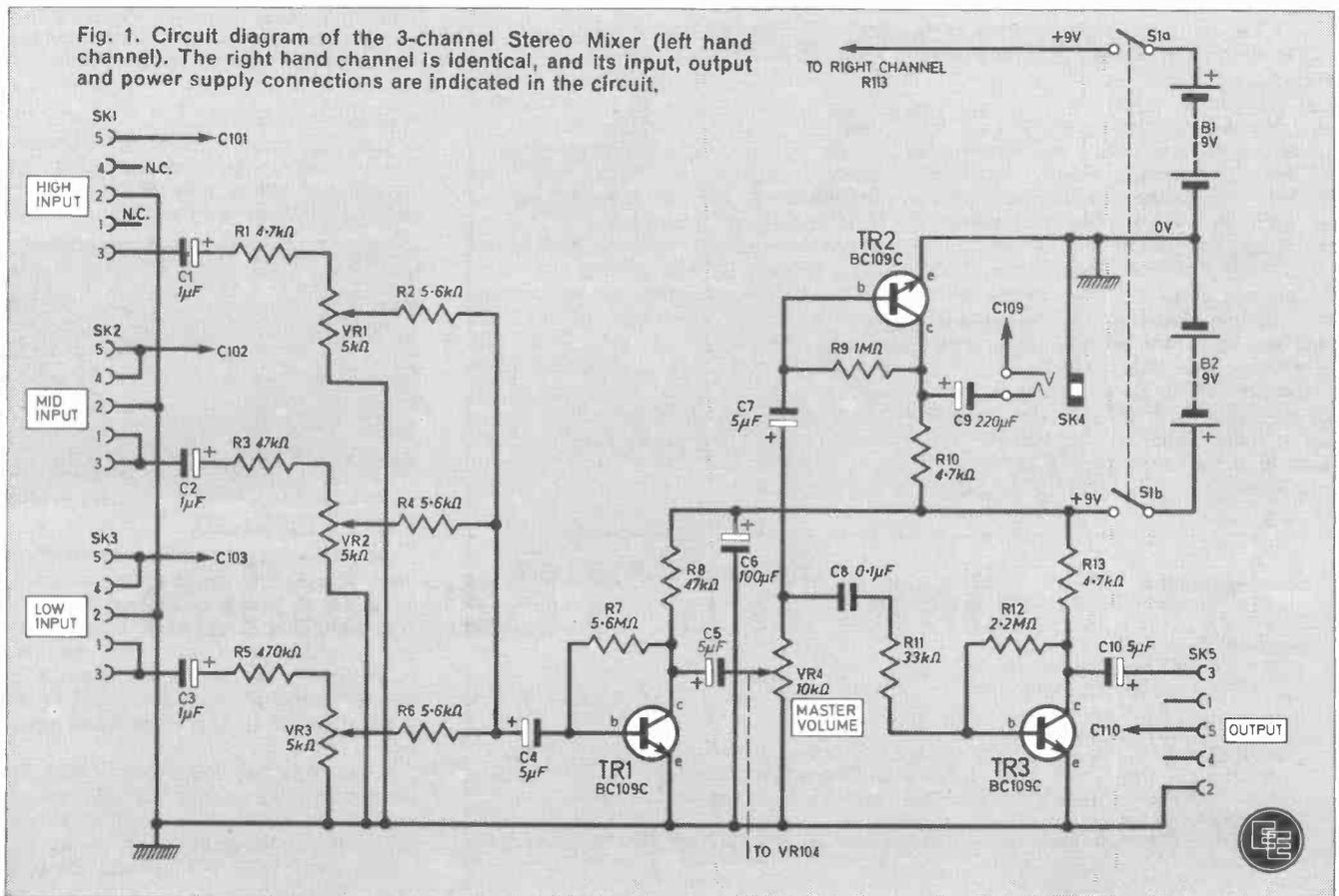
There are three stereo channels each with different sensitivities and level controls and a final amplifier with master output. A headphone amplifier is also provided.

## CIRCUIT DESCRIPTION

The circuit of the left hand channel of the Stereo Mixer can be seen in Fig 1. The other channel is identical to this.

The input signals enter the unit via SK1, 2 or 3. Resistors R1, R3 and R5 are designed to attenuate the signal so that it does not overload the next stage.

The level of each input is controlled by variable resistors VR1 to VR3 and their counterparts in the right hand channel. It should be noted that there are separate controls for left and right channels as well as



separate ones for the three inputs, making six in all.

## PRE-AMP

The input signals now pass via a 5.6kΩ resistor and d.c. blocking capacitor to TR1. This is a standard common emitter circuit with negative feedback applied via R7.

Output level is controlled by VR4 and its equivalent in the right hand channel. These two are ganged together and form the master volume.

Further amplification of the signal is provided by TR3 also connected in common emitter mode and the output is terminated at SK5.

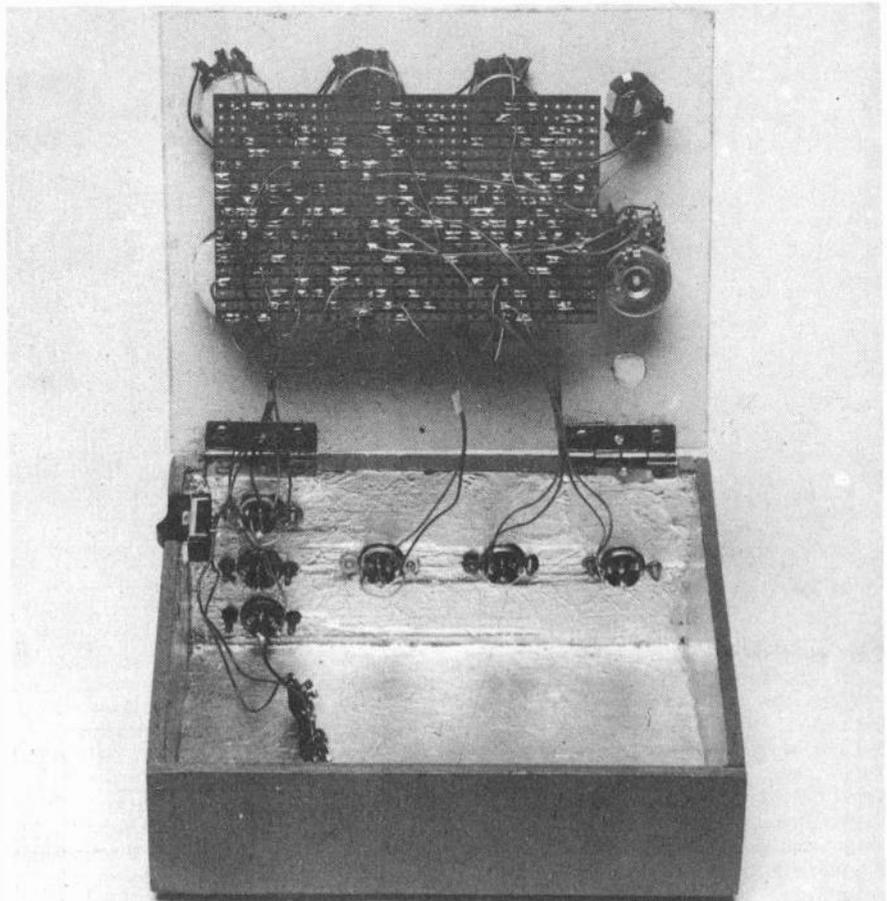
## HEADPHONES

Headphone monitoring is provided by TR2. The signal is taken from one end of VR4 and applied via C7 to the base of TR2. This is again connected as a common emitter amplifier.

The output is taken via C9 to a stereo jack. This is shared with the right hand channel. Because of the design, only high impedance headphones can be used.

## POWER

Battery power is provided by two PP3 batteries one for each channel and the on-off switch S1 is a two pole



The prototype 3-channel Stereo Mixer with front panel raised to expose circuit board, other components and interwiring. The plywood cabinet is lined with aluminium foil.

type because of this.

This may seem a novel arrangement but it does mean that batteries last longer and the effects of low battery voltage are less pronounced.

**CONSTRUCTION**  
starts here

## CIRCUIT BOARD

All the components are assembled on a piece of 0.15 inch stripboard 19 strips by 39 holes, according to Fig. 2. All right hand channel components are numbered from 100 so, for example, R1 is the input resistor in the left hand channel and R101 is the same resistor in the right hand channel.

After this has been completed the next stage is to assemble the cabinet and front panel. The cabinet in the prototype was made from 4mm plywood size 185×140×75mm sloping down to 40mm.

## COMPONENTS

### Resistors

R1, 101	4.7kΩ	R8, 108	47kΩ
R2, 102	5.6kΩ	R9, 109	1MΩ
R3, 103	47kΩ	R10, 110	4.7kΩ
R4, 104	5.6kΩ	R11, 111	33kΩ
R5, 105	470kΩ	R12, 112	2.2MΩ
R6, 106	5.6kΩ	R13, 113	4.7kΩ
R7, 107	5.6MΩ		

All 1/4W carbon ±5%

### Potentiometers

VR1-VR3, 101-103	5kΩ log. carbon (6 off)
VR4, 104	10kΩ log. carbon dual gang (1 off)

### Capacitors

C1-C3, 101-103	1μF 25V elect. (6 off)
C4, C5, 104, 105	5μF 25V elect. (4 off)
C6, 106	100μF 25V elect.
C7, 107	5μF 25V elect.
C8, 108	0.1μF polyester
C9, 109	220μF 25V elect.
C10, 110	5μF 25V elect.

### Semiconductors

TR1-TR3, 101-103	BC109C npn silicon (6 off)
------------------	----------------------------

### Miscellaneous

SK1, 2, 3, 5	5-pin DIN 180 degree (4 off)
SK4	0.25 inch stereo jack
S1	d.p.s.t. rocker
B1, 2	9V PP3 type (2 off)

Stripboard 0.15 inch matrix, 19 strips by 39 holes; battery clips (2 off); 4mm plywood for case; 4BA nuts, bolts and collars for mounting circuit board; aluminium panel, 185 × 50mm for front panel; foil for lining case; interconnecting wire.

Note that all component references prefixed by 100 refer to the right hand channel.

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Talk**  
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**COMPONENTS**  
approximate  
cost **£14.50**  
complete

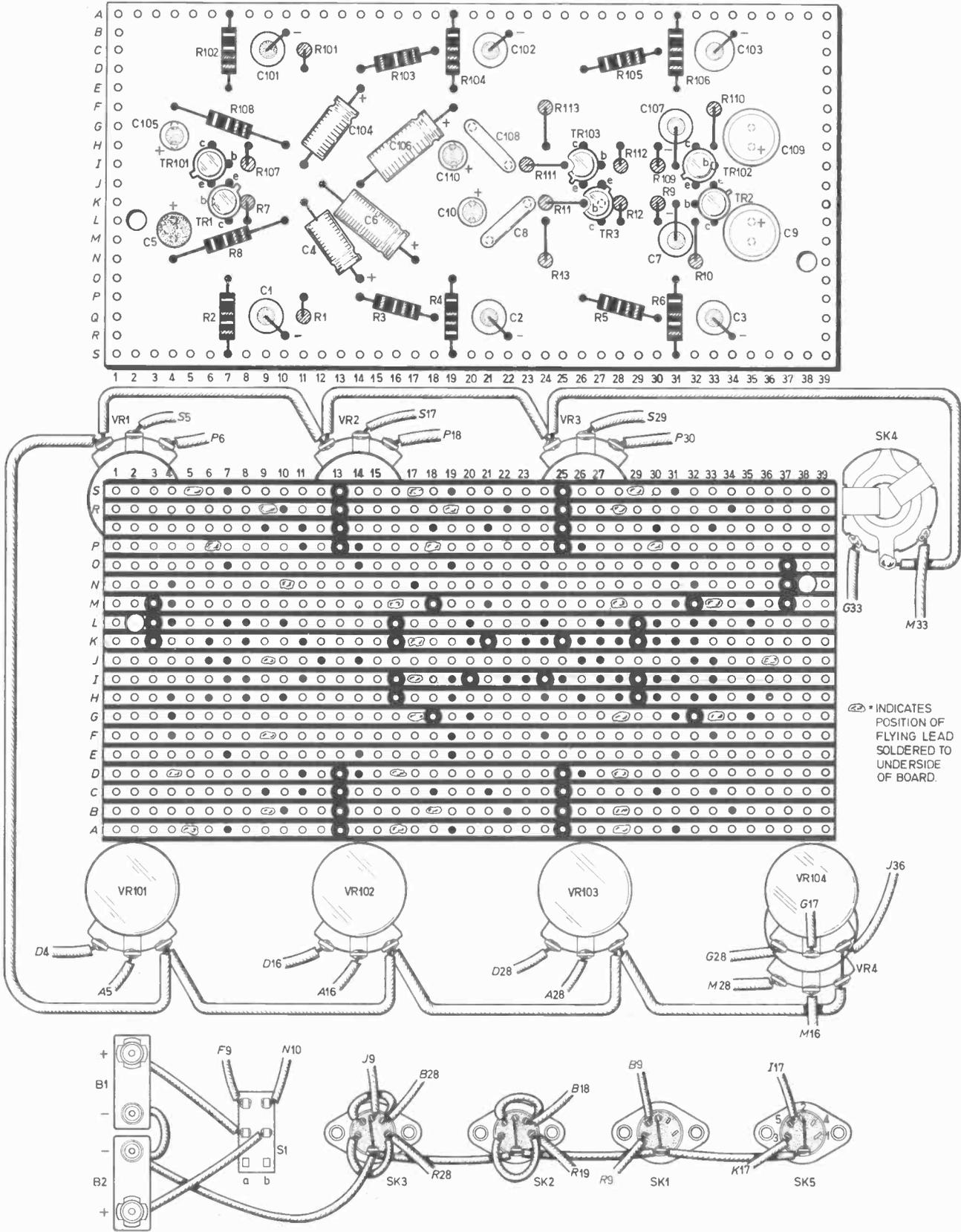


Fig. 2. The circuit board of the 3-channel Stereo Mixer. (Top) topside of board showing all components in situ. (Below) strip-side of board showing all breaks in copper strips. Also, note that the interconnecting leads are soldered to the strips as indicated by the solder "blobs".

## FRONT PANEL

The front panel is made from 16 s.w.g. aluminium and is fastened onto the cabinet by means of brass hinges. This makes access to the interior very easy.

Once all the off board components are mounted in place, the interwiring between them should be completed. This includes the sockets mounted in the back of the case.

The board should then be mounted in position above the controls using 4BA nuts, bolts and spacers. This was done using stiff wire in the prototype but the nuts and bolts are much better.

The wiring from the controls can now be completed. This project is

unusual in that wiring to the board is taken to the reverse, that is copper coated side. Make sure that connections from VR1 and 2 and 3 are as short as possible and that every joint is a good one, otherwise you will get hum pick up and noise.

The front panel should be earthed and additional screening can be provided by lining the case with tin foil.

## FINISHING OFF

All that remains now is to check the construction thoroughly and label up the front panel.

Possible modifications would be using separate sockets for the right and left inputs on each channel or providing two or three outputs all

connected in parallel, though these haven't been tried.

A point to bear in mind when using a tape recorder as a signal source is that the standard DIN socket arrangement is to have input and output of the recorder on the same socket.

This means that if pins 4 and 5 and pins 1 and 3 are wired together in the input socket on the mixer, then you will be feeding the output of the recorder straight back into its recording amplifier. This will affect the quality and magnitude of the signal actually entering the mixer.

The only way round this is to make sure that such a link does not exist and that the input only goes into pins 1 and 4. □



## Looking Ahead

Now is the time of year, when Old Moore Young carries out his famous trick of foretelling the future by looking through the bottom of an empty beer glass. My fellow Astrologers tell me that crystal balls and beer glasses are now "Old Hat", that all they do now, is to pop some questions into their computers and wait for the answers.

I was about to hire one of these monsters for half an hour, when I suddenly remembered that only recently, a computer operator, who happens to be a friend of mine, was popping questions into his computer one day, when suddenly without a word of warning it started firing questions back at him. He grabbed his coat and hat and started to run, and as far as I know he is still running.

So back to my beer glass. Ah! here we go. February, Government Minister announces Microwave Ovens are now one hundred per cent safe! March, Government Minister announces the opening of two thousand more Microwave Oven Testing Stations!

April, The Electricity Board announces that central heating with storage heaters is very cheap, and they will be delighted to install one for you for, £250. May, Dustmen demand extra pay for having to cart away storage heaters weighing half a ton. June, householders told to bury their unwanted storage heaters in the garden, as all refuse dumps are full!

This is terrible! At this point I reluctantly left my beer glass and decided I would ask an old Chinese Sage I know, called Dai Ling, if he could tell me whether these predictions would come true.

After I had put the question to him, he uttered just one mystical Chinese word, which sounded like "Famfino". I will translate it for the benefit of the one or two of my readers who don't speak Chinese, it is an expression of extreme dubiety!

There is one other forecast that I will guarantee will come true. The customers who write queries on their order forms, will be the last to receive their goods.

## Good Criticism

I am always pleased to have letters from readers, especially when they contain constructive criticism. A case in point, is a charming letter from Mr. E. F. Good (see *Letters* page December).

I recently suggested that you write your address in block capitals. Mr. Good says they look uncouth.

The point I was trying to make, is that your address should be clearly legible to us. Quite often the addresses look as though they have been written in Sanskrit or Cuneiform, and all we can do is to cut the address off the order and stick it on the parcel. I must make it abundantly clear, that Mr. Good's own writing is so perfect, that I thought at first it had been done with a special typewriter.

I also said "send the exact money". Nothing at all complicated was intended here, simply that you work out what the price should be, and send just that. Mr. Good's suggestion that the customer should send an open cheque limited to a certain amount, is an excellent one, and many customers already adopt this procedure.

It is particularly valuable at the present time, as price lists are usually young before the ink has dried. However, I must take exception on his last point, where he says that catalogues tell lies, by showing goods that are not available.

While I sympathise with his disappointment, he can take it from me, that none of us, would put a single item in our catalogue, if we thought that there was the slightest chance of it not being freely available for the life of the catalogue. Remember that the life of a catalogue is probably a year, because it is necessary to print that number in order to obtain a reasonable price. Also remember that our suppliers are not going to tell us if they intend to drop an item, for very obvious reasons.

The type of letter that delights me, is one like the following:

Dear Sirs,

If "Jenny" misses her battered old 1978 catalogue complete with coffee stains and her name written on it, tell her I love it, and am most willing to return it.

I received an out-of-date old catalogue, with a price list dated Jan 1979. (The back page is so badly printed, I cannot read it.)

On top of that, I had to pay the postman 7p surcharge as it was understamped.

If things are as bad as that I will let you have this catalogue back free and pay full postage.

Yours faithfully

One can never resist a little humour. By the time our friend reads this, Jenny will be too busy cleaning up the stains caused by her new baby, to worry about sending coffee stained catalogues to customers.

## Buzz Off

Finally, I recently had an order from a customer made out on a firm's headed note paper. The firm was called "Audio Buzz" and when I looked at the name on the cheque, it was, "Hornet", and it was un-signed!

I felt very tempted to write and say, "You can't sting me!", but I changed my mind in case Mr Hornet should take umbrage.

Wishing you all a successful constructional year in 1981.



By Dave Barrington

### New Publications

The new edition of the 1981 Maplin catalogue contains well over 5,000 products in its 320 pages. Of these over 1,000 are new items to this edition.

A new feature is the inclusion of a sectionalised alphabetical "thumb" index system to aid location of lines. This is in addition to the normal component index.

Having run out of superlatives to describe the Maplin Catalogue, price £1.25 mail order or £1.00 from W. H. Smiths, we can only add the following: BUY IT!

Two new publications which give details of practical designs for a 10/20W and a 25/30W hi fi power amplifiers using Darlington Devices has just been published by Mullard Ltd.

Copies are available from Technical Publications Department, Mullard Mitcham, New Road, Mitcham, Surrey, CR4 4XY.

### Capacitors

Before we press on with this month's component buying we should like to make a general point regarding capacitors used in all constructional projects.

When ordering capacitors you may be given one with greater working voltage than specified. This is quite in order. Most of our projects are low power and a good "rule of thumb" approach to apply here is to never accept one which has a lower rating than the voltage of the circuit.

Also, capacitors come in all shapes and sizes so make sure the component being supplied will fit on the circuit board or within the case.

## CONSTRUCTIONAL PROJECTS

### Car-Actuated Driveway Light

The *Car-Actuated Driveway Light* uses a RS decade bar display, type Bar LED 586-706. Another suitable red 10 segment "bargraph" i.e.d. is listed by Watford Electronics. Only six segments are used.

It is quite in order to use individual i.e.d.s for the display. These could be the TIL 209 or TIL 220 types. A small saving will be made by purchasing individual i.e.d.s and are more readily available.

Any relay with a coil resistance greater than 185 ohms and mains rated contacts at 2A to 3A according to the driveway bulb.

### Four-Band Radio

The coils, aerial, filters and amplifier i.c. required for the *4-Band Radio* are all available from Ambit International. The tuning capacitor and trimmers are available from Ambit, Home Radio, Watford Electronics and Maplin.

### Simple 3-Channel Stereo Mixer

All components for the *3-Channel Stereo Mixer* are readily available and should not be troublesome to obtain.

The front panel controls are all "log." types and the master volume control is a dual-ganged item.

### Ni-Cad Charger

The mains transformer used in the prototype unit of the *Ni-Cad Charger* was a RS type 196-381. It is possible to replace the 1mm range plugs and sockets with a multi-way rotary switch.

The TIP 3055 power transistor is available from most advertisers but be sure to mount it on the metal heatsink as indicated.

### I.C. Uniboard Power Supply

Looking through the "Comp" list for the *I.C. Uniboard—Power Supply*, the first items we come across that could cause problems are the wirewound resistors, rated at 4 watts.

Most suppliers seem to stock 3W and 7W types. However, the RS4 range stocked by Electrovalue are listed as 4W rating. Also the E24 wirewound series from Watford Electronics are claimed to be 5 watt types and would be suitable.

For a more even power dissipation (heat), the values of the wirewound resistors R2 and R3 could be changed to 4.7 ohms and 3.3 ohms 4 watts respectively.

It is strongly recommended that the TO-5 can voltage regulator type LM317H be used. The "H" denotes the TO-5 package. This device is available from Watford Electronics.

The TO-3 version can be used but will require a complete mica washer insulating bush kit.

The panel mounting TO-5 heatsink must be purchased with the insulating mounting pieces. These are listed in the Maplin catalogue as TO-5 Chassis Heatsink number WR34M.

A suitable mains transformer and bridge rectifier can be purchased from most advertisers, such as J. Bull, Magenta, Electrovalue, Maplin and Watford.

### Signal Tracer

When ordering the potentiometer VR1 for the *Signal Tracer* be sure to specify a log. (logarithmic) type with switch.

No other component problems should be encountered.

## NEW PRODUCTS

### Getting the Message

If you think that talking to a machine is a sign of impending madness—beware. The latest answering machine from Ansamatic is more than a glorified message taker.

This new model adds a new dimension to telephone answering by leading a caller through what might be a very complex message by asking questions and giving the caller time to answer; and if that is not enough it also acts as a dictation/transcription unit during the day. It is even set up so that if you make a mess the first time round you can go all the way through your message again.

Full details of the Doro 721 QA can be obtained from Ansamatic, Dept EE, Viatron

Doro  
721QA  
from  
Ansamatic

House, 928 High Street, Finchley, London N12 9SL.

### Fuel Economy

Cruise controls for the motor car are nothing new and at one time or another all sorts of ideas have been tried with varying degrees of success. However, the Cruise Sentry, marketed by Enviro Systems Ltd claims to be the "world's first 100 per cent electronic cruising control".

Various safeguards have been built into the design such that the system can be disengaged quickly and the

preset cruising speed can be modified at any point without first disengaging the unit.

The Cruise Sentry is available in the UK directly from Enviro Systems Ltd, Dept EE, Hemsfell Road, Grange-over-Sands, Cumbria LA11 6BE, price £78.50 plus VAT.

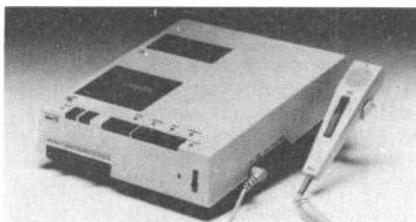
### Light Probe

The "Lite Probe" from Edward Fletcher and Partners consists of a small hand-held torch and a 230mm long flexible Fibre Optic Light Guide. It can be used for illumination and inspection in

inaccessible areas or wherever a direct light source will not penetrate.

It is easy to see who will benefit from such a device and the electronics constructor will find it especially useful when it comes to looking in dark corners.

The Lite Probe is available by post from the manufacturers: E. Fletcher and Partners Ltd, Dept EE, 25 West Park Road, Kew, Richmond, Surrey TW9 4DB, price £11.99 including post and packing and VAT.



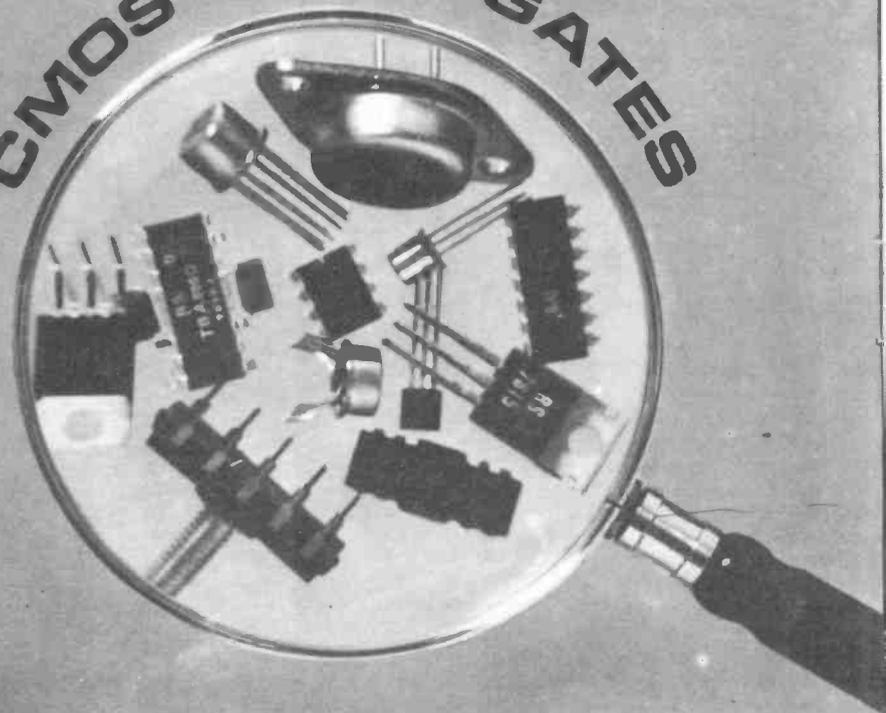
Enviro Systems Cruise Sentry

# I.C.s

## CMOS LOGIC GATES

### EXPLAINED PART 5

by O.N. BISHOP



SO FAR in this series the i.c.s described have all belonged to the group known as *linear* i.c.s. For the remainder of the series we shall be concerned with the other main group, the *digital* i.c.s. The essential difference between the two groups may be understood by looking at the way in which we describe their action.

#### LINEAR/DIGITAL

The action of a typical linear i.c., such as an amplifier is described in Fig. 5.1a. The input to the amplifier consists of a voltage that can vary over a given range of a few millivolts. The output of the amplifier varies correspondingly over a range of a few volts. For each value of input

voltage there is a corresponding output voltage and Fig. 5.1a is the graph that shows their relationship. The input and output voltages can take any of the infinite number of pairs of values within their ranges. The graph is a *line*, straight or perhaps curved, giving us the name *linear* for this type of circuit.

The action of a typical digital i.c. is described in Fig. 5.1b. It has two input terminals and one output terminal. The circuit operates properly only when its inputs are at one of two definite voltages. One voltage is 0 volt, the same voltage as the 0 volt rail of the power supply to the i.c. We often refer to this as "low" or use the symbol "0" as in Fig. 5.1b. The other voltage is a positive voltage, the same voltage as the positive power supply to the i.c. We refer to this as "high" or use the symbol "1". Voltages below low or higher than high usually damage the i.c. and voltages between low and high produce rather unpredictable results. So we are concerned with only two types of input—low or high, 0 or 1. Similarly the output of the circuit can be only low or high.

The behaviour of a digital circuit is not described by a graph but by a

table. In this we list all possible combinations of low and high inputs, together with the resulting output. Rather than write the words low and high or 0 volt and 9 volt we find it easier and clearer to use the symbols 0 and 1. The section of the i.c. is thus described by a table of *digits*, giving us the name *digital* for this type of circuit.

The action listed in Fig. 5.1b can be described in another way. It will be noticed that the output is high only when input A AND B are high. For all other input conditions, the output is low. In other words, the output is the result of applying the logical AND operation to the input conditions.

#### LOGICAL RULES

Digital circuits behave according to logical rules. This is why they are so important for performing logical operations and are the working elements of pocket calculators and digital computers. The table of Fig. 5.1b is identical with the *truth table* for AND, as it would be written out by a mathematician.

If we use the binary system, we can represent numbers by a series of 0s and 1s. For example, seven is represented by 111 in binary and 353 by 101100001. The voltages in our digital circuits can be used for logical operations, including arithmetical operations, having only two definite voltage

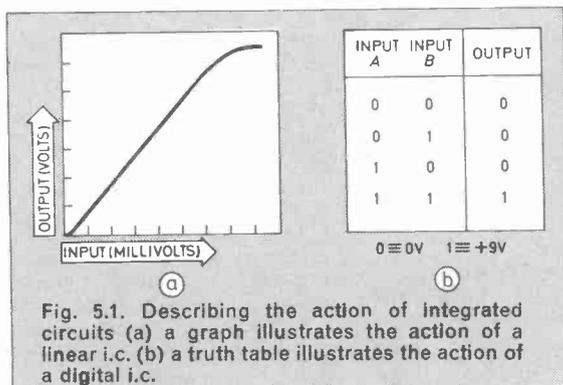


Fig. 5.1. Describing the action of integrated circuits (a) a graph illustrates the action of a linear i.c. (b) a truth table illustrates the action of a digital i.c.

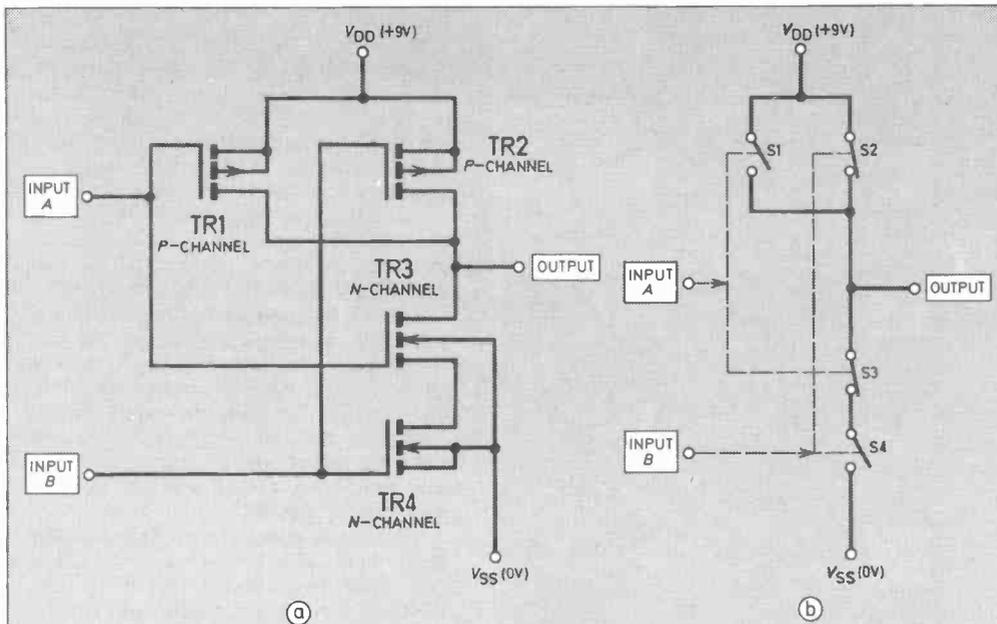


Fig. 5.2. A typical CMOS logic circuit (a) showing how the transistors are connected (b) equivalent circuit employing pairs of switches.

Table 5.1. Truth table for the action of circuits in Figs. 5.2 and 5.3.

INPUT A	INPUT B	OUTPUT
0	0	1
0	1	1
1	0	1
1	1	0

interconnected, means that extremely complex logic circuits can be fabricated on a single slice of silicon. In short, the properties of CMOS make it ideal for large-scale and very-large-scale integration (LSI and VLSI), providing us with microprocessors, memories and many other complex logic circuits.

levels. Digital i.c.s are reliable and fast acting, making them ideal for computers. This is why digital computers work in the binary system. Digital i.c.s are grouped into families according to their method of manufacture and operation. One of the earliest was DTL (diode-transistor logic) but this was quickly superseded by TTL (transistor-transistor logic); TTL (often known as the "7400 series") is widely used in computers because of its high speed of action. It requires relatively large amounts of power, but there are sub-families of TTL, such as the 74LS series (Low Power Schottky) which requires only one fifth of the power of standard TTL yet operates twice as fast. The TTL i.c.s employ ordinary bipolar transistors.

electrode of each transistor is insulated from the rest of the transistor by a film of silicon oxide, so the input impedance of each transistor is extremely high. This means that virtually no current is required to turn the transistor on or off. The result is that this family of i.c.s operates on only a few microamperes.

A further result is that the output of one circuit can be used as input to a hundred or more similar circuits. With TTL, the maximum number of circuits that can be so driven is usually limited to eight.

Low current consumption means small dissipation of power. This factor, combined with the ease with which hundreds of circuits may be

### CMOS PRINCIPLES

The principle of the simple logic circuit of Fig. 5.2a is shown in Fig. 5.2b. The switches are controlled in pairs, and are such that when one switch of a pair is off the other one is on. This follows from the fact that each pair consists of one p-channel and one n-channel transistor. Fig. 5.3 shows what happens for all possible combinations of inputs. The output is connected either to the positive supply line or to the 0 volt line, depending upon how the switches (i.e. the transistors) are set. The truth table of this action is seen in Table 5.1 and shows that for any given pair of inputs, the output is the opposite or

### CMOS DEVICES

Another large family is CMOS, which is based upon field effect transistors of the metal oxide silicon (MOS) type. Switching is performed by two complementary transistors, making the full name of this family "complementary metal oxide silicon" or CMOS for short. The CMOS family is the subject of the remaining articles of this series.

Each complementary pair of transistors consists of a p-channel MOS field effect transistor and an n-channel MOS field effect transistor. A p-channel transistor is switched on by a low input; an n-channel transistor is switched on by a high input.

In Fig. 5.2a we see how two complementary pairs of CMOS transistors are connected in an integrated circuit to perform a logical action. The "gate"

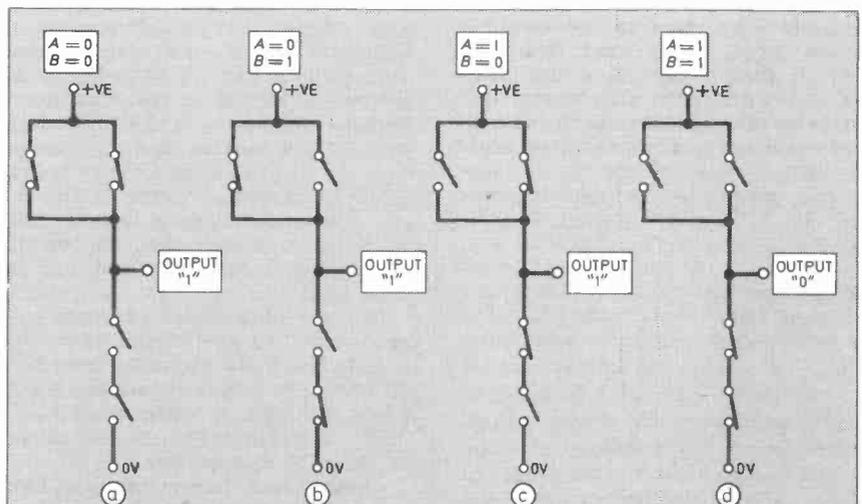


Fig. 5.3. Switching action of the logic circuit for all four possible combinations of input conditions. "0" = 0V and "1" = +9V.

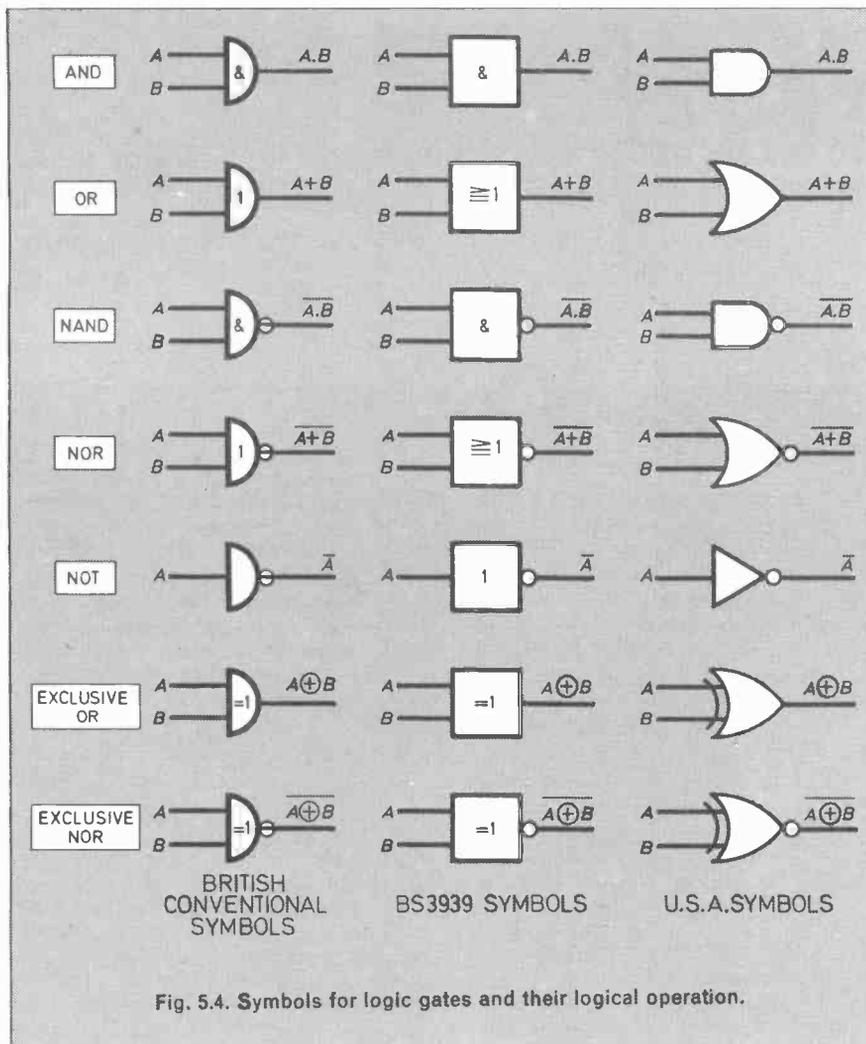


Fig. 5.4. Symbols for logic gates and their logical operation.

inverse of the output of an AND circuit (Fig. 5.1b). The output is INVERT-AND or NOT-AND, usually shortened to NAND.

The terms  $V_{DD}$  and  $V_{SS}$  need some explanation. Each MOS transistor has a "source" terminal through which electrons enter the transistor when a current flows. These come from the negative rail of the supply (0 volt) and the voltage at the source terminals of all transistors is called  $V_{SS}$ . The electrons drain away from each transistor by way of the "drain" terminals, toward the more positive voltage,  $V_{DD}$ . The difference between  $V_{DD}$  and  $V_{SS}$  ( $V_{DD} - V_{SS}$ ) can be anything between 3 volts and 18 volts and need not be regulated. This makes the CMOS family very convenient for use in battery-powered portable equipment (e.g. pocket calculators, digital wrist-watches). The third terminal to each transistor is the "gate", mentioned earlier. In speaking of logic circuits we often use the term gate to refer to a complete logical unit, such as the circuit of Fig. 5.2a. It is in this sense that the term will be used in the remainder of the series.

## LOGIC GATES

When we draw circuit diagrams of logic circuits we do not normally draw the individual transistors. Instead we use symbols to represent the gates (Fig. 5.4). The OR operation produces a high output when either A or B (or both) inputs are high; NOR is OR followed by the NOT (or INVERT) operation. In Fig. 5.4 the outputs are written according to the notation of Boolean algebra in which "." means AND, "+" means OR and " $\bar{A}$ " means "NOT A". On the symbols, NOT is indicated by the small circle at the output. These simple gates occupy little space on a silicon chip and an i.c. normally contains several gates of the same kind.

The pin connections of commonly-used CMOS i.c.s are illustrated in Fig. 5.5. Members of this family from RCA all bear type numbers beginning with 40 or 45. This is often prefixed by "CD", signifying i.c.s manufactured by the RCA Corporation.

Another well known family of CMOS i.c.s is from Motorola. Their prefix is MC1 followed by 40, 41 and 45. Generally these are pin compatible with those from RCA, e.g. MC14001

and CD4001, but check with data sheets first.

The first i.c.s to be produced belonged to the "A" series (CD4000A etc.), but these have now been replaced by the "B" series (CD4000B) which has greatly improved operating characteristics. In the full designation, the final letter indicates the type of package. The only kind likely to be met by the amateur is the dual-in-line plastic pack, indicated by the final letter E, as in CD4000BE.

All the B-series have buffered outputs. For example, the output of the NAND gate is followed by two NOT gates of the type shown in Fig. 5.6. The output is thus inverted twice, restoring it to its original form but with the advantage of more rapid rise and fall times, giving a better defined and crisper action.

The same NAND circuit followed by three NOT gates produces an AND output. Four gates of this type are supplied as the 4081BE, quadruple 2-input AND i.c. Buffering of outputs is a great improvement, but it increases the time that the gate takes to act (delay time) and makes it less suitable for operating at high frequency. Therefore certain i.c.s in the 4000 range are available with unbuffered outputs. These are designated by a "U" as in 4011UBE. Specialist CMOS i.c.s such as clocks, microprocessors and memories have their own type of numbering systems.

## FUNCTIONS

The 4000 i.c. is unusual in having two kinds of gate. Note that the NOR gates on this i.c. have three inputs. Their output is low when any one or more of their inputs are high. The single NOT (or inverter) gate is useful but it is often simpler to build such a gate from a NAND or NOR gate as in Fig. 5.7.

If a large number of inverters is required, the 4069 contains six such gates. Another i.c. containing inverters is the 4049, illustrated in Fig. 5.5. This is not only an inverter but also is a buffer. Note that it has no  $V_{DD}$  terminal but has a  $V_{CC}$  terminal instead. This i.c. can be used as a straightforward inverter i.c., the  $V_{CC}$  terminal being connected to the  $V_{DD}$  line.

Its special purpose is for interfacing between CMOS and other logic systems, such as TTL. The latter requires a 5 volt supply ( $V_{CC}$ ). By using this i.c., with pin 1 connected to +5 volt the inputs may be taken from CMOS, operating at any voltage in their range, and the maximum output voltage of any gate becomes +5 volts, which is compatible with TTL.

If buffer function is required, without the NOT action, there is the 4050 buffer i.c. which gives high output when its input is high and vice versa.

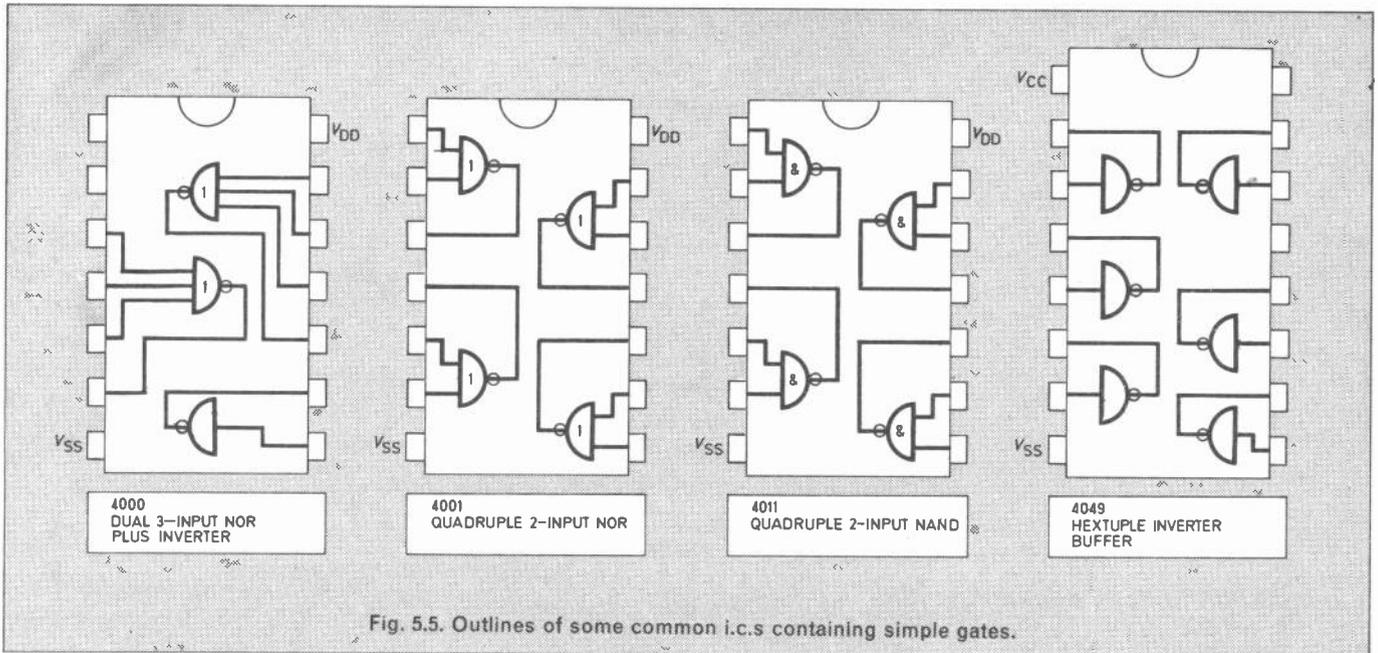


Fig. 5.5. Outlines of some common i.c.s containing simple gates.

Table 5.2 lists the logic gates currently available in the CMOS family. In addition, there is the 4007 "do-it-yourself" logic gate i.c. that will be

Table 5.2 Logic gates in the CMOS 4000 series.

Function	No. of inputs	Series number	No. of gates per package
AND	2	4081	4
	3	4073	3
	4	4082	2
	8	4068	1
NAND	2	4011	4
	3	4023	3
	4	4012	2
	8	4068	1
OR	2	4071	4
	3	4075	3
	4	4072	2
	8	4078	1
NOR	2	4001	4
	3	4025	3
	3	4000	2*
	4	4002	2
	8	4078	1
NOT	1	4049	6**
	1	4069	6
	1	4502	6***
	1	4041	4**
NON-INVERTING BUFFERS	1	4050	6***
	1	4503	6***
	1	4041	4**
EXCLUSIVE-OR	2	4070	4
EXCLUSIVE-NOR	2	4077	4

\* plus one NOT gate  
 \*\* buffer  
 \*\*\* tri-state output

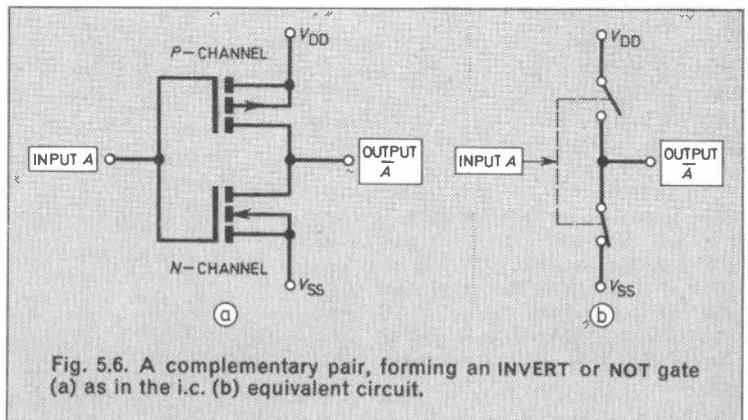


Fig. 5.6. A complementary pair, forming an INVERT or NOT gate (a) as in the i.c. (b) equivalent circuit.

described in a later part of this series. Certain devices, such as the 4078 and 4041 appear under two headings. They have two outputs, one output being the normal or "true" output and the other being the inverse of this. The 4078 can therefore be used as a NOR gate and as an OR gate at the same time.

Another logical function that is often used is EXCLUSIVE-OR. The gate has two inputs and differs from OR in that output is high when either A or B but not both A and B are high. In other words, its output is low when both A and B are low or when both A and B are high. Identical inputs give a low output.

A set of such gates is often used to compare one set of binary digits with another, one gate being used for the corresponding digits of each set. If both sets of inputs are identical, all outputs are low.

### TRI-STATE OUTPUTS

The 4502 and 4503 buffers differ from the others in that they have

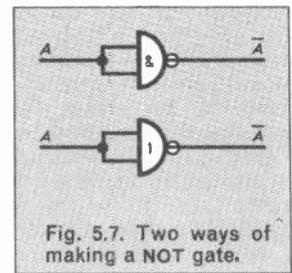


Fig. 5.7. Two ways of making a NOT gate.

what is known as a "tri-state" output. This may seem nonsense after it has been stressed that logic i.c.s have only two states—high and low. The third state is "high impedance". As Fig. 5.8 shows, in the high impedance state the output stage of the gate is isolated from the earlier stages.

This type of output is particularly useful in computers and microprocessor systems when we want to be able to use the same sets of lines (or buses) for transferring data between various parts of the system. The output terminals of all parts of the system are permanently wired to the

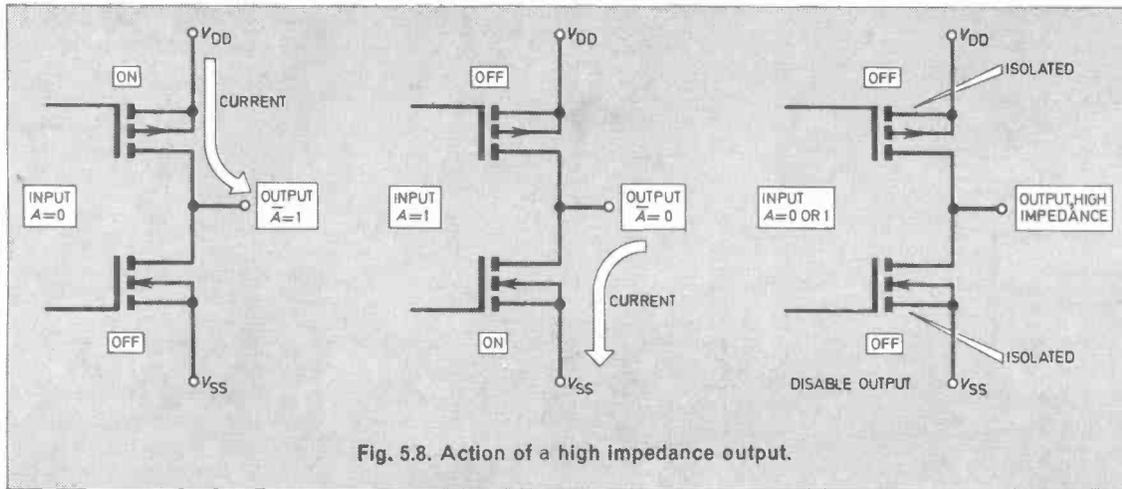


Fig. 5.8. Action of a high impedance output.

buses, but can be in effect disconnected under electronic control whenever necessary. When one i.c. is connected to the bus and transmitting data signals, the outputs of all other i.c.s wired to that bus are in the high impedance state so that they act as if they were not really there.

Perhaps the most versatile logic gate i.c. is the 4048. Not only does it have tri-state output but it has three control inputs that cause it to perform the AND, NAND, OR or NOR functions with up to eight inputs. Further functions are two 4-input gates, their outputs going to a 2-input gate, giving OR/AND, OR/NAND, AND/OR or AND/NOR.

Furthermore the i.c. has an expander input to which a second 4048 can be connected, giving a 16-input gate. For details of how to use this gate, see the manufacturer's data sheets.

### WORKING WITH CMOS

Apart from the well known precaution of avoiding static charges that could damage the i.c., working with CMOS presents no problems. They can be powered by battery or from an unregulated mains power-pack at any voltage between 3 volts and 18 volts. Their inputs can be connected directly to 0 volt or the positive rail. Indeed, it is essential to do this for any unused inputs, otherwise the i.c. will not function properly. The optimal operating voltage is around 10 volts; a 9 volt PP3 battery is suitable for portable equipment and, since current consumption is low, (0.01µA per gate when quiescent) the battery will last a long time.

Currents of a few milliamperes can be drawn from the output terminals. A convenient way of indicating the state of an output is to wire an l.e.d. between the output and  $V_{SS}$  (0 volt). No series resistor is needed if the supply is below 6 volts.

For switching on filament lamps or other devices, the output can be fed directly to the base of a transistor. For high-power switching, one of the

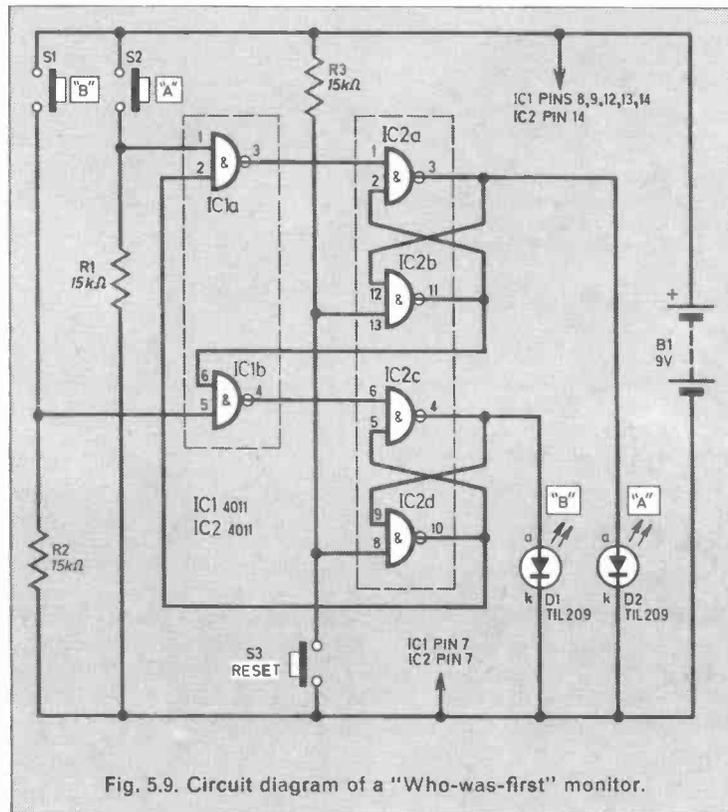


Fig. 5.9. Circuit diagram of a "Who-was-first" monitor.

vmos field-effect power transistors is ideal (VN66AF for example).

### TWO FOR YOU TO TRY

The delay time of CMOS gates is less than a microsecond, so they are ideal for timing operations. In the circuit of Fig. 5.9 we use them for split-second timing, to indicate which of two buttons was the first to be pressed. This circuit could be useful as a judge in "snap" or other games where it is essential to know "who was first".

The l.e.d.s are turned on by pairs of gates cross-connected to make flip-flops. To begin with, push-button S3 is pressed to make inputs to pins 8 and 13 low. When the button is

released they are held high by pull-resistor R3. Resetting makes outputs at pins 3 and 4 go low, so the l.e.d.s are not lit. To switch an l.e.d. on, a low pulse must arrive at pin 1 or 6. The gates in IC1 control the inputs to IC2. Since pin 1 is low (because of R1) and 2 is high (from IC2 pin 10) output of IC1 pin 3 is high. If S1 (player A) is pressed first, the output becomes low, triggering the flip-flop to change state and lighting D2. Now pin 11 of IC2 is low, so both inputs to player B's gate in IC1 are low. If button S2 is pressed, the output at pin 4 stays low. B is too late!

If B is pressed before A, the reverse happens: D1 lights and D2 remains dark.

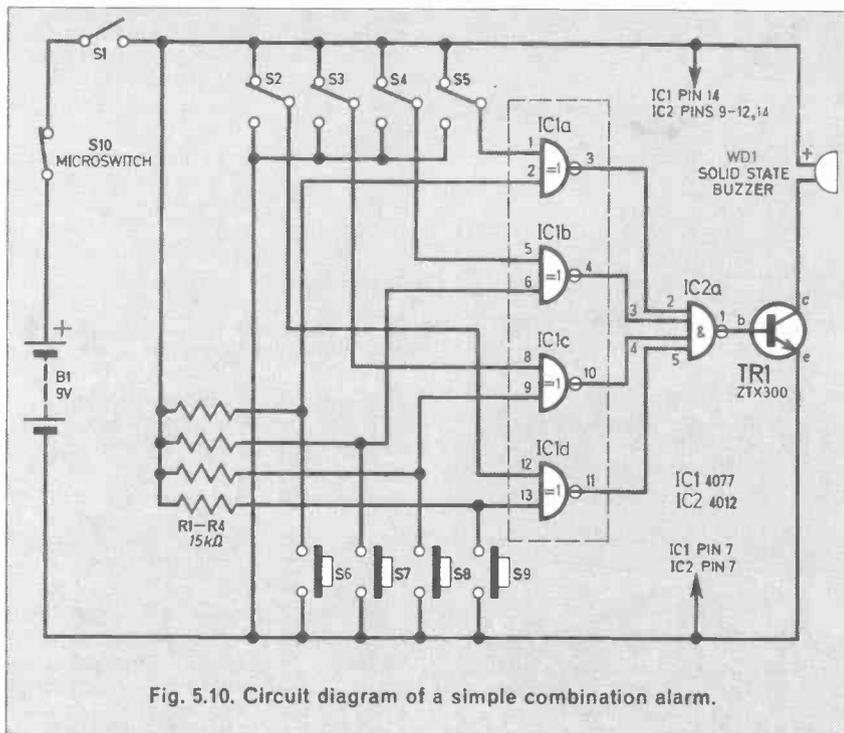


Fig. 5.10. Circuit diagram of a simple combination alarm.

The combination alarm of Fig. 5.10, can be used as the basis of many kinds of combination lock circuits. Here it is used to sound the alarm when a person not in the know opens the door of a room or cupboard. S1 is the master switch, hidden just inside the doorway. S10 is a micro-switch, open when the door is closed, but closing whenever the door is opened. S2 to S5 are switches inside

the room that may be set to any one of 16 high-low combinations. S6 to S9 are push-buttons mounted outside the door or on its outer surface. When leaving the room, set the combination on S2 to S5; then close S1. The alarm will probably sound, but stops when the door is shut (opening S10).

Since the circuit is now off, no battery current is being wasted. The door cannot be opened again without

sounding the alarm and, unless the intruder knows were S1 is hidden, the alarm sounds until the door is closed again. However, if the one correct combination of buttons S6 to S9 is pressed, the inputs to pins 2, 6, 9 and 13 will match those at pins 1, 5, 8 and 12. In this event all outputs from IC1 are high.

An all-high input to the NAND gate of IC2 makes its output go low. No other combination of inputs causes this to happen. The circuit is automatically switched on (by S10) as the door is opened but, since the output of IC2 is low, no alarm sounds. S1 should be in reach of the doorway so that the circuit can be turned off. However, if even one button is pressed (or not pressed) incorrectly, one of the pairs of inputs fails to match, one exclusive-NOR gate gives a low input and the output of IC2 goes high, sounding the alarm.

For simplicity this circuit uses a solid-state buzzer. This may be mounted outside the room or elsewhere. By using an extra i.c. a flip-flop could be provided so that, once triggered, the alarm would sound indefinitely. This circuit has only 16 combinations, but has the advantage that a single mistake makes the alarm sound as soon as any attempt is made to try to open the door. It could be extended to eight buttons (256 combinations) by using a second 4077 and by substituting an 8-input NAND gate (4068) for IC2.

Next Month: Multivibrators and Flip-Flops.

## BOOK REVIEWS

### TRANSISTORS—QUESTIONS AND ANSWERS (4th Edition)

**Author** Ian R. Sinclair  
**Price** £1.75  
**Size** 165 × 110mm 104 pages  
**Publisher** Newnes Technical Books  
**ISBN** 0 408 00485 1

IT MAY COME as quite a surprise but the transistor has now been with us for over thirty years and although vast strides have been made in design and applications, semiconductor principles still form the backbone of virtually all modern electronic equipment.

It is against this background that Questions and Answers—Transistors by Ian Sinclair has been re-released. Unfortunately, it's not quite so easy as you might imagine to answer a question such as "What is a transistor?" in half a page and some answers have been oversimplified to the point of making them difficult to follow.

However, the book does cover a lot of ground and could be used as a quick reference volume. Whether it provides the "simple and concise answers" quoted on the back cover is another matter.

S.E.D.

### TELEVISION AND RADIO 1981 (19th Edition)

**Editor** Eric Croston  
**Price** £2.90  
**Size** 190 × 229mm 224 pages  
**Publisher** Independent Broadcasting Authority  
**ISBN** 0 900485 39 6

EXPANSION is the theme of this year's book, as the IBA looks forward to the Fourth Channel, due to commence in the autumn of 1982. New horizons and fresh opportunities are discussed, and the plans for the next decade outlined. Packed with background facts, figures and photographs this colourful and informative publication gets better every year; without a single advertisement!

The seven main sections include a focus on Radio, Education, Drama, Sports, Science, Religion, The Arts and Regional Broadcasting, all presented in a lively format with plenty of well produced colour photographs of the stars and presenters, technicians and crew.

Technical details include radio reception area maps for each local station, showing transmitter sites for m.w. and v.h.f. together with frequency data.

D.G.



A QUICK means of locating faults in radio frequency, intermediate frequency and audio frequency stages of receivers, or in amplifiers used with microphone, pick-up or other input, is to use a signal tracer. The tracer described here can be switched at once for r.f. or a.f. circuits, and has enough sensitivity for low signal levels.

### AMPLIFIER AND PROBE

From the circuit in Fig. 1 it will be seen that there are two main items—the probe, with its isolating and detector circuits, and amplifier. The latter has an input gain control VR1, and preamplifier TR1.

Amplified signals from TR1 collector pass to TR2, which is directly coupled to the output transistor TR3. The output is taken from the emitter of TR3 to a 75 ohm speaker, and will be found to provide easily adequate volume. The whole amplifier has considerable gain, though needing relatively few components.

Switch S1 selects a.f. or r.f. conductors of the twin screened flexible lead to the probe. With S1 in the a.f. position, audio signals are taken via C2 and R1 in the probe. When S1 is set to the r.f., audio is obtained via R2, after detection by D1 in the probe, C1 being an isolating capacitor.



### AMPLIFIER BOARD

The amplifier is built up on a piece of 0.15 inch stripboard, size 10 strips by 22 holes and components are positioned as in Fig. 2. Place a few items

at a time, turn the board over and solder the projecting leads, and snip off excess wire. Locate C5, C7 and C8 with the polarity shown.

A few points should be noted. Breaks in the copper strips are needed as shown in Fig. 2. These can be made with a cutter, or with a few turns with a sharp drill. Check that each break is complete, and that fragments of foil are not turned out to touch adjacent strips.

Later, the board will be fixed to the metal panel by two bolts, with extra nuts to give clearance.

Provide flying leads for the speaker, and red and black for positive (via S2) and negative battery connections. Connections should also be made to VR1 slider and a wire is taken from the negative line to one end of VR1 to form a common earth point.

### PANEL ITEMS

The front panel is made from sheet aluminium, 165 x 85mm. An aperture to match the speaker cone is cut with an adjustable tank or washer cutter, and perforated metal or fabric is cemented behind it, then the speaker cemented in place. The switch S1 and VR1/S2 are located as in Fig. 2.

The screened lead passes out through a grommet, as does a flexible wire fitted with a crocodile clip, used for earthing when necessary.

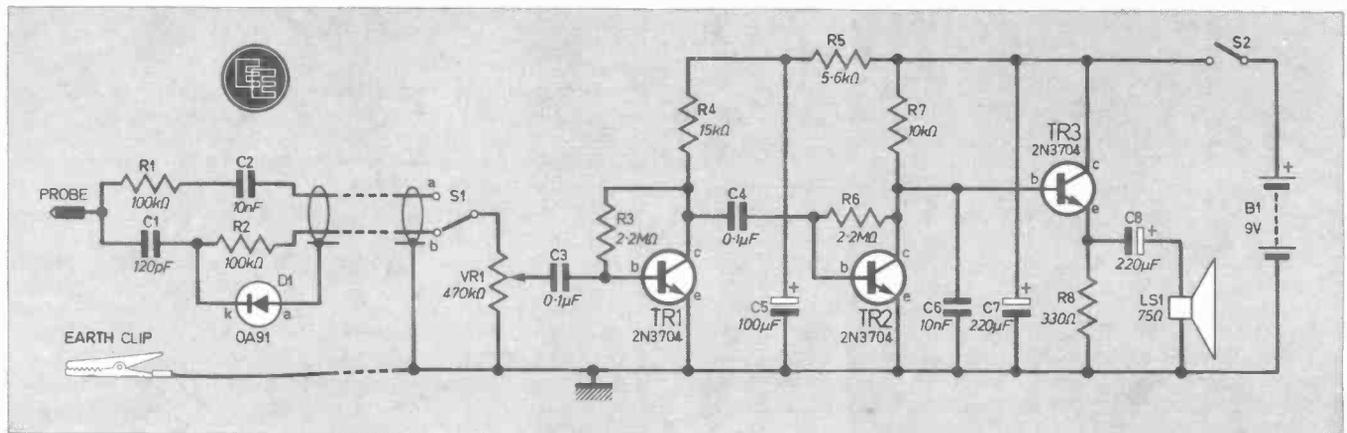
### CASE

This was made from wood. The bottom is 100 x 165mm and top 75 x 165mm. Thin plywood is suitable here. Each side is made from 8mm plywood, 100mm wide at the bottom, sloping to 75mm wide at the top, and 73mm high. Four screws hold the panel in place. A PP7 or other 9V battery is accommodated.

### PROBE ASSEMBLY

This was made from a felt-tipped pen case, with the inside contents removed. Components are first

Fig. 1. Full circuit diagram of the Signal Tracer. Note that position a on S1 selects the a.f. components and position b the r.f.



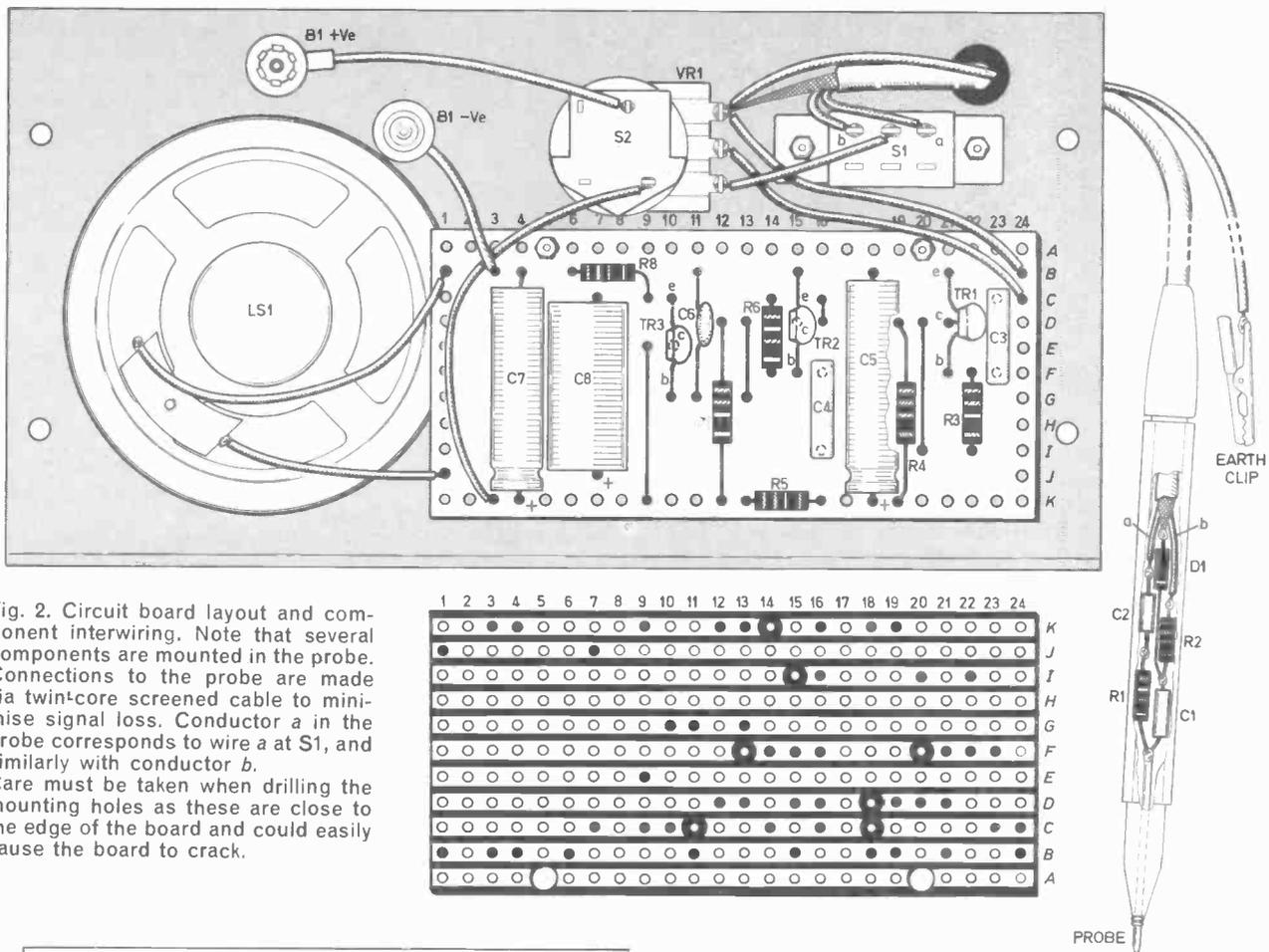


Fig. 2. Circuit board layout and component interwiring. Note that several components are mounted in the probe. Connections to the probe are made via twin-core screened cable to minimise signal loss. Conductor a in the probe corresponds to wire a at S1, and similarly with conductor b. Care must be taken when drilling the mounting holes as these are close to the edge of the board and could easily cause the board to crack.

## COMPONENTS

### Resistors

- R1 100k $\Omega$
- R2 100k $\Omega$
- R3 2.2M $\Omega$
- R4 15k $\Omega$
- R5 5.6k $\Omega$
- R6 2.2M $\Omega$
- R7 10k $\Omega$
- R8 330 $\Omega$

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

See  
**Shop  
Talk**  
page 93

### Capacitors

- C1 120pF polystyrene
- C2 10nF polyester or polystyrene
- C3 0.1 $\mu$ F polyester
- C4 0.1 $\mu$ F polyester
- C5 100 $\mu$ F 25V elect.
- C6 10nF polyester or polystyrene
- C7 220 $\mu$ F 25V elect.
- C8 220 $\mu$ F 25V elect.

### Semiconductors

- TR1-TR3 2N3704 npn silicon (3 off)
- D1 OA91 small signal germanium diode

### Miscellaneous

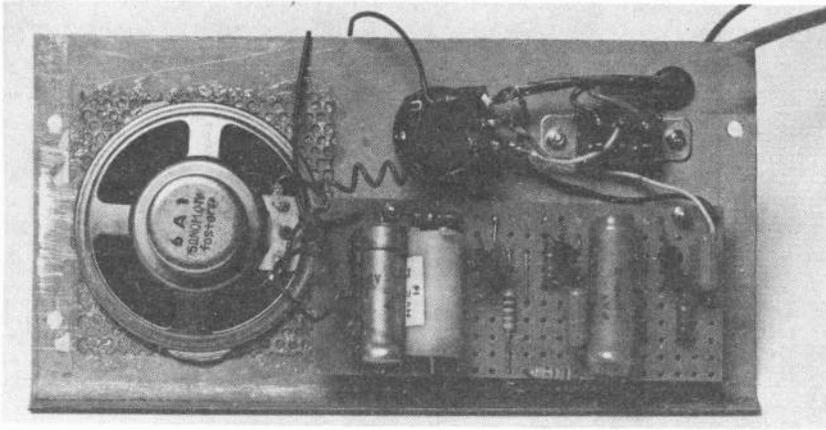
- VR1/S2 470k $\Omega$  log. potentiometer with s.p.s.t. switch
- S2 s.p.d.t. slide switch
- LS1 75 ohm, 2.5 inch diameter speaker
- B1 9V PP7 type with connectors

Stripboard, 0.15 inch matrix, size 10 strips by 22 holes; 8mm plywood for cabinet; aluminium panel, size 165 x 80mm, for front panel; screened cable; interconnecting wire; empty pen shell for probe housing; nail for probe; crocodile clip; knob; expanded metal mesh for speaker covering.



Exterior of the completed unit showing earth lead and probe in foreground.

COMPONENTS  
approximate  
cost **£7**



View of the rear of the front panel showing circuit board in position.

arranged as in Fig. 2, and soldered together. Use sleeving where necessary, though most joints can be kept clear of bare connections and other joints.

The probe is a piece of very stout wire, and is initially left long enough to pass down through the case. The pen top should have already been threaded on the screened lead. Draw items into the case as in Fig. 2, and solder a small washer or loop of wire round the probe, at the end of the case, to prevent it going back in. Cut the wire so that about 10mm projects. Fit the case top.

### TRACER USE

For all audio equipment, set S1 to the a.f. position. With non-working apparatus, test systematically from the earlier point at which the audio signal will be available. This could be the microphone itself.

Move the probe progressively along through the audio circuits, to take in leads, plugs and jack sockets, connections from sockets to switches or controls, coupling capacitors, and so on.

If the signal ceases to be heard in the tracer speaker, the interruption must arise between the point the previous test was made, and this point.

As pre-amplifiers and other stages are introduced, gain will have to be reduced by VR1, to avoid overloading. Where a signal is found at the base of a transistor, but not its collector, investigate the stage in detail by checking resistors and other components.

The earth clip is used to earth the tracer to the equipment being tested. Attach this to the earth line of the latter.

### I.F. AND R.F.

With receiver i.f. circuits, set S1 to the r.f. position. The signal can then be detected and traced through the intermediate frequency transformers, and associated components. In this way, the stage at which signals cease to be heard can quickly be found.

Radio frequency circuits allow some tests in a similar way, depending on the signal level. To test an aerial circuit alone, an external aerial will usually need to be coupled to it, to provide a signal for the detector. This coupling can often be provided by means of a few turns of insulated wire on the ferrite rod aerial, where used, and connected to aerial and earth.

*The tracer is intended only for use with transistor equipment where no high voltages are present.* □

## BOOK REVIEWS

### UNDERSTANDING COMMUNICATIONS SYSTEMS

**Authors** Don L. Cannon and Gerald Luecke  
**Price** £3.50 Limp  
**Size** 210 × 134mm 288 pages  
**Publisher** Texas Instruments Ltd  
**ISBN** 0 89512 035 6

**T**HIS is one of the Understanding Series of books developed at the Texas Instruments Learning Centre, Dallas, Texas, to provide easy-to-understand texts for all those wanting to learn quickly and effectively about modern electronic technology.

The volume is divided into ten sections, each with a learning quiz: plus a short but useful glossary. Although based on a "block-schematic" rather than a circuit-diagram approach, this book undoubtedly does what it sets out to do: provides an understandable in-depth introduction to the whole world of modern telecommunications including radio, television, telephone networks and computer data networks.

It is far from a "beginners only" book although the beginner will find in it the merits of a well-designed teaching course. Unfortunately for British readers it suffers from a serious handicap. Many of the systems and standards used in the UK differ from those found in the United States.

For example all television in this book is 525 line NTSC and it is Bell Telephone System rather than British

Telecom that is mentioned in several sections. This is a serious disadvantage in an otherwise excellent and up-to-date book.

P.H.

### SOUND RECORDING FROM MICROPHONE TO MASTERTAPE

**Author** David Tombs  
**Price** £7.95 Hardback  
**Size** 220 × 145mm 222 pages  
**Publisher** David and Charles  
**ISBN** 0 7153 7954 2

**H**ANDS UP who remembers the old reel to reel tape recorders that everyone used to enjoy making silly noises into. You may also remember that however hard you tried to make a professional-sounding recording, it always seemed to come out wrong.

Of course good equipment always helps but even with the most expensive rig in the world, it's still what you do with it that counts and that's where this new book scores.

The author, a professional sound engineer, has set out deliberately to inform and encourage the amateur to get the best out of his equipment, not by spending a fortune on sophisticated gadgetry but by greater understanding of all the aspects of sound recording.

Some of the techniques used for catching animal sounds are particularly interesting and these are both fascinating to read and practical to use. Other topics covered in detail include studio recording, tape editing, and an extensive section on microphones and the author gives many tricks of the trade for getting round problems quickly and effectively.

This hardback volume costs £7.95 which is about average for a book of this size but for anyone looking for an authoritative text on the subject, it is well worth it.

S.E.D.

Long Wave  
 Medium Wave  
 SW1 1.6-4.5MHz  
 SW2 4.6-14.6MHz

# 4 BAND RADIO

By R.A. Penfold



the degree to which the set can pick up just one transmission from a close group of stations).

The oscillator is tuned to a frequency which is 455kHz above the input signal frequency, and the heterodyne effect then produces a difference output frequency at the required i.f. For example, if the desired reception frequency is 900kHz, the oscillator would be tuned to 1.355MHz (1,355kHz), giving a difference frequency of 455kHz (1,355 - 900 = 455).

## TUNED CIRCUIT

A tuned circuit at the input of the mixer is used to select signals at the desired reception frequency and attenuate other frequencies. This is necessary to limit the amount of signals fed to the mixer and prevent it from being overloaded. It also attenuates spurious responses which are a problem with any superhet.

One of these responses is called the "image response", and in the example given above it would occur at 1.81MHz (1,810kHz - 1,355kHz = 455kHz). Other responses occur due to breakthrough at the intermediate frequency and due to harmonics on the oscillator signal (signals at multiples of the oscillator frequency). At the frequencies involved here a single tuned circuit at the input is sufficient to adequately attenuate these unwanted responses.

## TWO STAGE I.F.

Two stages of i.f. amplification are employed in the receiver, and a ceramic filter is used to couple the two stages. The latter requires no alignment as it is accurately manufactured to operate at the correct frequency, and this helps to simplify the alignment of the set. The ceramic

**A** PART from covering the standard medium and long wavebands, this receiver additionally has two short wave ranges covering from about 1.6MHz to 4.5MHz, and 4.6MHz to 14.6MHz.

The set is primarily intended for the reception of ordinary a.m. broadcast stations, but it has a b.f.o. (beat frequency oscillator) which can be switched in for s.s.b. (single side-band) and c.w. (Morse) transmissions, enabling most amateur band transmissions to be resolved.

## SENSITIVITY

The circuit is of the superheterodyne type, and is therefore quite sensitive and selective when compared with a simple t.r.f. (tuned radio frequency) set. It is also easier to operate. However, it is also far more complex and expensive to build than a simple t.r.f. set, and is likely to cost more than a comparable ready-made receiver! Nevertheless, it does make a very worthwhile and interesting constructional project that can provide many hours of entertainment when finished.

The circuit has been designed to eliminate the complicated alignment that is normally associated with superhet receivers, and the simple alignment that is required can be completed without the aid of any test equipment.

## SUPERHET

While it is not essential for constructors to understand the superheterodyne principle, it is very helpful to have such an understanding. The block diagram of Fig. 1 shows the stage line-up of the receiver, and helps to show the way in which it operates.

The aerial signal is applied to one input of a mixer, and the other input of the mixer is fed from an r.f. oscillator. The purpose of these two stages is to convert the incoming signal to another frequency, known as the intermediate frequency or i.f. In this case an i.f. of 455kHz is used, and whatever the received signal frequency may be, it is converted to 455kHz.

The point of doing this is that at the fixed and relatively low intermediate frequency it is easy to obtain high gain and a reasonably narrow bandwidth. This gives the set good sensitivity and selectivity (the latter being

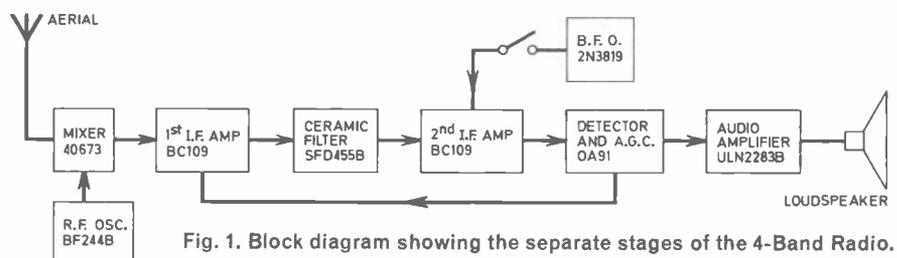


Fig. 1. Block diagram showing the separate stages of the 4-Band Radio.

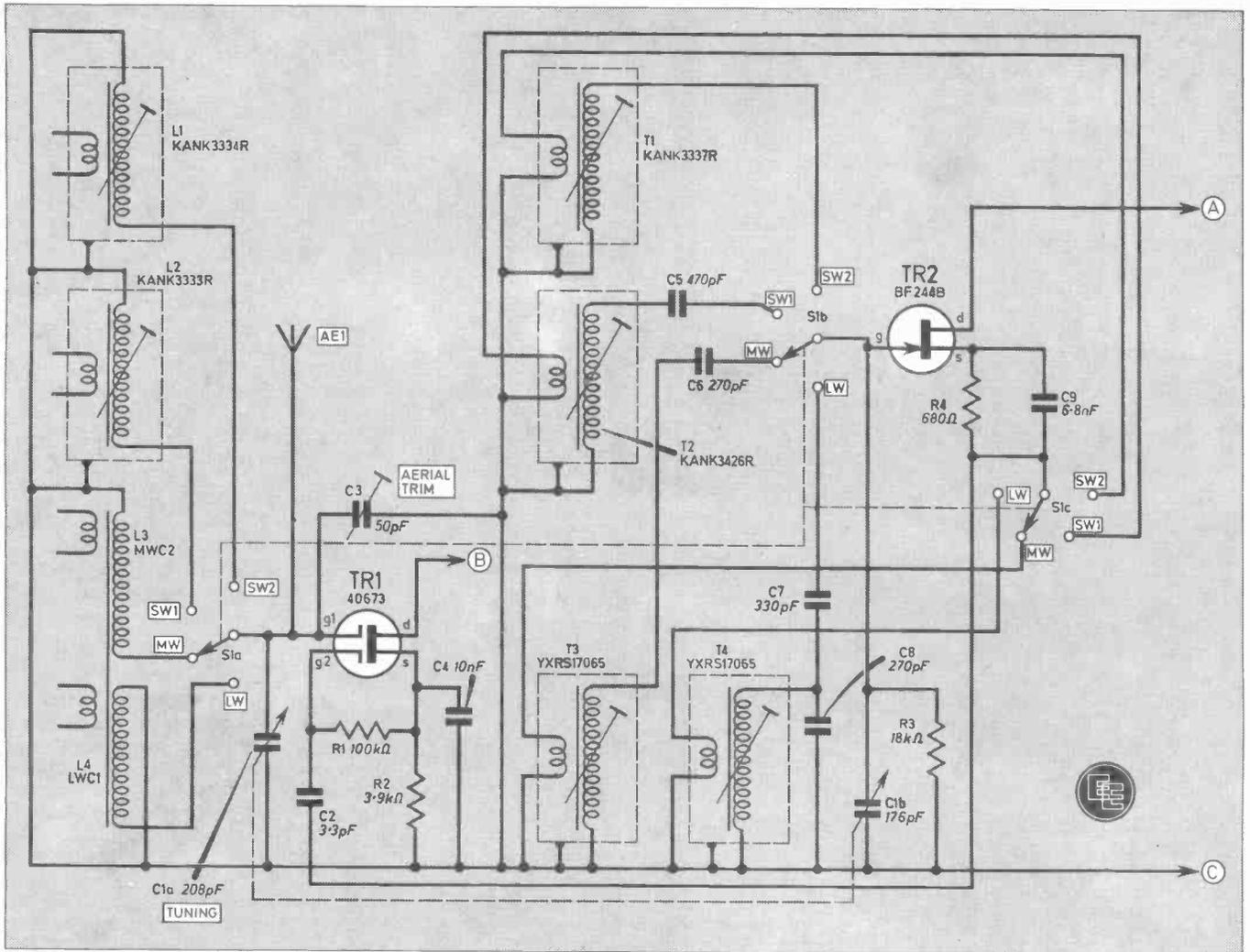


Fig. 2. The circuit diagram of the mixer and oscillator section of the 4-Band Radio.

filter provides most of the system selectivity.

The output from the second i.f. amplifier is fed to a detector which extracts the audio signal which is modulated onto the carrier wave. This is then fed to an audio power amplifier and to the loudspeaker.

In addition to the audio signal, the detector produces a d.c. potential which is proportional to the strength of the received carrier wave, and this is used to control the gain of the first i.f. amplifier. The circuit is arranged so that the stronger this d.c. signal, the lower the gain of the first i.f. stage. This is known as a.g.c. (automatic gain control) and has the effect of giving an almost constant audio output level from signals of greatly differing strengths. It also prevents very strong signals from overloading the set, and helps to counteract fading when receiving stations that are prone to this phenomenon.

A b.f.o. can be used to inject a signal into the second i.f. amplifier to permit the reception of s.s.b. and c.w. transmissions.

## MIXER AND OSCILLATOR

The circuit diagram of the mixer and oscillator stages of the receiver is shown in Fig. 2. This is really quite simple, although the waveband switching slightly complicates matters.

A dual gate m.o.s.f.e.t. (TR1) is used in the mixer stage. R2 is the source bias resistor and C4 is its bypass capacitor. The gate 2 terminal must be biased about 1 volt positive, and R1 couples a suitable bias voltage to this terminal from the source of TR1. The oscillator signal is coupled to the gate 2 terminal of TR1, and has the effect of varying the gain from the gate 1 terminal of TR1 to its drain terminal. The aerial signal is coupled to the gate 1 terminal, and is modulated by the oscillator signal to give the required heterodyne effect.

## COILS

There are four aerial coils, one for each waveband where L3 and L4 are the medium wave and long wave coils respectively, and are part of a ferrite rod aerial assembly.

Ferrite aerials are not very efficient at the higher frequencies involved in short wave reception, and so a telescopic aerial is used on the two short wave bands. In order to provide a good signal transfer this aerial is coupled direct into gate 1 of TR1. L1 and L2 are the two short wave aerial coils, and S1a is used to select the required aerial coil.

A m.o.s.f.e.t. has a very high input impedance, and the aerial coils can therefore be coupled direct to TR1, with the low impedance coupling winding on each coil being ignored. The coils are used to bias gate 1 of TR1 to the negative supply rail.

Tuning capacitor C1 is the tuning capacitor for the aerial coils, and C3 is the aerial trimmer control. The latter is used to keep the aerial tuned circuit peaked at the correct frequency, and eliminates the need for any complicated r.f. alignment.

Transistor TR2 is a j.u.g.f.e.t. device which is used as the basis of the oscillator. It is used in the source follower mode with the selected oscillator transformer being used to pro-

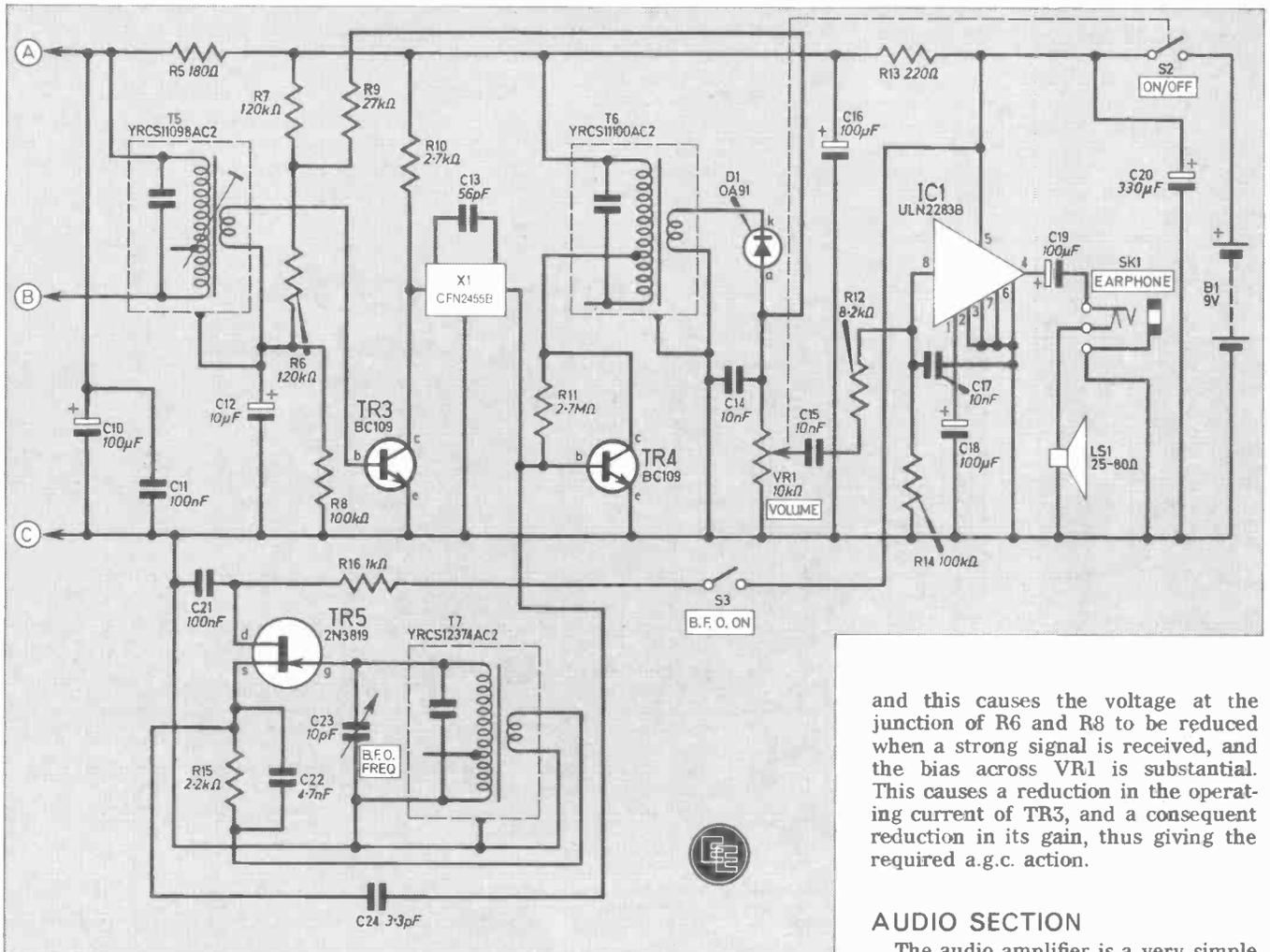


Fig. 3. The remainder of the circuit diagram containing the r.f. amplifier, detector, a.g.c., audio and b.f.o. stages of the 4-Band Radio.

vide positive feedback from the source circuit to the input at the gate.

Although the source follower has less than unity voltage gain, there is sufficient feedback to sustain oscillation due to the voltage step-up through each oscillator transformer. Components R4 and C9 are the source bias resistor and bypass capacitor, with R3 acting as the gate bias resistor.

The tuning capacitor for the oscillator is ganged with the "mixer" variable capacitor. S1b selects the tuned winding of the required oscillator coil and S1c selects the appropriate oscillator coil primary winding. On the medium, long, and short wave 1 ranges, C1b has a value which is slightly too high, and padder capacitors C5 to C7 are used in series with it to effectively reduce its value. Additionally, C8 is connected across the tuned winding of the longwave transformer in order to reduce its operating frequency range to the correct level.

The output from the oscillator is coupled to the mixer via C2. As TR2

is used in the source follower mode it has a fairly low output impedance, and gives reasonably good freedom from oscillator "pulling".

### I.F. AND AUDIO

The circuit diagram of the i.f. amplifier, detector, a.g.c., audio, and b.f.o. stages appears in Fig. 3.

Transformer T5 couples the output from the mixer to the input of the first i.f. amplifier transistor, TR3. The output from TR3 is coupled to the second i.f. stage by X1, a two stage ceramic filter, and C13 is used to couple the two stages. The second i.f. amplifier is a simple common emitter amplifier which is coupled by T6 to the detector. The latter is quite conventional, and consists of D1, C14 and VR1. TR3 is biased via R6 and the secondary winding of T5 from a potential divider formed by R6, R7 and R8. However, R9 and VR1 are shunted across R6, R8, and have an effect on the bias current of TR3. In fact, the smoothed r.f. half cycles across VR1 produce a negative bias,

and this causes the voltage at the junction of R6 and R8 to be reduced when a strong signal is received, and the bias across VR1 is substantial. This causes a reduction in the operating current of TR3, and a consequent reduction in its gain, thus giving the required a.g.c. action.

### AUDIO SECTION

The audio amplifier is a very simple type which is based on the ULN2283B audio i.c. Its input is biased by R14, and C15 provides d.c. blocking at the input. An r.f. filter consisting of R12 and C17 is connected at the input of the amplifier to ensure that no significant r.f. signal breaks through to the i.c., as this would almost certainly result in instability. Capacitor C19 provides d.c. blocking at the output. The output connects to the speaker via a break contact on the earphone socket, and this automatically cuts out the internal speaker when the earphone is in use. The set can be used with any normal type or earphone or headphones (e.g. low impedance magnetic, crystal).

### B.F.O.

The b.f.o. uses the same configuration as the local oscillator, but uses an i.f. transformer so that it oscillates at 455kHz. C23 enables the operating frequency to be tuned slightly either side of 455kHz to permit the reception of upper and lower sideband signals. The b.f.o. signal is loosely coupled into the second i.f. stage by C24. Only a fairly low level of b.f.o. injection can be used as this signal would otherwise strongly operate the a.g.c. circuitry,

and seriously reduce the sensitivity of the set. Switch S3 controls the positive supply line to the b.f.o, and acts as the b.f.o. on/off switch. The b.f.o. is still coupled to the second i.f. stage when it is switched off, but it has no significant effect on the i.f. amplifier due to the loose coupling used.

The quiescent current consumption of the set is about 15mA, but this can rise to over 50mA at high volume levels as the output stage of IC1 is a class B type.



## COMPONENT PANEL

With the exception of the controls, phones socket, telescopic aerial, and battery, all the components are mounted on a piece of plain 0.1 inch matrix s.r.b.p. panel, and wired together on the underside of the panel. Fig. 4 illustrates the component layout and the underside wiring of the panel. The board measures 149 x 114 mm and is arranged 58 x 42 holes. This is a standard size in which 0.1 inch matrix board is sold.

Commence construction of the board by drilling the three mounting holes. The coils and i.f. transformers are then fitted into place. Although these have bases designed to fit a 0.15 inch matrix layout, they will fit diagonally onto a 0.1 inch matrix board. It is necessary to slightly enlarge the holes that take the mounting lugs of these components, and a drill bit of about 2mm in diameter is needed to do this. The mounting lugs are bent flat against the underside of the panel in order to hold the coils firmly in position.

## FERRITE ROD

The ferrite rod aerial is mounted in a pair of purpose-made plastic clips, and the latter are mounted on the board using very short (about 6mm long) M3 or 6BA bolts and fixing nuts. Two holes in the board should be enlarged so that they will accept these mounting bolts.

Next the other components are gradually fitted on to the board, their leadout wires are bent flat against the underside of the panel, and they are wired together in the appropriate way. In most cases the leadout wires are long enough to complete this wiring, but in a few cases it will be necessary to use say, 22 s.w.g. tinned

copper link wires. It is advisable to insulate the wiring with p.v.c. sleeving at places where it is congested, so as to avoid the possibility of accidental short circuits occurring.

It is the larger windings of L3 and L4 that are used, and a visual inspection of the medium wave coil will show which two tags connect to the

main winding. The larger winding of the long wave coil connects to the two tags either side of a coloured spot marked on the coil former.

Although TR1 is a m.o.s.f.e.t. device, it has internal circuitry to protect it against static charges and therefore requires no special handling precautions.

## COMPONENTS

### Resistors

R1	100k $\Omega$	R9	27k $\Omega$
R2	3.9k $\Omega$	R10	2.7k $\Omega$
R3	18k $\Omega$	R11	2.7M $\Omega$
R4	680 $\Omega$	R12	8.2k $\Omega$
R5	180 $\Omega$	R13	220 $\Omega$
R6	120k $\Omega$	R14	100k $\Omega$
R7	120k $\Omega$	R15	2.2k $\Omega$
R8	100k $\Omega$	R16	1k $\Omega$

All  $\frac{1}{4}$  Watt carbon  $\pm 5\%$ ,  $\pm 10\%$  over 1M $\Omega$ .

### Capacitors

C1	208pF + 176pF ganged air spaced (Jackson type O) slow motion drive	C13	56pF ceramic plate
C2	3.3pF ceramic	C14	10nF polyester C280
C3	50pF air spaced (Jackson type C804)	C15	10nF polyester type C280
C4	10nF ceramic	C16	100 $\mu$ F 10V
C5	470pF ceramic plate	C17	10nF ceramic plate
C6	270pF ceramic plate	C18	100 $\mu$ F 10V
C7	330pF ceramic plate	C19	100 $\mu$ F 10V elect.
C8	270pF ceramic plate	C20	330 $\mu$ F 10V
C9	6.8nF ceramic plate	C21	100nF polyester type C280
C10	100 $\mu$ F 10V elect.	C22	4.7nF ceramic plate
C11	100nF polyester type C280	C23	10pF air spaced (Jackson type C804)
C12	10 $\mu$ F 10V elect.	C24	3.3pF ceramic

### Semiconductors

IC1	U1N2283B 875mW audio amplifier i.c.
TR1	40673 or MEM616 dual gate m.o.s.f.e.t.
TR2	BF244B <i>n</i> -channel j.u.g.f.e.t.
TR3	BC109 silicon <i>n</i> p <i>n</i>
TR4	BC109 silicon <i>n</i> p <i>n</i>
TR5	2N3819 <i>n</i> -channel f.e.t.
D1	OA91 silicon diode

### Inductors

L1	KANK3334R 5.5 $\mu$ H shortwave coil
L2	KANK3333R 45 $\mu$ H shortwave coil
L3	MWC2 medium wave antenna coil
L4	LWC1 longwave antenna coil
T1	KANK3337R 5 $\mu$ H shortwave oscillator coils
T2	KANK3426R 38 $\mu$ H shortwave oscillator coils
T3	YXRS17065 180 $\mu$ H medium wave oscillator coils
T4	YXRS17065 180 $\mu$ H medium wave oscillator coils
T5	YRCS11098AC2 1st a.m. if. transformer
T6	YRCS11100AC2 3rd a.m. if. transformer
T7	YRCS12374AC2 2nd a.m. if. transformer

### Miscellaneous

S1	3-pole 4-way rotary
VR1/S2	10k $\Omega$ log. with ganged switch
S3	miniature s.p.s.t. toggle
SK1	3.5mm jack socket with single break contact
LS1	miniature loudspeaker having coil impedance 25 to 80 ohms
X1	CFN2455B 455kHz a.m./i.f. ceramic filter
AE1	telescopic aerial, 1 metre extended
B1	9V PP6 battery

0.1in plain matrix board size 58 x 40 holes; Verocase type 75-1411D (205 x 140 x 75mm) or similar; 160mm long 9.5mm diameter ferrite rod; control knobs (4 off); mounting clips for the ferrite aerial, type FRPC (2 off); Jackson 44mm, 6 to 1 dial and drive (m.e.s.).

### NOTE

If C1 is a component having integral trimmers, these should be fully unscrewed so as to provide minimum capacitance.

**COMPONENTS**  
approximate  
cost **£35**

See  
**Shop  
Talk**

page 93

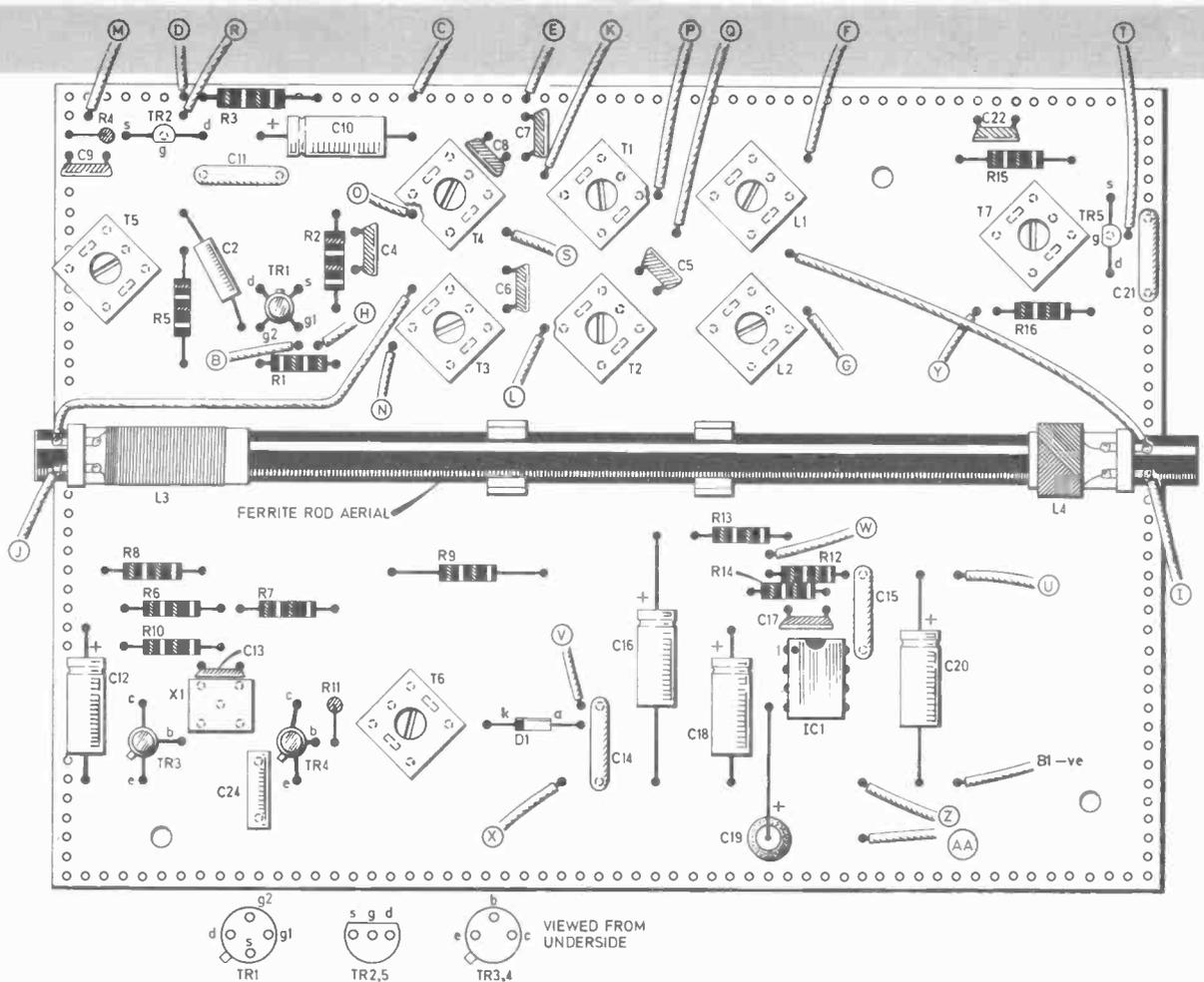
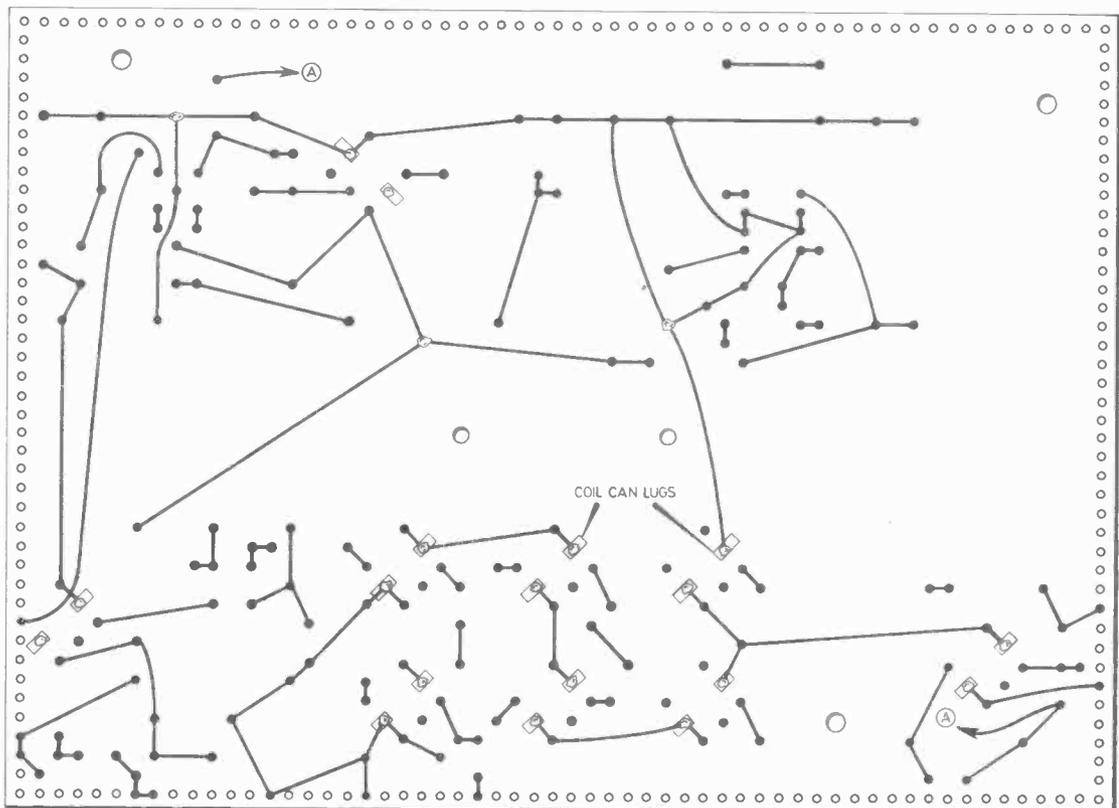


Fig. 4. The layout of the components on the topside of the circuit board and their interconnection (below) on the underside. Also shows flying leads to the case mounting components.



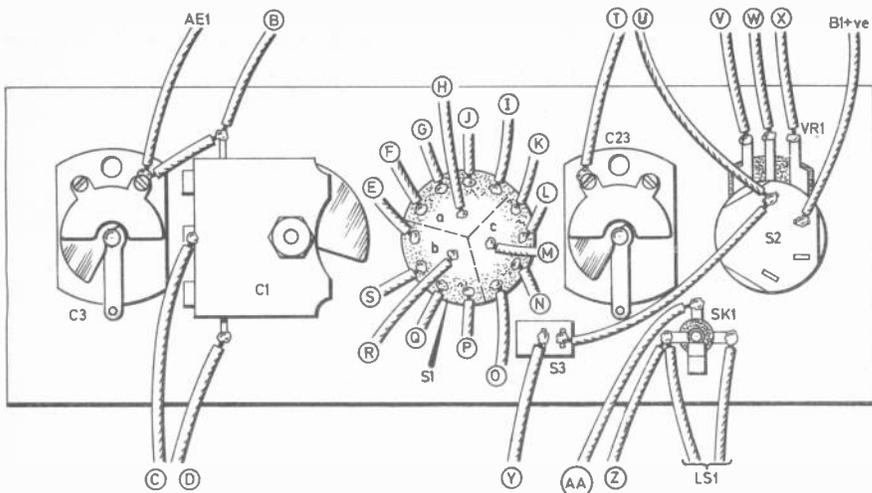


Fig. 5. The layout and interwiring of the front panel mounted components. See photograph and text for C3/C1 bracket fixing details.

## CASE

The prototype was housed in a Verobox which has approximate outside dimensions of 205 x 140 x 75mm. It is not essential to use the same case, and any box of a similar size and of non-metallic (or largely non-metallic) construction should be suitable. The set would probably work if housed in a metal case, but the ferrite aerial would be screened by the case, and performance on the medium and long wavebands would suffer since the set would have to operate using the telescopic aerial alone.

## FRONT PANEL LAYOUT

Reference to the accompanying photographs will show the front panel layout of the unit, and it is recommended that constructors should keep

to this general layout. The rotary controls each require a standard 10mm diameter mounting hole, except for C1 which is fitted with a slow motion drive and dial. This requires a main 25mm diameter cut-out which can most easily be made using a chassis punch. An alternative is to drill a ring of small, closely spaced holes just inside the perimeter of the required cut-out. It should then be possible to punch out the piece of metal at the centre of the cut-out, and file the rugged hole to a neat finish using a large half round file.

The two smaller mounting holes can then be drilled in the panel, after using the drive as a template to help mark the positions of the holes. Short M3 or 6BA bolts (about 6mm long) and fixing nuts are used to fix the drive to the panel, with the mounting

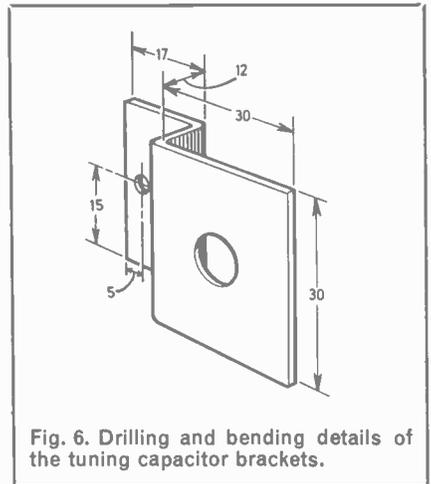


Fig. 6. Drilling and bending details of the tuning capacitor brackets.

plate of the drive being positioned on the rear side of the panel.

If SK1 and S3 are standard components they will each require a 6.5mm diameter mounting hole.

Mounting and wiring details on the front panel are shown in Fig. 5.

## TUNING CAPACITOR BRACKET

A small aluminium mounting bracket is required for the tuning capacitor, and this is detailed in Fig. 6. It can be constructed from thin (20 or 22 s.w.g.) aluminium as it is mainly required to prevent the whole of the tuning capacitor from rotating when the tuning drive is operated, rather than to give any support to the component.

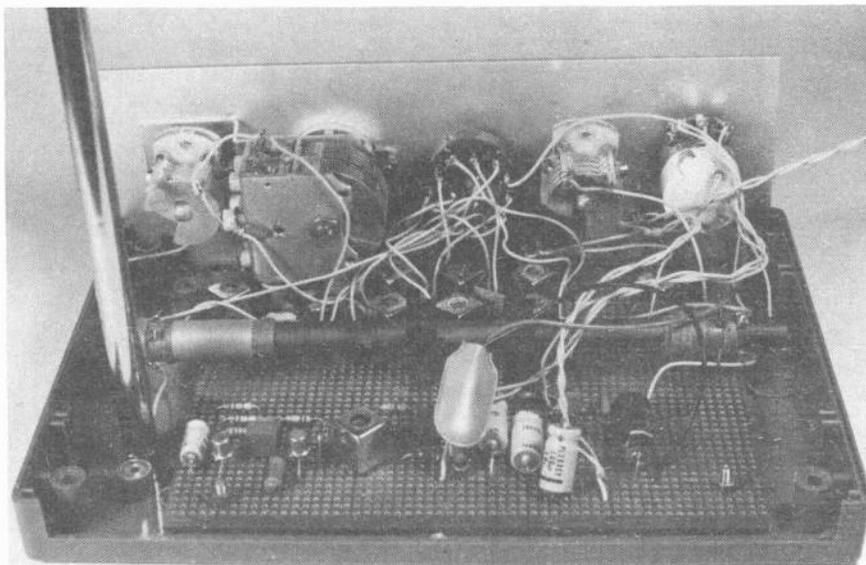
The position of the mounting hole for C3 is found by fitting the bracket into place, and then marking through the mounting hole for C3 in the front panel. The bracket is fixed to C1 using a short 4BA screw which fits into a threaded hole in the front of the component. This must not be allowed to penetrate more than about 3 or 4mm into C1 as this could result in the capacitor becoming damaged. If necessary, use washers to reduce the penetration of the screw to an acceptable level.

The mounting bush and nut of C3 are used to effectively bolt the bracket to the front panel.

## AERIAL AND SPEAKER

The telescopic aerial is mounted on the base panel of the cabinet, towards the rear, right hand corner. Most types have provision for mounting by means of a 4BA screw which fits into a threaded hole in the base of the aerial. A hole for the aerial must also be made in the top panel of the case.

The loudspeaker is mounted on the top panel of the case, and a small matrix of holes about 6mm in diameter are drilled in the top panel to



form a speaker grille. The speaker is then carefully glued in place beneath this using a good quality general purpose adhesive such as Bostik No. 1.

## WIRING

Next, the component panel is wired up to the other components. The complete wiring is shown in Figs. 4 and 5. Start by wiring the panel to the waveband switch, S1. This wiring must be kept as short as possible, and will probably be easier if S1 is temporarily dismantled from the front panel while this wiring is completed. The other wiring is all quite straight forward. The connection to the telescopic aerial is made via a 4BA solder tag fitted on the mounting bolt.

When the wiring has been completed, the component panel is mounted on the base of the cabinet. The specified case has mounting pillars moulded into its base section, but in this application these tend to get in the way. They can easily be drilled away using a drill of about 10mm in diameter. The component panel can then be used as a sort of template with which the positions of the three mounting holes in the case are located. The panel is mounted using M3 or 6BA bolts about 12.5mm long.

The PP6 battery fits into the space at the rear of the case, and an aluminium mounting bracket can be fabricated for it, and fixed to the rear panel.

## ADJUSTMENT

After giving the wiring a thorough check for errors, and correcting any that are found, the set is ready for testing and alignment. Start with the set switched to the medium waveband (MW), as it should be possible to locate a few stations on this band with little difficulty. L3 can be slid along the ferrite rod to peak received signals. Tune accurately to a station of consistent strength, and then adjust the core of T5 to peak this signal. It is easiest to accurately peak adjustments with the set tuned to a weak station as these will not be much affected by the a.g.c. action of the set. The tuning of T6 is very broad, and the setting of its core not very critical, although it should not be unscrewed too far as this could give a poor passband shape, and could even cause instability.

Now tune to a station with the vanes of C1 about half meshed, set C3 for about half capacitance, and slide L3 along the ferrite rod to the position that gives maximum signal strength. L3 should then be taped or glued in this position. There is no need to adjust the core of T3 unless there is an obvious lack of coverage at one or other end of the medium waveband.

T3 core can then be adjusted to correct this, and L3 should be realigned. However, it is unlikely that T3 will need any adjustment.

Next switch S1 to the long waveband position (LW), adjust C1 for slightly less than half capacity, and adjust the core of T4 to tune-in BBC Radio 4, 200kHz long wave transmission. With C3 still at half capacitance, L4 is slid along the ferrite rod to peak this transmission, and is then glued or taped in this position.

With the telescopic aerial fully extended, switch S1 to the SW1 position, search for a station with C1 at about half capacity, and adjust the core of L2 to peak this station (with C3 still at half maximum capacitance). Switch S1 to the SW2 position and repeat this procedure with the core of L1. Note that a proper trimming tool must be used when adjusting the cores of L1 and L2.

Finally, the b.f.o. is aligned. Tune accurately to any a.m. broadcast station and switch on the b.f.o. using S3. By adjusting the core of T7 it should be possible to produce an audio tone from the speaker that varies in pitch as the core is adjusted. With C23 set at half maximum capacitance, adjust the core of T7 for the lowest possible audio output note.

## USING THE SET

The tuning, wavechange, volume, and on/off controls of the unit are quite conventional. The aerial trimmer control (C3) is merely adjusted to peak received signals. The b.f.o. is switched in for the reception of s.s.b. and c.w. signals, and in the case of the latter the setting of the b.f.o. tuning control (C23) is of little importance. For the reception of s.s.b. the b.f.o. tuning must be offset from a central position. Lower sideband is almost exclusively used on the three low frequency amateur bands (160, 80 and 40 metres), and this mode requires the vanes of C23 to be adjusted so that they are virtually fully meshed.

Table 1. Received frequency as a function of dial position for the two short-wave bands in the prototype.

Dial Reading	Received frequency (MHz)	
	Range SW1	Range SW2
0	1.66	4.6
10	1.79	4.95
20	1.9	5.35
30	2.01	5.75
40	2.15	6.2
50	2.3	6.8
60	2.55	7.6
70	2.9	8.7
80	3.5	10.5
90	4.25	13.1
100	4.5	14.6

The 20 metre amateur band lies at the high frequency end of the sw2 range (vanes of C1 almost unmeshed), and upper sideband is the form of s.s.b. mainly used on this band. Upper sideband reception needs C23 to be offset in the other direction, with its vanes largely unmeshed.

For c.w. reception, the tuning control is adjusted to give an audio tone of the desired pitch. The tuning is much more critical than for s.s.b. reception, and the tuning control must be carefully adjusted to give an audio output of the correct pitch. Strong s.s.b. signals will swamp the b.f.o. signal, giving a very distorted audio output. This can be avoided by keeping the volume control well advanced, and detuning C3 to keep the volume down to a reasonable level.

When using the set on the short wavebands the telescopic aerial should be fully extended, and it is advisable to use a fairly long aerial (about 1 metre or more). It is not essential to extend the aerial for medium and long wave reception, although performance on these bands will be improved by doing so.

## EARTH AND AERIAL

Performance can be improved by using an earth connection, and this merely connects to the negative supply rail. There is plenty of space on the rear panel to accommodate an earth socket. The earth itself can consist of a metal pipe buried in the ground and connected to the receiver by a lead which should be as short as possible.

An external longwire aerial can be coupled to the telescopic aerial, and again, a suitable socket can be added to the rear panel of the set. An external aerial will be of most use on the SW1 range during daylight hours (when signal strengths are normally low), but can also be of benefit on any band when conditions are poor and signal strengths are low. An external aerial should not be used if the telescopic aerial is capable of providing good signal strengths, as the mixer could become overloaded with a consequent reduction in performance.

## DIAL CALIBRATION

To assist users in tuning, the author has provided the data in Table 1 from measurements taken on the prototype unit. The dial marker is sited centrally above the dial. The Table allows the operator to see at a glance which frequency is being tuned in by noting the dial reading and the band selector switch position. A copy of this Table glued to the top of the case should prove very useful.

✧



to part of two stalls. Perhaps this was due to the rather ambiguous legal position surrounding the whole subject.

## THE PRESS

Magazines play a big part in encouraging electronics as an interest and a hobby and all the major titles were represented. It gave each magazine a chance to show off their projects and meet their readers.

The fact that it was getting near to Christmas time hadn't eluded the staff at EVERYDAY ELECTRONICS and the major part of the stand was given over to electronic games. These certainly attracted the public, especially the children, including four year old Clare Birkby from Wargrave near Reading.

Her father, Mr Roy Birkby, told us how Clare and her seven year old sister Jane became interested in electronics.

# BREADBOARD 80

## SHOW REPORT

**R**ECESION—What recession? So one exhibitor summed up the response amongst visitors to this year's Breadboard 80 Exhibition held at the Royal Horticultural Halls in London recently.

Attendances were 60 per cent up on last years figures and at £1.50 a time there can't have been many casual observers.

### EXHIBITORS

From the exhibitors point of view this could only have meant more business and improved public relations although it was surprising how few new products were on show.

Still product consolidation isn't such a bad thing and as Tina Knight, Managing Director of Continental Specialities Corporation put it:

"We can offer last year's models slightly cheaper which helps us and the customers as well. We get a chance to meet people and get our latest catalogues out."

In fact CSC have just introduced an extension to their Experimenter Solderless Breadboard System which consists of free leaflets called "Three for Free". These contain full circuit and assembly details for three simple projects. CSC hope to keep adding to the range.

Other new products include two new frequency counters and a new

"idea box" which has gone down very well in the United States.

Meanwhile that other stalwart of the electronics market, Vero, were relying chiefly on their Verobloc solderless breadboard and Verokit hobby kits to provide interest—and with some success.

Mike Humphries, Retail Sales Manager said: "Sales have been incredible. Over 2,000 catalogues have gone at 40p each and we've handed out over 5,000 leaflets on the Verokits."

However, Vero were also showing off their new wire wrapping kit. Priced at around £38 it contains a power wrap tool with rechargeable batteries, battery charger, stripping tool, cutters and wire, and is all British.

### COMPONENT SUPPLIERS

Overall most of the major component suppliers had a stand of some sort although several of our regular advertisers were conspicuous by their absence. Again Maplin Electronics had the largest stand and their main attractions were the new "Matinee" organ and the 5600 synthesiser, both of which were demonstrated frequently. However, the new catalogue was by far the biggest selling point.

The promised CB contingent was in fact quite small, really only confined



Getting younger every year! Four year old Clare Birkby tries her hand at the Live Wire Game.

He said: "I bought a computer kit recently and the two girls became interested in all the bits and pieces whilst I was building it up. They wanted to know what everything was and now Jane can read the circuit diagrams."

Of course many people of all ages have taken up electronics but its a sign of our times that when one fellow explained why he would have more time for his hobby, he said: "I'm being made redundant tomorrow." ❏

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# Everyday ELECTRONICS

**MARCH 1981**  
ISSUE ON SALE  
FRIDAY, FEBRUARY 20

# Everyday News

## APPRENTICE OF THE YEAR

Andrew Easdown a 21 year old former apprentice at Chatham Naval Base has been named the M.o.D. Apprentice of the Year.

He was presented with his award by the Countess Mountbatten of Burma in a ceremony at the Ministry of Defence, Whitehall early in December.

Andrew, son of an Army cook, was one of 2,000 final year apprentices eligible for the award and his trophy took the form of a gold plated contemporary column on an oak plinth. He finished his apprenticeship in August and is now a professional and technical officer working on Chatham Naval Base development.

In the run up to the final award each of the four areas of M.o.D. responsibility nominated their own Apprentice of the Year and Andrew won the Dockyard section. The other areas were Royal Ordnance Factories, Services Support and Procurement Executive.

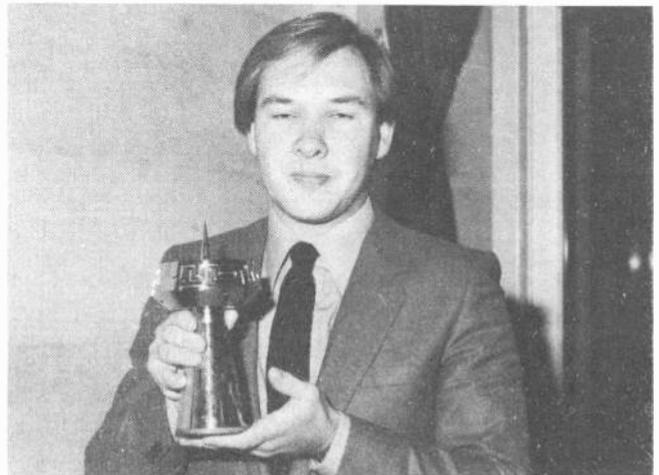
At the same ceremony the Countess unveiled two clocks made by apprentices at RAE Farnborough in memory of her father, Earl Mountbatten of Burma.

One of these clocks, a reproduction 1710 English design, was made from brass and stainless steel and en-

closed in an oak case. The timber was salvaged from the HMS Victory during restoration work.

The other was an ultra-modern electronic design with both analogue and digital time display controlled by a pulse signal from the Post Office transmitter in Rugby.

Both have been installed in the Concourse Hall of the Ministry of Defence Building and will be a permanent tribute to Earl Mounbatten who, in the early days of his naval career, was a signals officer.



## INDUSTRIAL REVOLUTION

*One would be blind not to see the ever growing importance of all kinds of information, not only for vital business decisions but for personal choices in our everyday life, for consumer products and services.*

*We have traditionally relied on paper and print for most of such information. Now, progress in electronics and the availability of computing capacity at low cost by integrated circuits is making it possible to collect, process and distribute much more information much more quickly to many more users in many more ways.*

*The effect of information technology may indeed amount to a new industrial revolution; and just as we in Europe led the world in the transition from agricultural economies to industrialised societies, so we need to be in the forefront of this new change.*

The above is an extract from a speech given by the Minister of State for Industry, Mr. Adam Butler, M.P., at a symposium on Viewdata Systems in The Hague recently.

Mr. Butler, who has special responsibility for information technology, forecast that the effects of information technology may amount to a new industrial revolution in which Europe must lead the world.

### Just the Ticket

A contract from British Rail for 200 electronic ticket issuing machines worth in the region of £1 million has been awarded to Westinghouse Revenue Controls, the ticket machine branch of Westinghouse Brake and Signal Co Ltd.

These intermediate ticket machines are an improved version of the small station microprocessor-based machine, sixty of which are being delivered for use in the

Clyde rail area of the Scottish Region of British Rail. They have a full tally-roll printout and record data in a magnetic cartridge for subsequent analysis.

**British Telecom, the fourth largest telecommunications system in the world, now has 26.7 million telephones on line through 6,310 exchanges. Despite the doubling in size over the last ten years the number of staff at 240,000 is substantially the same as before.**

## M.P.s on Trial

In their response to the Home Office discussion document "Open Channel" the Citizens Band Association have drafted a 24-point response in which they are highly critical of their proposals, particularly with regards to expense and efficiency of such a service. They do, of course, offer alternative suggestions.

In a separate letter to M.P.s the association have also offered to loan a Citizens Band Receiver so that they may make their own evaluations on the merits of such a service. They regret that they are unable to loan transmitters, as their possession and operation is illegal.

### —On The Air—

*In the first nine months of 1980 only 331 people were charged with illegal use of 27MHz CB radios. Six were acquitted and 325 convicted. This is a tiny fraction of an estimated 200,000 illegal users.*

*Legal licensed "hams" are increasing fast. Membership of the Royal Society of Great Britain topped 25,000 last year with the enrolment of a record 4,215 new members.*

### TEACHING MICROS

Twenty-nine projects to the value of £1.2 million have been approved by the British Government in the first phase of a four-year programme to encourage the development of microelectronics in education. The total programme, including items like teacher-training and software, has been budgeted at £9 million up to 1984.



## ANALYSIS

### GIMMICKS GALORE

A prominent and essential feature of our Twentieth Century consumer society, particularly marked in consumer electronics, is the endless search for and promotion of new ideas translated into saleable products, at least different but ostensibly also better than "last year's model".

There was no problem in selling radio in the 1920s and 1930s. The rapid spread of sound broadcasting did the trick. The pattern was repeated with television in the 1950s and momentum was maintained up to saturation point. Slump was averted by a switch to 625-line monochrome followed by colour TV.

Sound radio also experienced new booms with the transistor portable and later the cassette radio and clock radio. Audio had its booms, too, with the L.P. record, (first mono, then stereo), reel-to-reel recorders, cassette recorders and the music centre.

The new wave of promotion, now that saturation has set in for colour TV with almost every household having one, is concentration on VTRs and, soon, video disc, plus an urge to equip with teletext, to expand our repertoire of TV games and even to add on home computing equipment with the TV as a VDU.

We are by no means nearing the end of the road. Even old-fashioned steam radio is scheduled to have a new generation of micro-processor-controlled domestic receiver capable of being programmed in advance for a whole week of listening. It will not only switch itself on and off at the right times but will automatically tune itself to the correct channel and if alternative channels are available, that for best reception. Programming will just be a simple matter of stroking a light-pen across a bar-code adjacent to the programme details in the Radio Times. The MPU does the rest.

Brian G. Peck

This year's Leeds Electronics Exhibition will be held from June 30 to July 2 in association with the organisers of the All Electronics/E.C.I.F. Show.

### Safety at Sea

A new type of radio navigation beacon designed to be easily used by small boats, including pleasure craft, is on trial at a number of locations round the coast of Britain. Developed by Standard Telecommunications Laboratories, the beacon transmits on v.h.f. and can be received on any v.h.f. radio, even on a domestic portable.

A yachtsman can fix his bearing by timing with a stop watch for maximum or minimum audio signal or, alternatively, by counting tone cycles. Range is typically 20 nautical miles if the beacon is well-sited above sea level as is the trial installation at North Foreland.

### First Computer Language Standards

Computing in the UK enters a new phase with the publication by British Standards Institution of the first British Standards to deal with general purpose programming languages.

The standards involved are BS 5904 and BS 5905 which specify the semantics and syntax for two different computer programming languages (RTL/2 and CORAL 66) already in common use for the control of industrial processing and general applications in real-time computer systems.

The 12th annual Scottish Electronics Exhibition and Convention, "Scotalex '81," will be held during the period June 2 to 4, 1981, at the Royal Highland Exhibition Hall, Ingliston, Edinburgh EH28 8NF. Admission is free via tickets available from Exhibitors or the Organisers, the Institution of Electronics.

## Chips for Maggie

The millionth integrated circuit microprocessor, otherwise known as "the chip," to be produced by the Mullard UK factory was presented to the Prime Minister Margaret Thatcher in the House of Commons recently.

### Buzby meets Tintti

The chatty British Telecom bird, Buzby, is making his first real flight abroad to Finland.

The National Association of Telephone Companies in Finland has just signed a contract with British Telecom for the exclusive rights in Finland to the Buzby character for all forms of advertising, excluding merchandising.

In Finland, Buzby will be known as "Tintti", and will appear in four of his original British TV advertising campaigns: Happy Birthday, The Hospital, Laughing Buzby and The Girlfriend.

## ON SHOW

Projects from the Young Engineer for Britain competition (see last month's issue), are among exhibits being displayed at the Brighton and Hove Engineerium in an exhibition jointly organised by the Industry/Education Unit, Department of Industry and Industrial Containment Ltd.

The exhibition is open until February 28 and includes the overall winners of the 1979 and 1980 competitions. Although the exhibition is free, there is a charge of 30p for children, OAPs, and 60p for adults to the Engineerium.

The Home Secretary has appointed the Rt. Hon. Lord Thomson of Monifeth to be Chairman of the Independent Broadcasting Authority in succession to Lady Plowden, D.B.E. Appointed to be Deputy Chairman of the I.B.A. is Sir John Riddell, Bt.

## THINK BIG—SAYS TEXAS

Equipment designers attending *Interface 80* at London's Talk of the Town were urged to think big where memory chips are concerned. According to speakers at this year's Texas Instruments seminar it will be wise to design new computing equipment around 64K devices even though the entire capacity may not be utilised initially. The cost of memories is steadily falling, and it will prove economical in the coming months to use the larger devices.

A wide range of micro-products were introduced to the large audience on each of the four days of the seminar. Memories, speech synthesis i.c., microprocessors and support circuits, bubble memories; linear devices, advanced low power Schottky logic devices; switching mode power supplies; and solid state sensors, a particularly interesting area of current development.

New devices for sensing temperature position, flow, pressure, level, acceleration were described. Many of these seem destined to find employment in the automotive field, as part of comprehensive indicating and controlling systems that could eventually become standard equipment in motor cars.

Of particular note is the pinning arrangements for the Texas memory chip family. These have been arranged so that ROMs and RAMs are pin-for-pin allowing interchangeably between the two types. Further to this, higher density chips (more bytes per package) have been designed in a new 28-pin package which are virtually pin-for-pin with the 24-pin chips requiring only a couple of link wires for the change to be effected. Designers can now layout for a 28-pin system (larger memory) and use 24-pin packages initially, and readily increase memory capability on the same board by merely plugging in.

# RADIO WORLD

By Pat Hawker, G3VA

## Station identification made easy

Recently, for an Irish broadcaster's journal, I attempted to indicate some of the technical developments and improvements that I would like to see in sound radio receivers. After surveying such possibilities as better balance between speech and music, microprocessor-controlled frequency-synthesis tuning, and reception of programmes direct from satellites and rather reluctantly coming to the conclusion that most of these were still some way off, I finally produced a short list of more modest requirements.

These included simpler tuning and "granny-proof" station identification and low-cost "touch-button" rather than knob tuning of a memorised list of stations as already general practice for television.

My wish (shared by very many listeners) for easier tuning and station identification is, of course, already occupying the attention of many professional engineers in industry and broadcasting. For example many different organisations, including the BBC and Philips of Eindhoven, have developed very cunning digital data systems that can be inserted onto a v.h.f. radio signal in much the same way as the Oracle and Ceefax teletext data are carried on television transmissions.

By means of simple, low-cost matrix displays these systems can show the listener the station and programme to which the set is tuned, can help accurate tuning, and carry other information such as time or short messages relating to the programme.

A lot of work has already been put into developing such systems and there have been field trials in a number of countries. One recent international trial, carried out in Switzerland under the aegis of the European Broadcasting Union, included tests of five different systems, one each from France, Finland, the Netherlands, Sweden and the UK. Three of the systems, including that submitted by the BBC, are designed to carry the data on subcarriers at about 57kHz. Two use a 19kHz sub-carrier.

The tests were carried out in an area known to be subject to multipath reflections, since it is now well recognised that data signals can be very vulnerable to echoes or "ghosts". While the trials are reported to have left the engineers reasonably optimistic that a reliable data and station identification system will be feasible, it was, unfortunately, concluded that none of the five systems tested can be regarded as sufficiently reliable when operating in difficult conditions. The engineers concerned are now considering whether some modified form of coding the data will need to be incorporated to provide better protection against errors.

But at least it looks as though station and programme identification will prove to be one of the first of my list of requirements likely to become available.

## Red faces after RAE

Talking recently to would-be radio amateurs who had sat the Radio Amateurs' Examination on December 1, 1980, it became clear that there are still criticisms of some of the questions being asked—although it is recognised that since the introduction of the multiple choice form of paper in May 1979, the percentage of candidates who successfully pass the examination has risen significantly. In multiple choice, four possible answers are provided to each question and the candidate then has to indicate which one he feels is correct.

The trouble appears to be that candidates consider that in some cases the more you know about the subject the less sure you become that only one of the answers is "correct" and that the other three are positively "wrong".

There is also a feeling, possibly mistaken, that the examination includes a few "trick" questions. This type of unease was intensified last December when a number of the more knowledgeable candidates realised that none of the answers given to one of the questions could possibly be correct.

The City and Guilds Institute have since admitted that indeed this was the case and have announced that they will omit Question 37 in Part 2 of the paper from their marking. Fair enough, but I wonder whether this takes into account the psychological stress that the unanswerable question may have placed on those suffering from examination nerves.

## Transatlantic on 70 MHz

Although the present sunspot cycle reached its peak in November 1979, some very high frequencies were once again being reflected by the ionosphere during November 1980. Indeed for the first time ever, a British amateur, Gordon Pheasant, G4BPY of Walsall, had the thrill of knowing that his 70MHz signals were spanning the Atlantic and enabling him to conduct a cross-band 70/50MHz two-way contact with Canadian station VE1 ASG in St John, New Brunswick.

Cross-band working was necessary since North American stations cannot use 70MHz and similarly the 50MHz band is not available to British amateurs. The contact was made on November 17 when the Canadian station copied weak Morse signals from the British amateur at a time when his own signals, 20MHz lower in frequency, were being strongly received in Europe.

Gordon Pheasant, ten days later, also became the first British amateur to "work all continents" by means of crossband 28/50MHz contacts.

High energy particles constantly bombarding the upper atmosphere include cosmic rays. For more than 50 years astro-physicists have been arguing

whether they originate in our own galaxy or whether they are of extragalactic origin. The answer is still in doubt but an East-West controversy is evident, with Russian scientists favouring the galaxy; British astronomers suggesting extragalactic sources.

## Take care

In the days before the risk of causing television interference forced us all to shield our transmitters, many amateurs favoured breadboard or open rack-and-panel construction. These had their merits but also their dangers.

As I discovered several times, inadvertent touching of wires carrying 350V, 500V or more was not something to be quickly forgotten and indeed not all amateurs lived to tell the tale. Today the danger of shock, except perhaps during injudicious servicing of equipment, have virtually been eliminated.

However, even today one should never take too casual an attitude towards any equipment or appliance connected to the mains. I was reminded of this by hearing about an amateur who lost all his equipment and suffered other household damage from a fire caused by his going out leaving a soldering-iron switched on.

Attention to good practice in such matters, and also in the use of suitable plugs, multi-way adaptors, correct fuses and periodical examination of all flexible leads is very much to be recommended. Some of us, and I plead guilty, fall into bad habits such as using matchsticks to insert wires into sockets or failing to ensure good all-round ventilation of equipment. Toxic smoke and fumes from some modern furnishing materials can make any fire deadly dangerous.

A few years ago the manufacturing members of the British Radio Equipment Manufacturers Association agreed a series of recommendations that deserve to be widely known. For example, do see that all electrical equipment which does not have to remain operational is switched off at the mains outlet if you are going away for an extended period. Do not continue to operate equipment if you are in any doubt about it working normally, or if it is damaged in any way.

Do not remove any fixed cover unless you are qualified to do so—and even then withdraw the mains plug before you start. Do not leave equipment switched on when it is unattended. Check that it is switched off at night and when you go out.

Make sure other members of the family know how to switch it off. Do not obstruct the necessary all-round ventilation (of a TV set) and especially do not stand it close to curtains or on soft furnishings such as carpets (unless legs are fitted). Overheating can cause unnecessary damage and shortens the life of equipment.

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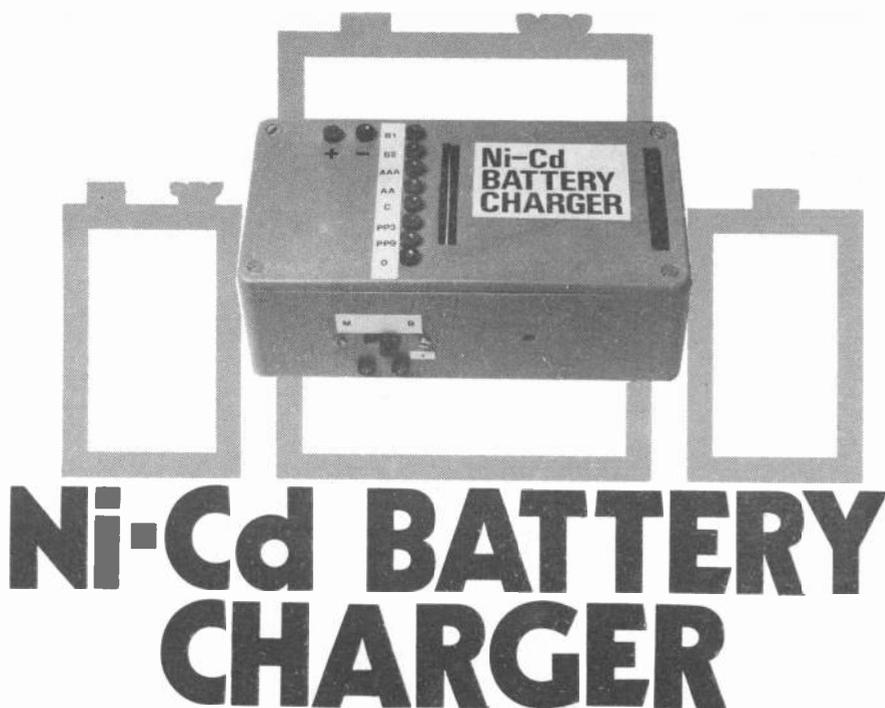


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# Ni-Cd BATTERY CHARGER

By T. R. de Vaux Balbirnie B.Sc.

PORTABLE electronic equipment usually relies on "dry" batteries for a power supply. For occasional use these are ideal in providing a compact, efficient and safe source of energy.

Their chief disadvantage is the cost as regular users of battery operated radios will testify. Alkaline batteries give much better performance but cost more than the regular type.

There are two alternatives. Either a mains unit may be used (but only where a suitable supply exists) or rechargeable batteries employed. Of the various kinds of rechargeable batteries, the nickel cadmium is the most useful for general applications.

These are robust and will withstand all sorts of misuse such as being left discharged for long periods. They will be damaged, however, by overcharging, that is, charging them by a current which is substantially greater than that recommended.

In practice, this means that a constant current charging circuit is needed and this is the subject of the present article.

## POPULAR BATTERIES

Table 1 lists most of the popular batteries, some of the popular applications and the appropriate charging rate for the nickel cadmium versions. It is not harmful to charge nickel cadmium batteries at a lower rate, of course, but it takes longer.

One particular case is the "D" battery (HP2/U2 size). No provision has been made for this as the recommended charging rate is 500mA which is too much for the present circuit. If "D" cells have to be charged, then the 250mA output

appropriate for the smaller "C" cell will be used and double the time given.

The rates given in the table are the *maximum continuous* charge rates. They will fully charge a battery in 12 hours. No harm will result if they are left charging for longer than this.

The PP3 battery, charged at 9mA, will be fully charged in 14 hours and it should not be left for longer than that.

## CHARGE RATES

The present circuit allows for seven charge rates to suit all batteries listed including two button cells. After setting the correct rate for a given battery, the circuit will deliver this current irrespective of operating conditions.

Any number of individual cells may be connected in series to be charged as long as their total does not exceed 9 volts. Similarly, a single 6 volt or 9 volt battery may be used.

One point about nickel cadmium batteries is that their output voltage is nominally 1.2 volts rather than the 1.5 volts of dry batteries.

Table 1. Charge currents for different Ni-Cd battery sizes.

Size	Typical Applications	Charge Current (mA)
AAA	calculators, photoflash	20
AA	calculators, shavers, torches	60
C	torches, tape recorders	250
PP3	calculators, radios, general electronic equipment	9
PP9	radios, electronic equipment	100
B1	photoflash, watches	1.5
B2	cameras, various	3

However, in practice, nickel cadmium cells and their dry cell counterparts behave in a very similar manner in most circuits because of their lower internal resistance.

In a 9 volt battery (PP3 or PP9) there are six separate cells internally connected in series in the regular version. In the nickel cadmium type there are seven ( $7 \times 1.2 = 8.4$  volts). Again, these will behave in much the same way when used in a circuit.

## CAR BATTERY

A special feature of the present design is its ability to charge nickel cadmium cells by means of a car battery as well as from the mains. This was originally intended for use on camping holidays to charge the batteries in an electric shaver.

Some constructors may find it such an attractive idea that they will miss out the mains section altogether and use it just this way.

## CIRCUIT

The full circuit diagram is shown in Fig. 1. With S1 set to position shown, that is for mains operation, current flows from the secondary of the mains transformer to the bridge rectifier consisting of four separate diodes D1-D4. The rectified current is now smoothed by the electrolytic capacitor C1.

If S1 is set to other position for battery operation, d.c. current enters at this point. In either case there will be a 12 volt supply across C1. The current now flows through R1 and the two diodes connected in series D5 and D6.

As these are silicon diodes, they will have approximately 0.6 volts across their terminals. There will therefore be about 1.2 volts across the pair. This voltage appears at the base of TR1.

The value of R1 is chosen to allow sufficient base current to flow in TR1 under all working conditions. TR1 will be biased "on" with about 0.6 volts across the base/emitter junction (as this behaves as a silicon diode as well). This leaves the other 0.6 volts to appear across the emitter resistor.

## EMITTER RESISTOR

The emitter resistor is really any one of a set of fixed resistors R2 to R10 which may be selected by a plug and socket system. A specific current will flow through the emitter resistor as predicted by Ohm's Law.

Now, for a transistor,  $I_c = I_c + I_b$  and as the base current,  $I_b$ , is small compared with the collector,  $I_c$  (the transistor has a high  $h_{fe}$ )  $I_c$  and  $I_e$  will be almost the same. It will be seen that  $I_c$ , which charges the batteries, only depends on the value of R2-R10.

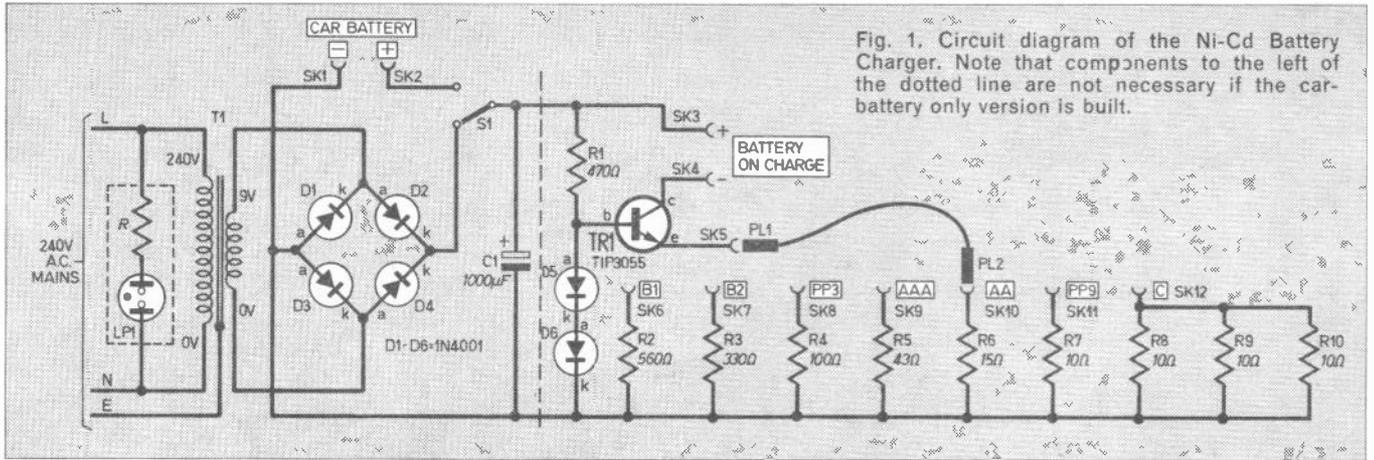


Fig. 1. Circuit diagram of the Ni-Cd Battery Charger. Note that components to the left of the dotted line are not necessary if the car-battery only version is built.

For quite a wide variation in operating conditions, therefore, the charging current will be fairly constant. This state will be maintained so long as no more than approximately 9 volts of batteries are connected to the output.

There will be at least one volt across the transistor collector/emitter and there would soon be insufficient voltage left out of the 12 volt supply to operate the circuit. Where a small number of batteries are connected for charging, the bulk of the supply voltage will be "dropped" across the transistor.

If the circuit is set to a high charge rate then a considerable amount of heat will be generated in the transistor.

### WORST CONDITIONS

Under the "worst" conditions, there will be about 10 volts across the transistor with 250mA flowing. Using  $\text{Watts} = \text{Amps} \times \text{Volts}$ , power dissipated =  $10 \times 0.25 = 2.5$  watts. If an efficient heat sink were not used for the transistor it would lead to overheating.

If the user is only going to charge 9 volt batteries where most of the voltage will appear across the battery and relatively little across the transistor, there will be far less heat produced. Furthermore, if only small charging currents are to be used, a smaller transistor without a heat sink might serve.

For the prototype, it was considered that the most versatile circuit was best especially in view of the small difference in constructional costs.

**COMPONENTS**  
 Approximate  
 cost **£11**



### CIRCUIT BOARD

The circuit panel was built on a piece of 0.1 inch stripboard (14 strips by 29 holes). Breaks should be made in the tracks in the places indicated and care must be taken to make good soldered joints with no bridging between the copper tracks.

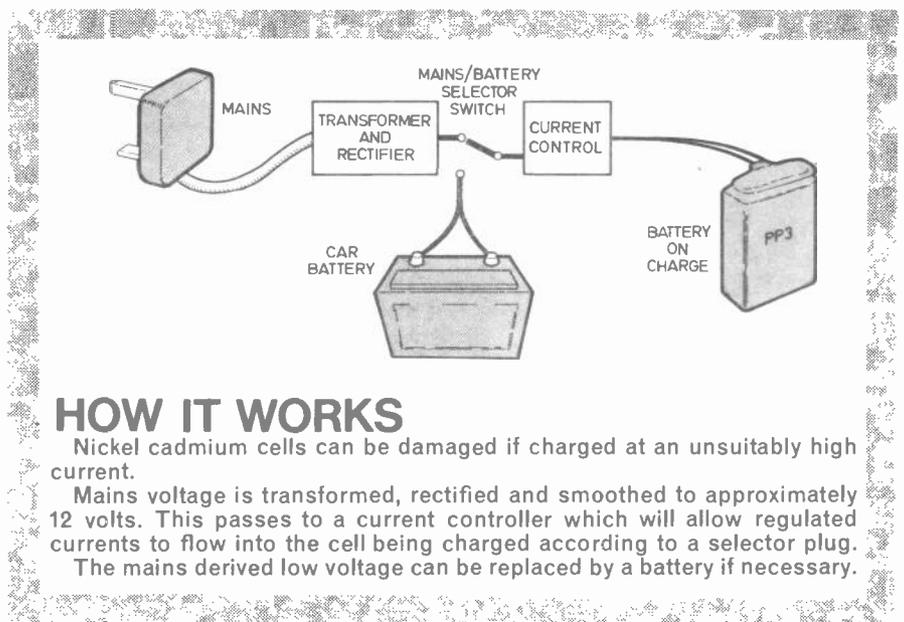
In the prototype R2 to R10 are selected by a system of miniature sockets. A flying lead with a plug on each end is plugged into the socket SK5 and the appropriate one for the battery being charged. An alternative would be to use a rotary switch.

The values of R2 to R10 are chosen from the preferred values and the currents will probably err on the low side. A little extra charging time may be allowed for this. The value of 3.3 ohms for the "C" type battery was obtained by connecting three 10 ohm resistors in parallel in the manner shown.

### TRANSFORMER

One corner is cut off the transformer panel to allow the connections to the secondary to pass to the circuit panel. The raw edge is protected with a piece of insulation stripped from a scrap of thick wire. The mains connections to the transformer primary should be made with three core wire.

The earth wire is connected to a solder tag and secured under the nut of a transformer fixing bolt. A hole is drilled in the case just large enough to allow the mains lead to pass out. Some slack should be allowed and a cable retainer fitted to the wire so



### HOW IT WORKS

Nickel cadmium cells can be damaged if charged at an unsuitably high current.

Mains voltage is transformed, rectified and smoothed to approximately 12 volts. This passes to a current controller which will allow regulated currents to flow into the cell being charged according to a selector plug.

The mains derived low voltage can be replaced by a battery if necessary.

# Ni-Cd BATTERY CHARGER

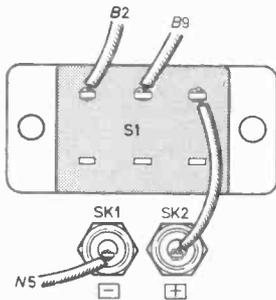
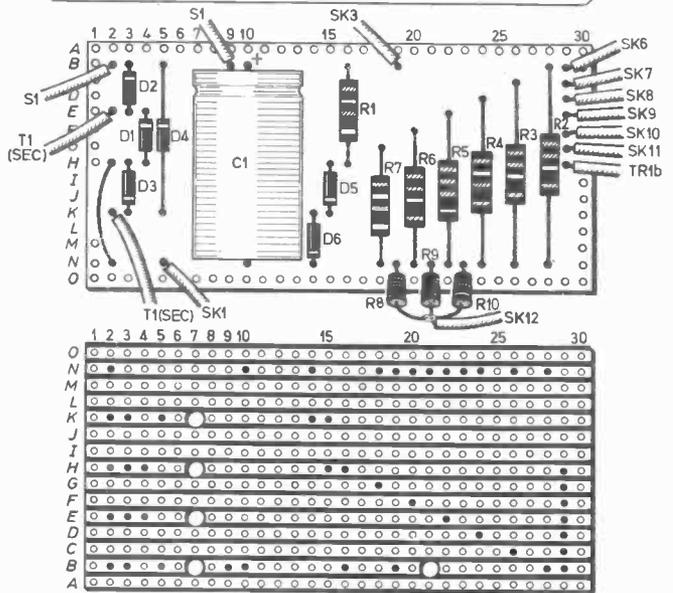
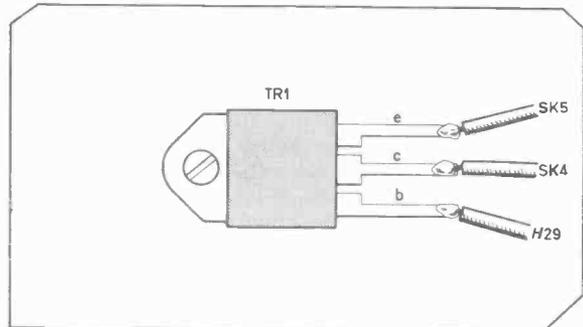
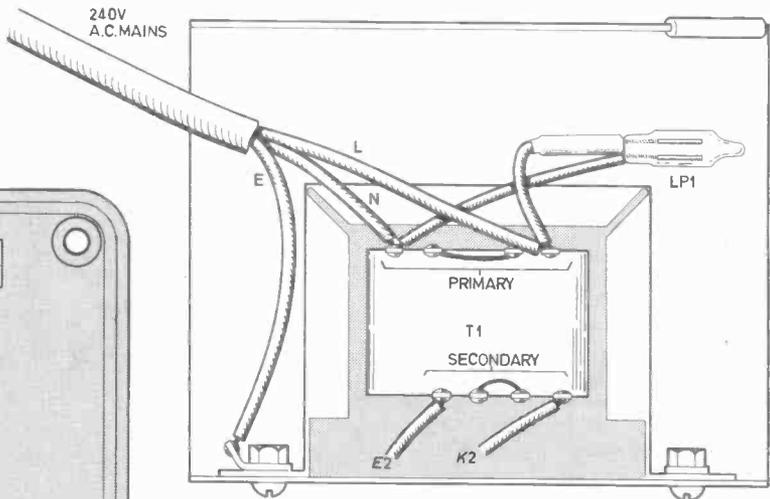
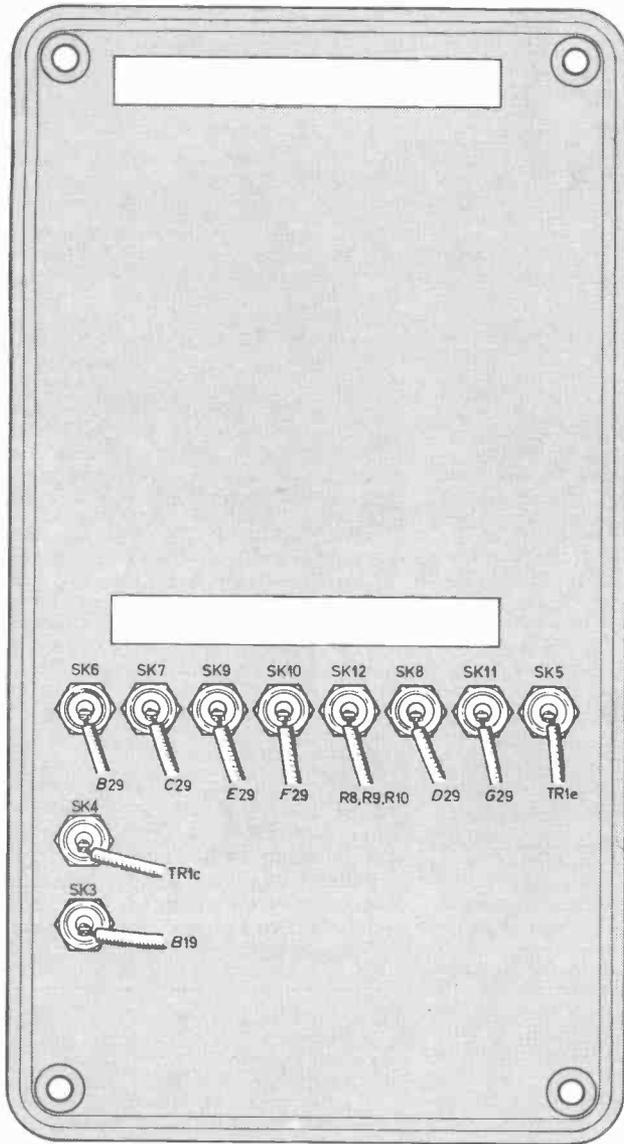


Fig. 2. Circuit board layout and wiring to off-board components. The transformer is mounted on a U-shaped aluminium heatsink and the power transistor is mounted on an aluminium plate which also acts as a heatsink.

## COMPONENTS

### Resistors

R1 470Ω  
R2 560Ω  
R3 330Ω  
R4 100Ω  
R5 43Ω  
R6 15Ω  
R7-R10 10Ω (4 off)  
All  $\frac{1}{4}$ W carbon  $\pm 5\%$

See  
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Talk**

page 93

### Capacitor

C1 1000μF 25V elect.

### Semiconductors

TR1 TIP3055 *npn* silicon plastic power package  
D1-D6 1N4001 1A 50V silicon rectifier diode (6 off)

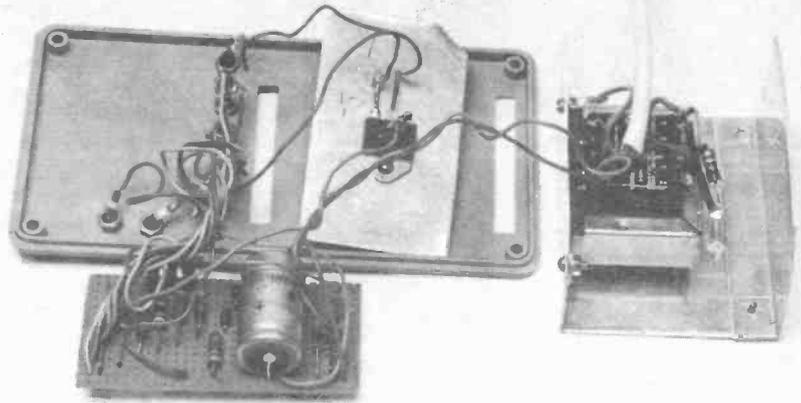
### Miscellaneous

T1 mains primary/9V 600mA secondary  
S1 s.p.d.t. toggle or slide switch  
LP1 mains panel mounting neon indicator.  
SK1-SK12 1mm sockets (9 off red, 3 off black)  
PL1, 2 1mm plug, black (2 off)  
Plastics box 150 × 80 × 50mm, Bimbox 2005/15 or similar; 0.1 inch matrix stripboard, 14 strips × 29 holes; sheet aluminium for transformer and transistor heat-sinks; interconnecting wire; three-core, 3A mains cable.

that accidental strain will not pull the connections loose. A mains switch was not thought necessary.

### HEAT SINK

It was found that the small mains transformer specified produced rather a lot of heat. It was therefore necessary to take special precautions in the mounting of this component using aluminium panels (see photographs and Fig. 2) to avoid overheating.



Exploded view of interior components of the battery charger. The transformer mounted on its heat sink can be seen on the right with the transistor laying on top of the front panel in the centre of the picture. The circuit board is lying below the front panel.

There was a strong temptation to use a metal case for the project to reduce problems due to this heat. Unfortunately, good-looking metal boxes are expensive and demand greater care with mains connections.

It was therefore decided to use an ABS plastic box and no overheating was experienced with the layout given. Constructors are strongly advised to follow the original plans for this reason. In particular, the two slots cut into the top of the box are necessary to promote an airflow.

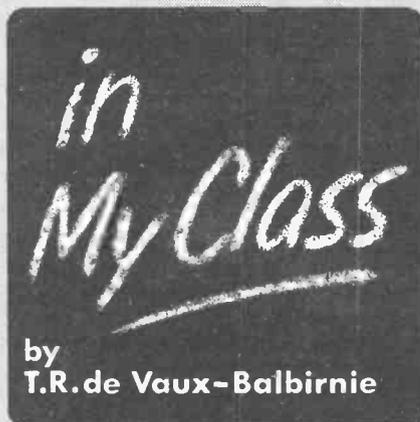
These should not be covered up during use. In a final test on the prototype, it was left switched on delivering 250mA with short-circuited output terminals. After 36 hours, the case was just slightly warm to the touch.

Under car battery use there will be far less heat produced as the mains transformer is not used. Although a more substantial mains transformer would be more efficient and keep cooler it would increase the size of the finished project.

The neon indicator in the prototype is optional. A ready made mains neon is used here. In the prototype a small hole was drilled in the case so that the neon could be plainly seen through it. Where there is any danger of bare wires touching an aluminium panel, they should be sleeved with scraps of insulation.

### SETTING UP

After fitting a 1 amp fuse to the mains plug, the unit may be checked on its various settings in the following way. A milliammeter should be connected straight across the terminals to which the battery under charge will be connected. The values of current should be equal to, or rather less than, those given in Table 1. A check may be done with a car battery and, of course, in this case the unit is not plugged in to the mains. A long period under full load should confirm that it remains cool. □



I HAD set the class an exercise. They were asked to check diodes using multitesters. They were to set their meters to "ohms" then to check that they

read zero when the leads were touched together. Then they connected the diode to the leads, first one way round then the other.

A good diode would show low resistance one way and high resistance the other. A low or a high reading on both occasions would indicate a faulty component.

When everyone has succeeded in separating the good diodes from the bad John came up with a question—was it right that the negative end of the diode was marked? I confirmed that our diodes had a white band indicating the negative or cathode end. He was puzzled because, in every case, a good diode showed low resistance when the marked end was connected to the positive lead of the meter.

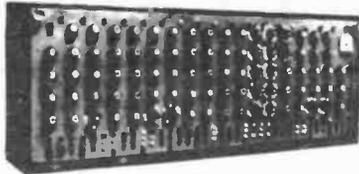
It told him that his mistake was in supposing that the lead marked

"positive" is connected to the positive terminal of the internal battery. This is not so, at least not with most multimeters. The polarity marked on the meter refers to its use as a voltmeter or an ammeter—the positive lead must be connected to the positive terminal of the supply.

When the meter is switched to "ohms" an internal battery is connected and it turns out that the polarity of the leads is opposite to what is expected—the lead marked "positive" is connected to the negative of the battery. I drew a diagram to illustrate this point.

When simply checking for good and bad diodes this is unimportant but where the cathode of a diode needs to be identified, some diodes are not marked, then this fact needs to be remembered.

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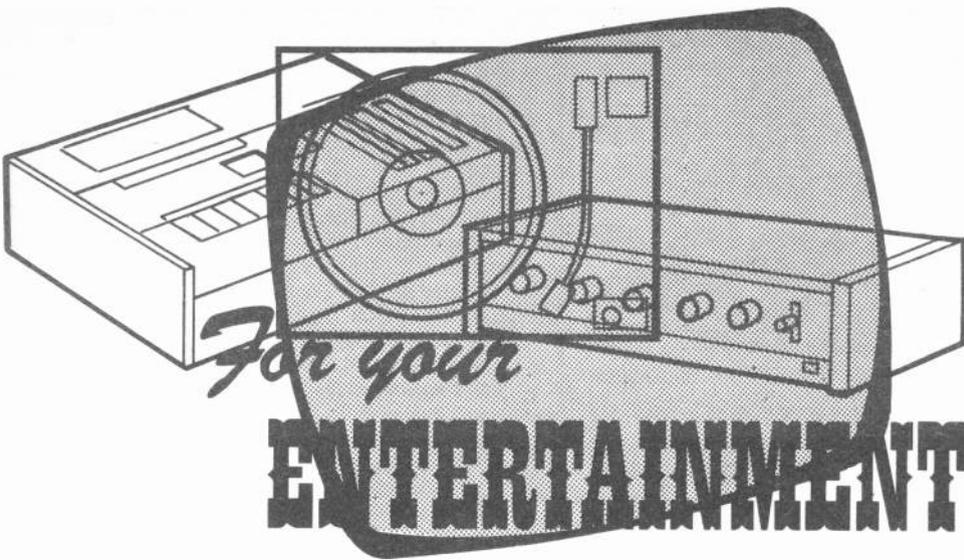
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By BARRY FOX

### Time Out

Like something out science fiction, the occupants of a block of North London houses woke up recently and went about their daily business exactly one hour late.

In the early hours of the morning the London Electricity Board had shut off their mains supply for an hour while working on an emergency repair. As a result every mains-powered analogue electric clock and alarm was effectively set back by an hour.

Because it all happened while they were asleep, residents only found out if they had a digital clock which re-set to a warning 8888 display. Others found out only when they were berated by angry employers for turning up to work an hour late.

"Have you thought through what this could mean, for example, to someone who misses a non-refundable airline flight", I asked the LEB. "We can hardly go round knocking on doors in the middle of the night to warn people that they are going to wake up an hour late the next day" was the reply.

"But you could drop duplicated notes through their doors warning them to check their clocks when they wake up" we persisted. "We never thought of that" admitted the LEB.

So will the simple warning scheme be implemented? Only time and readers' experience will tell us.

### Classic Hoax

It becomes increasingly difficult to feel any sympathy for the record companies and their current financial strife. It seems they don't even listen to their own records and they don't read the magazines that report on them.

In a classic hoax the managers of an Edinburgh record shop sent "demo" tapes of famous pop and jazz artists to the talent spotters of their own record companies. The tapes were labelled only with pseudonyms and, yes, you've guessed it, the record companies unani- mously rejected them.

The same week Decca, the record company which once rejected a demo tape made for them by the then-unknown Beatles, staged an impressive trade and press demonstration of its digital recording equipment at the elegant Arts

Club in Warwick Square. But only a handful of the old-established music reviewing magazines were invited. The new hi-fi magazines, which have been enthusing in print over Decca's digital work for the last 18 months, only found out by chance or not at all.

To cap the same memorable week, Malcolm McLaren (the man who sold EMI the Sex Pistols) claimed to have collected £55,000 from EMI for a group called Bow Wow. Their first record was entitled C30, C60, C90 and yes, again, you've guessed it, the lyrics seemed to encourage listeners to tape records rather than buy them.

Commenting on the record, EMI say they have released the record "to bring the whole business of home taping out into the open". Others in the industry were less charitable. But the Bow Wow disc soon climbed the sales charts and became a hit!

### Power Packs

Some time ago I suggested that readers try scavenging the flat batteries from used Polaroid SX-70 instant-film packs. Even after all ten picture shots have been used up these batteries usually hold a useful reserve of 6 volt power. The only difficulty in using the batteries is securing the leads to the metal terminal tags, because these will not take solder.

Polaroid is however now selling flat batteries on their own, complete with a holder with external fly leads. The only snag now is the price.

The "Polapulse design kit", which should by now be available in the UK will cost around £15. For that you get five flat carbon-zinc 6 volt Polapulse batteries and a moulded plastic holder into which the battery inserts as a push fit. The external fly leads on the battery holder go through the case to internal pressure contacts which bear hard against the battery terminals to provide a secure electrical connection.

Although the batteries have a shelf life of three years, are leak proof and will deliver up to 26A for instantaneous discharge and 1A for nearly six minutes, the £15 price tag seems very high. Polaroid say this is because the kits are only being offered in limited quantities for designers who are looking at the possibility of using flat Polapulse batteries to

power electronic toys, recorders, radios and remote control devices.

Readers will doubtless immediately hit on the idea of buying a single kit and then "feeding" the battery holder with more batteries scavenged from old SX-70 packs. Unfortunately this isn't feasible. Polaroid have (deliberately?) designed the Polapulse battery holder so that it will not accept old XS-70 batteries.

You can, in fact, get the size right by stripping an SX-70 battery from its outer protective wrapper but the terminals are still in the wrong position. However, it shouldn't be too difficult to build a battery holder, for instance from Perspex, with pressure terminals in just the right place to accept an SX-70 battery.

### Life of a Bulb

Have you ever timed the working life of a light bulb? For that matter have you ever met anyone who has ever timed the working life of a light bulb? Perhaps now is the time to start.

The companies who make and sell electric light bulbs are very touchy over the question of guaranteed life and the possibility of otherwise of making light bulbs last longer than they currently do. It's obviously a tricky commercial problem for them. A short-life bulb only sells more until the public realises it offers short life. A long-lasting light bulb can be sold for more money but by definition fewer of them will be sold.

At least one manufacturer discharges a high voltage from a capacitor through every light bulb coming off the production line to limit its working life. This is not as malicious as you might expect. The aim is to create stresses in the filament which make it fail suddenly, rather than run on with decreasing light output and efficiency. And if a light bulb fails before its guaranteed life a purchaser shouldn't have too much problem claiming a free replacement.

But now we are back to that original question. Who actually times the working life of their light bulbs?

### No Guarantee

Recently I noticed a disturbing trend which raises more questions. Woolworths are starting to sell light bulbs without any mention of guaranteed life.

I asked the company for comments. After a little vacillation they came up with the reassurance that they guarantee "most of our bulbs for 1,000 hours and our stores will always change a bulb which fails to last the guaranteed time". This inevitably raises the question of how purchasers are to know which Woolworths (Winfield brand) fall under the "most of" category and which don't.

Is this perhaps advance warning of an alarming new trend—an end even to guarantees of 1,000 hours? And are bulbs now being sold without a guarantee of 1,000 hours regularly failing after shorter periods?

If any reader has carried out any serious tests on lamp bulb life, or feels inclined to do so, I would be pleased to receive them, collate the results, put them to manufacturers where appropriate and publish any useful findings. Any such tests should confirm voltage rating for the bulb, nominal mains voltage, rated life (if stated), actual life measured and, of course, brand name of bulb under test.

# I.C. UNIBOARDS

## SIMPLE INTEGRATED CIRCUIT DESIGNS

# 6V:7.5V:9V POWER SUPPLY

No. 3

BY A. R. WINSTANLEY

**T**HIS MONTH'S design is a Mini Power Unit designed for general-purpose applications. From a mains input it will supply 6V, 7.5V or 9V d.c. The maximum recommended load is about 300mA, although in some applications (where noise is not important) this can rise to 500mA maximum.

The Mini Power Unit, although useful for powering radios, cassette recorders, calculators from the mains could also be used as a simple bench power unit, where it has proved ideal for simple experiments and testing.

### CIRCUIT

The full circuit can be seen in Fig. 1. Mains voltage is applied through S1 (the on/off switch) and FS1 to the primary of T1, a step-down transformer. This reduces the mains to 12V a.c. and this is rectified by D1-D4 and smoothed by C2 to produce a d.c.

output of roughly 17V, no load. The capacitor C1 removes noise which may arise in the bridge rectifier diodes and D5 is a standard l.e.d. with current-limiting resistor R1. This provides a "power on" indication.

In its present form the 17V d.c. is of course not variable. Furthermore, being unregulated, it will tend to reduce somewhat as the load current increases.

### VOLTAGE REGULATOR

The most important part of the circuit is IC1, a LM317H three-terminal variable voltage regulator. The 17V d.c. is passed through R2 and R3 to the input of the regulator. These two resistors, which are wirewound, assist in diverting power dissipation away from IC1, allowing it to run more efficiently.

The integrated circuit itself is fully protected. Included on the chip are

both thermal overload protection and current-limiting circuits. This means that the i.c. will shut down if overheating due to insufficient heatsinking occurs.

Current limiting prevents the current passing through the device from exceeding 750mA as actually measured on the prototype.

This means that the Mini Power Unit will not suffer any damage if the output is temporarily shorted, although prolonged short-circuits are not recommended.

### OUTPUT

A reference voltage is supplied via R10 and 240 ohms is the value used in most applications. The output of the regulator depends on the resistance between the Pin 3 of IC1, and 0V. The formula is:

$$\text{Output voltage} = 1.2 (240 + R) \text{ Volts}$$

where R is the resistance (in ohms) between Pin 3 and ground.

The various resistor values are selected by S2 so that by altering this switch, various output voltages are obtainable. Fixed resistors (as opposed to presets) are used as shown so that 6, 7.5 or 9 volts are obtainable at the touch of a switch. Also, no test equipment is needed in setting up readers' models.

Capacitors C3, C4 and C5 in the circuit help to improve the performance of the unit by reducing noise around the i.c. and on the voltage rails.

### MULTIPLUG LEAD

This design is intended for use with a "multiplug" power lead. On one end this has a 2.5mm and 3.5mm jack plug, together with a 2.1mm and 2.5mm d.c. power plug. The other end requires a 3.5mm jack plug.

The sockets SK1 and SK2 are two insulated 3.5mm jacks. Depending on which socket the multi-plug power lead is inserted into, the tips of the

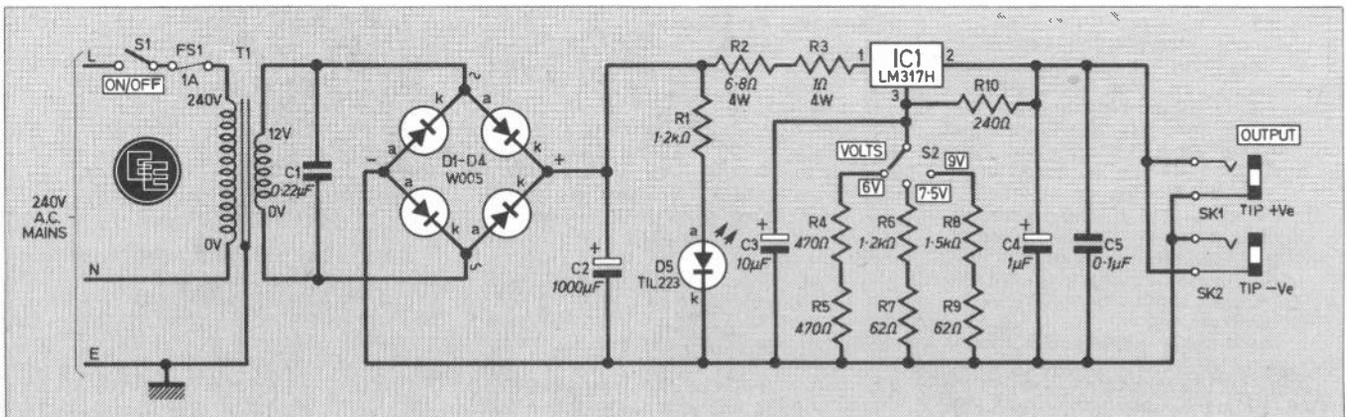
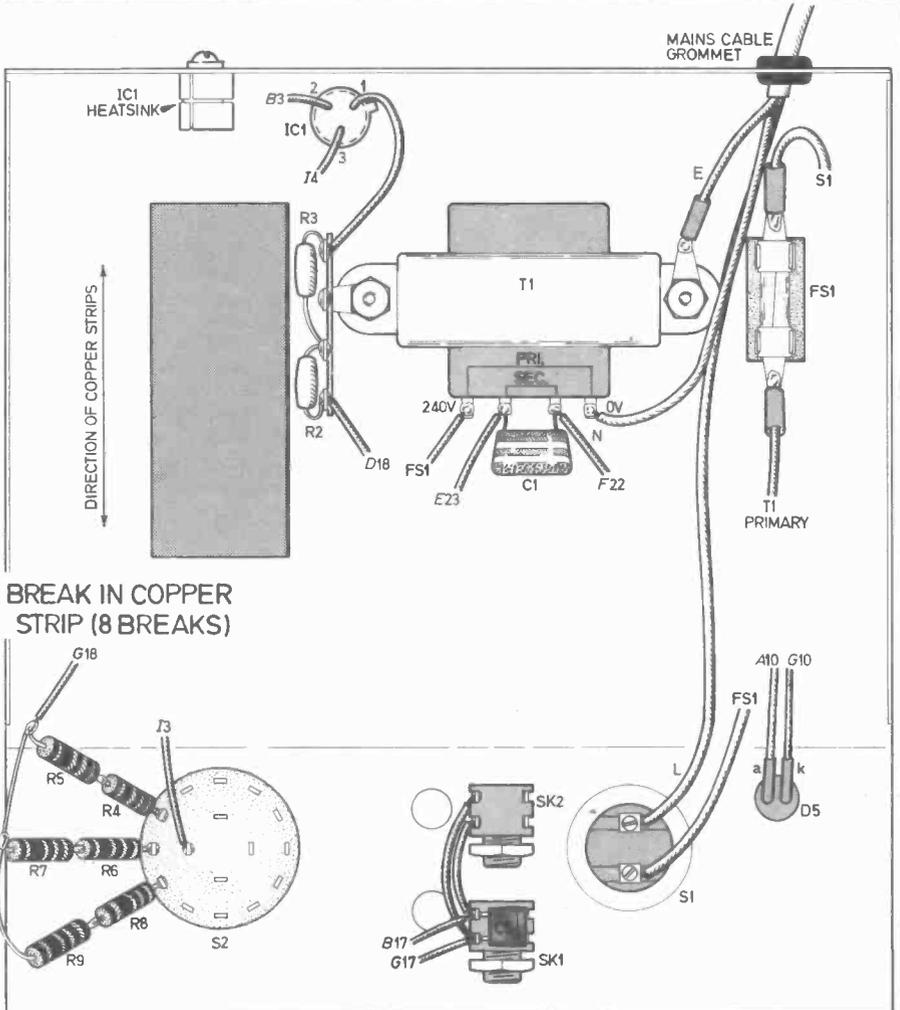
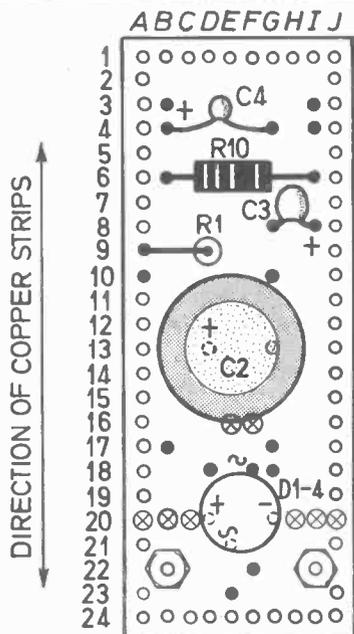


Fig. 1. Full circuit diagram of the Uniboard Power Supply.



## COMPONENTS

### Resistors

R1	1.2k $\Omega$	R6	1.2k $\Omega$
*R2	6.8 $\Omega$ 4W	R7	62 $\Omega$
*R3	1 $\Omega$ 4W	R8	1.5k $\Omega$
R4	470 $\Omega$	R9	62 $\Omega$
R5	470 $\Omega$	R10	240 $\Omega$

All  $\frac{1}{2}$ W carbon  $\pm$  5%, except R2, R3.  
\* Wire-wound

### Capacitors

C1	0.22 $\mu$ F polyester C280
C2	1000 $\mu$ F 25V elect.
C3	10 $\mu$ F 35V tantalum bead
C4	1 $\mu$ F 35V tantalum bead
C5	0.1 $\mu$ F ceramic plate

### Semiconductors

IC1	LM317H variable voltage regulator, TO-5 can
D1-D4	W005 50V, 1.5A bridge rectifier
D5	T1L223 0.2 inch yellow l.e.d.

### Miscellaneous

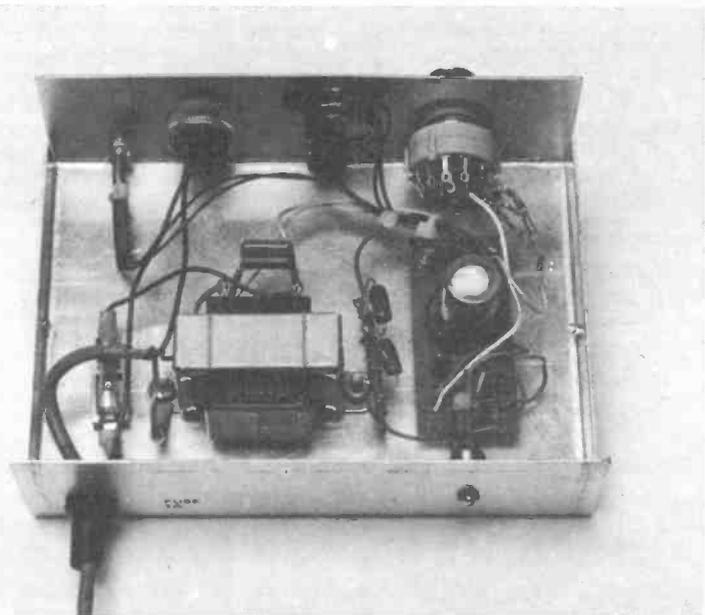
T1	Mains primary/ 12V 500mA secondary
S1	s.p.s.t. mains rocker switch
S2	one-pole, three-way rotary switch (see text)
SK1, 2	3.5mm mono jack, fully insulated type (2 off)
FS1	20mm 1A fuse with chassis mounting holder

Case, 150 x 125 x 50mm, type TP2, or similar; 0.1 inch matrix stripboard, 10 strips x 24 holes; panel mounting TO-5 type heat-sink; four-way tagstrip; solder tag; lens clip for D5; knob; multi-plug power lead; adhesive rubber feet; mounting hardware; cable grommet and retainer; three core mains cable; interconnecting wire.

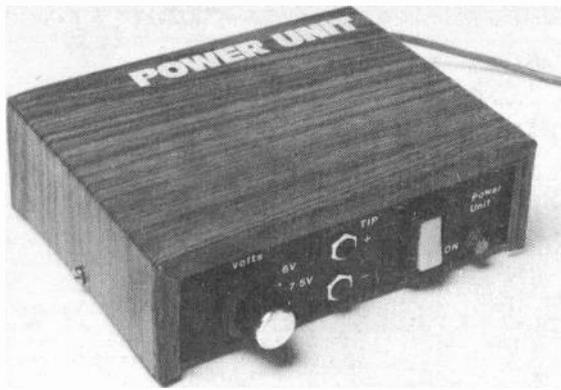
Guidance only  
Approx cost  
See page 93

**£12.50**  
complete

Fig. 2. Circuit board layout and interconnection diagram. The heatsink for IC1 must be insulated from the metal chassis.



Interior view of the unit from the rear. The wiring to the front panel mounted controls can be clearly seen.



Exterior view of the completed power supply showing front panel controls and labelling.

multi-plug will be positive (SK1) or negative (SK2). Therefore an output of either polarity is obtainable, making the Mini Power Unit compatible with many types of apparatus.

### TRANSFORMER

It would be wise to obtain the transformer first, and then choose a housing of suitable height to encase the unit. The prototype was built in an aluminium/steel box measuring 150 x 125 x 50mm.

Some components are accommodated on a piece of 0.1 inch matrix stripboard of the usual Uniboard dimensions, 10 strips x 24 holes. The board layout is shown in Fig. 2 along with the off-board component interwiring. The stripboard requires two 6BA clearance holes so that it can be bolted down with nuts, bolts and spacers.

The rotary switch S2 is mounted on the front panel, and resistors R4 to R9 are soldered to its terminals as shown. A four-pole three-way switch can be employed, of which only one section is used, so that a one-pole three-way switch is achieved.

For SK1 and SK2 fully insulated sockets *must* be used. The standard

Output Voltage	Actual Voltage (no load)	Actual Voltage (with load)
6V	6.2V	6.1V at 200mA
7.5V	7.8V	7.8V at 250mA
9V	9.3V	9.2V at 300mA

metal open sockets will short out the output and are not suitable here. Fig. 2 shows how these two sockets are wired. Note that C5 is also soldered across SK1.

### HEAT SINK

The i.c. is fixed down with a TO-5 panel-mounting heatsink to help in heat dissipation. The three wires to the i.c. should be soldered on and then the TO-5 case should be pushed into the heatsink, which is then bolted to the back panel with a steel 6BA bolt passing through an insulating bush.

Also the aluminium-oxide washer (provided with the heatsink) is sandwiched between the chassis and the

heatsink, thereby preventing electrical contact.

The two power resistors can be soldered onto a piece of insulated tag strip which can be retained by one of the transformer mounting bolts. The other bolt on the transformer holds a solder tag in place, to which the earth input should be connected. This earths the metal case.

The mains cable passes through a hole in the chassis rear panel. This hole must be fitted with a rubber grommet to prevent chafing and also a cable retainer to hold the mains lead firmly in position. Miniature 3A three-core cable can be used for the mains input. Elsewhere employ standard hook-up wire. Plastic sleeving (2mm diameter) should be used as necessary on the l.e.d. and i.c. leads to prevent short-circuiting.

### FINISHING OFF

The l.e.d. should be fitted with a lens-clip to keep it in place and to improve appearance. If you wish to letter the front panel do this before fitting the panel mounted components and use rub-down lettering as required. A couple of coats of lacquer will help protect the transfers.

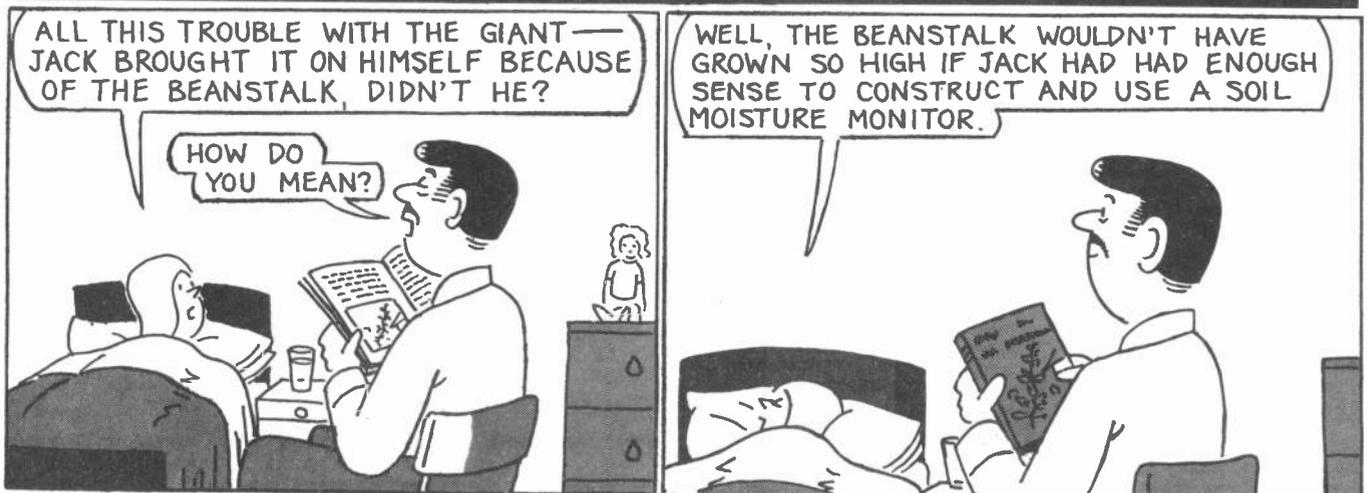
Solder a 3.5mm jack plug to the bare end of the multi-way power lead. The tips of the multiplug are connected to the wire with the tracer marking. Stick four adhesive feet onto the bottom of the case.

With construction complete, check all interwiring carefully, especially that going to IC1, and then switch on the mains to the unit. If a voltmeter is available then test to see that roughly the correct output voltages are generated (of the correct polarity) when S2 is operated.

The unit is then finished and ready for use. Table One gives a brief summary of readings taken on the author's prototype. □

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BY DOUG BAKER



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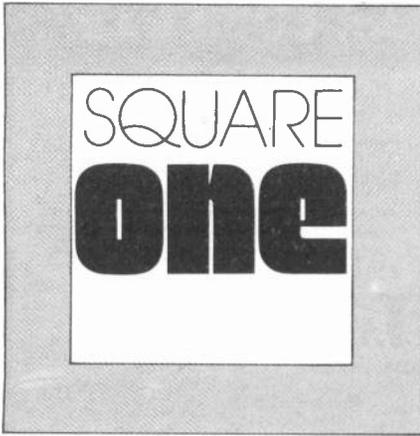
JET 010. Duo display (far right)  
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ONCE THE electrical connections are complete the would-be constructor is often tempted to think that the major part of the job is done and little thought need be given to the rather less glamorous subject of hardware.

However it is very often true to say that the reason for electrical equipment failure is mechanical rather than electrical and can be traced back to flimsy or inadequate component mountings.

### NUTS AND BOLTS

Perhaps the most basic mounting device is the nut and bolt. These can be used to fasten virtually anything to anything but with such a large range of sizes, styles and materials, obviously certain types will be more suitable for certain applications than others.

The first distinction is metal or plastic. The latter should always be used to mount items which may become live or are fragile.

Metal types are rather more diverse but basically they can be classified in terms of size or head design.

Screw sizes are either classified in terms of diameter (6mm, 3mm, etc) or according to the BA range (2BA, 6BA, etc). It is more usual for E.E. to use the latter system and the largest size bolt is 0BA running to the smallest, 8BA.

## FOR BEGINNERS

### SCREW HEAD

The design of the screw head generally falls into two categories: counter-sunk, where the head is tapered underneath and allows the screw to lie flush with the panel surface; and non counter-sunk where the head may be domed, bevelled or flat (cheese head). The choice of design here is usually left to the taste of the constructor.

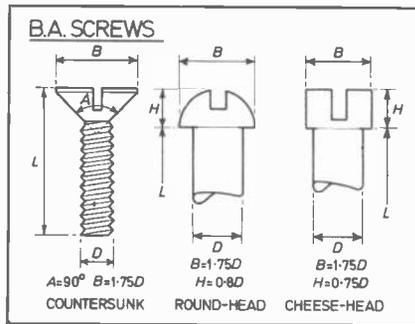


Table 1: Size and drilling data for BA nuts and bolts.

Number	Diameter (mm)	Diameter (inches)	Tapping drill size	Clearance drill size
8	2.2	0.087	No. 50	No. 43
6	2.8	0.110	No. 43	No. 33
4	3.6	0.142	No. 32	No. 27
2	4.7	0.185	No. 24	No. 12
0	6.0	0.236	No. 10	Letter B

A third type of screw is the self-tapper. As its name implies it can be inserted into a hole of suitable size and will distort the hole slightly so as to form a screw thread which it can then grip. This type of screw is very useful when it is inconvenient to locate a nut behind the hole you are using.

Of course all the above metal nuts and bolts can be obtained in a variety

of finishes, including chrome plate and brass.

### CIRCUIT BOARDS

When it comes to locating circuit boards, there are a variety of methods. The commonest is to use a spacing collar with a long nut and bolt. These collars can even be made from empty ball pen shells.

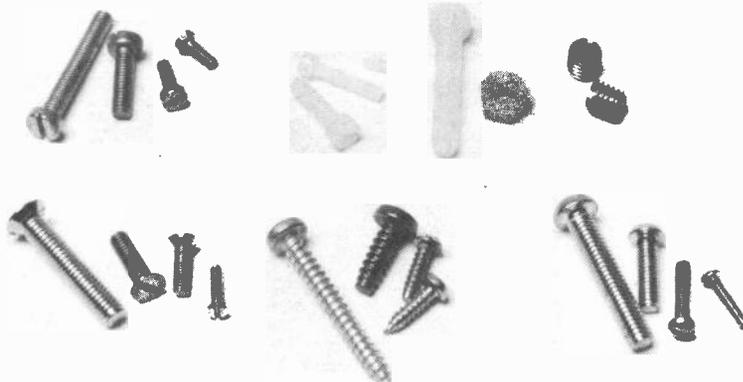
A variation on this is to use threaded collars which require a small bolt at each end.

Probably the easiest way of securing the board is by using self adhesive circuit board guide. This consists of a preformed plastic section attached to which is a length of self adhesive material. The guide can be cut to length, slipped on the board, and then the whole stuck down firmly in the case. It can be obtained for vertical or horizontal board mounting.

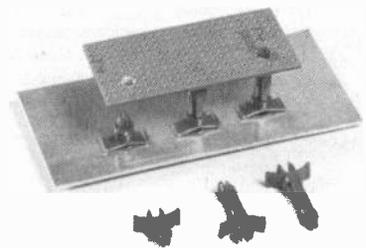
Another method of mounting is really a variation on the bolt and collar detailed above. This is a specially designed plastic support pillar which can be clipped onto the board and also the case through holes of an appropriate size. Some designs allow the boards to be stacked. However this arrangement is only really suitable for light duty, low power equipment.

### SPECIAL CASES

If the constructor is willing to restrict his choice of board size and case then he may well want to use one of the cases available with preformed slots on the interior walls. These are available in both metal and plastic and allow certain sizes of circuit board to be simply slotted into position without further mounting problems.



Top row (left to right): cheese head bolts; nylon bolts; grubscrews.  
Bottom row: counter-sunk bolts; self-tapping screws; dome-head bolts.



Plastic board mounting pillars.

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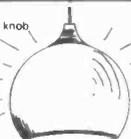
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- \*Special Price\* MK6 and MK7 together. Order as RC500K £12.50
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- MK10 — 16 Way Keyboard—for use with the MK8 kit, to generate 16 different codes for decoding by the ML926 or ML928 receiver (MK12 kit). £5.40
- MK12 — 16 Channel IR Receiver—for use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary depending on whether the ML926 or ML928 is specified. Includes its own mains supply. Size 9 x 4 x 2 cms, excluding transformer. £11.95

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6-0-6V 80p  
9-0-9V 85p  
12-0-12V 90p  
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4000	17	4019	42	4069	19
4001	18	4023	22	4070	19
4002	18	4025	21	4071	18
4007	17	4026	1-30	4077	26
4011	19	4027	40	4081	20
4012	17	4028	50	4083	54
4013	38	4040	80	4501	24
4015	75	4049	38	4511	90
4016	35	4050	40	4514	1-80
4017	70	4060	1-80	4516	1-80

## INTEGRATED CIRCUITS



555 Timer	21p
741 Op. Amp.	19p
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AY-3-1270 Thermometer	£4.50
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LM378S Dual 6W Amp.	£1.45
LM380 2W Audio Amp.	£3.50
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LM3914 Dot/Bar Driver	£2.10
MM74C911 4 digit display controller	£6.50
MM74C915 7 segment-BCD converter	96p
MM74C926 4 digit counter with 7 seg. o/p	£4.50
S566B Touchdimmer	£2.50
SL440 AC Power phase control	£1.75
SN76477 Complex Sound Generator	£2.52
TBA800 5W Audio Amp.	88p
TBA810AS 7W Audio Amp.	£1.00
TDA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp.	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data sheets. Data Sheets only, 10p each device.

## LEDs

0-1" Red or 0-2"	9p
0-1" Green or 0-2"	12p
0-1" Yellow	12p
0-2" Yellow	12p
0-2" clips	3p
Rectangular Red	18p
Rectangular Green	20p
Rectangular Yellow	21p

## TRIACS



400V Plastic Case (Texas)	
3A	48p
8A	58p
16A	95p
12A	85p
6A with trigger	80p
8A Isolated tab	65p
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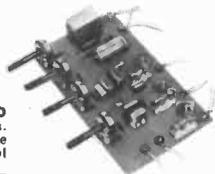
**KS238 "MICROPHONE OPERATED THREE CHANNEL SOUND TO LIGHT".** Complete with microphone, 300 Watts per channel, automatic treble-middle-bass filters. Operates from 240V A.C. **£14.34 inc VAT**



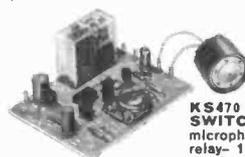
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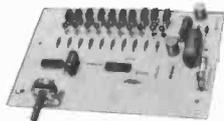
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### Minimum & Sub Miniature

Volts	Milli-amps	Ref. No.	Price £	P&P
3.0-3	200	238	2.60	.70
0.6-0.6	1A 1A	212	3.00	.75
9.0-9	100	13	2.30	.70
0.9-0.9	330 330	235	2.15	.70
0.8-9-0.8-9	500 500	207	2.75	.75
0.8-9-0.8-9	1A 1A	208	3.85	.75
0-15-0-15	200 200	236	2.15	.70
0-20-0-20	300 300	214	2.75	.90
20-12-0-12-20	700(DC)	221	3.50	.90
0-15-20-0-15-20	1A 1A	206	4.60	1.05
0-15-27-0-15-27	500 500	203	4.05	.85
0-15-27-0-15-27	1A 1A	204	6.10	1.05

### 12 AND/OR 24 VOLT

12v	24V	Amps	Ref. No.	Price £	P&P
0.5	0.25	111	2.30	.75	
1.0	0.5	213	2.75	.90	
2	1	71	3.25	.90	
4	2	18	4.05	.85	
6	3	70	5.60	.95	
8	4	108	7.40	1.20	
10	5	72	8.25	1.20	
12	6	116	8.85	1.20	
16	8	17	10.85	1.30	
20	10	115	13.85	1.50	
30	15	187	16.85	1.50	
60	30	226	33.35	1.80	

### 30 VOLT (Pri 220-240V)

Amps	Ref. No.	Price £	P&P
0.5	112	2.85	.90
1.0	79	3.60	.90
2.0	3	5.60	1.05
3.0	20	6.30	1.20
4.0	21	6.60	1.20
5.0	51	9.60	1.20
6.0	117	11.10	1.20
8.0	88	14.35	1.50
10.0	89	16.60	1.50

### 50 VOLT (Pri 220-240V)

Amps	Ref. No.	Price £	P&P
0.5	102	3.60	.90
1.0	103	4.60	1.05
2.0	104	7.30	1.20
3.0	105	8.60	1.20
4.0	106	10.85	1.30
6.0	107	15.10	1.50
8.0	118	20.20	1.70
10.0	119	24.10	2.20

### 60 VOLT (Pri 220-240V)

Amps	Ref. No.	Price £	P&P
0.5	124	3.85	.90
1.0	126	5.60	1.05
2.0	127	7.55	1.20
3.0	125	11.10	1.30
4.0	123	12.35	1.50
5.0	40	14.15	1.60
6.0	120	17.60	1.60

### AUTO TRANSFORMERS

Input/Output Tapped 0-115-210-240V

VA (Watts)	Ref. No.	Price £	P&P
20	113	2.65	.90
75	64	4.10	.90
150	4	5.60	1.05

### Input/Output Tapped

VA (Watts)	Ref. No.	Price £	P&P
300	53	10.10	1.20
500	67	10.85	1.50
1000	84	18.60	1.60

### Also 1500/2000/3000VA

### MAINS ISOLATING (Centre Tapped & Screened)

Pri: 120/240V Sec: 120/240V

VA (Watts)	Ref. No.	Price £	P&P
60	149	6.60	1.05
100	150	7.60	1.30
200	151	11.10	1.30
250	152	13.30	1.60
350	153	16.30	1.60
1000	156	37.10	3.20

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# CIRCUIT EXCHANGE

## ELECTRONIC VOLTMETER

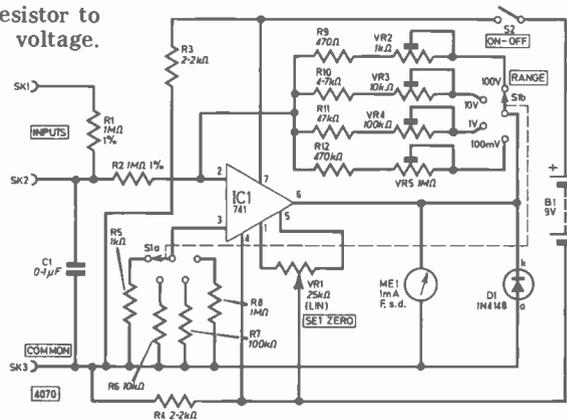
Here is the circuit diagram for an Electronic Voltmeter which I have built. The input impedance is nominally 1 megohm on all ranges (SK3 and SK2) and the ranges are: 100mV, 1V, 10V, 100V.

The design requires no expensive 1 per cent resistors or hard-to-obtain large-value resistors. S1b selects the appropriate feedback resistor which determines the range of the meter and calibration is achieved by adjusting the presets in series with the fixed resistors.

S1a selects the necessary resistor to minimise the output offset voltage. The 25 kilohm linear potentiometer is for zeroing purposes.

SK1 and its associated 1 megohm resistor is optional and provides voltage ranges of 200mV, 2V, and 200V. If this facility is included the two 1 megohm resistors must be 1 per cent tolerance.

D. J. Edwards,  
St Ann's,  
Nottingham

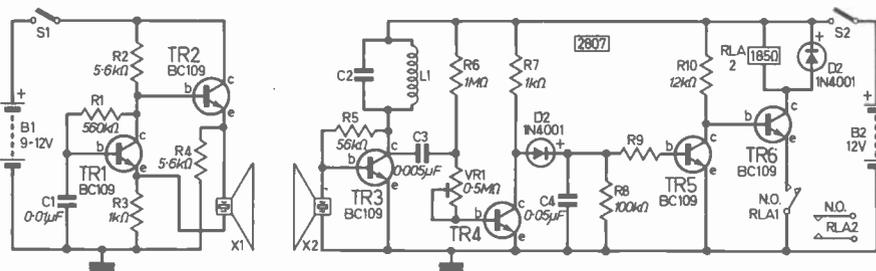


## ULTRA-SONIC TRANSMITTER-RECEIVER

This circuit can be used as a switch as well as an alarm. It comprises a transmitter with a basic oscillator circuit tuned to 30kHz and a matching receiver.

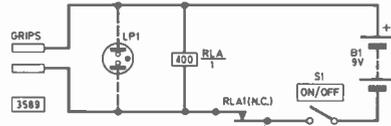
**Transmitter**—TR1 and TR2 are emitter coupled via the transducer X1 so the circuit oscillates at the frequency of the transducer and generates an ultrasonic signal.

**Receiver**—The circuit C2, L1 is tuned to the required frequency. Values for C2 and L1 can be worked out by trial and error or using a fixed value for L1 and varying the capacitor for best possible results where  $f = 2\pi \sqrt{L1 \times C2}$ .



## ELECTRIC SHOCK MACHINE

The "Electric Shock Machine", or induction coil as it is called, is a popular novelty

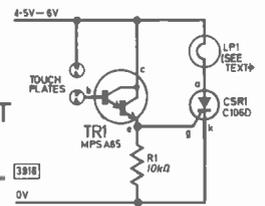


The circuit I put forward needs only a relay (300-400 ohms) with at least one normally-closed contact, a s.p.s.t. switch and a PP3 battery.

The circuit works on the back e.m.f. from the relay coil (which is usually a nuisance) produced every time the relay turns off. The voltage produced is sufficient to make a neon lamp glow, or to give a "jolt".

Nicholas Ray,  
Buntingford, Herts

## TOUCH-ON PILOT LIGHT



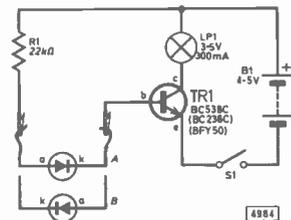
I have devised a Touch-On Pilot Light that might interest other readers.

The design uses the very minimum of components and has no on/off switch so that it is always in the standby mode without using any current. This is because the lamp used (a Japanese bi-metal flashing lamp) switches itself off after a certain period and then "waits" for the thyristor to switch it on again. I have found that, in practice, just one transistor is usually not sufficient to supply the current for even a sensitive gate thyristor, so that I have resorted to using an npn Darlington transistor as the touch sensitive element with very high input impedance.

R. L. A. Trost,  
Soest,  
Holland

## DIODE POLARITY TESTER

Here is my own idea for a Diode Polarity Tester which will also ascertain if a diode is working or not. The circuit is quite simple.



With the diode connected at position A the bulb will light. If it is reversed as at position B, the bulb will not light. By a process of elimination alternating the diode between A and B the polarity of the diode (and whether or not it is working) can be ascertained.

Mark Danielson (aged 14),  
Chelmsford,  
Essex

# CIRCUIT EXCHANGE

# LETTERS

## Great Stimulant—But . . .

For the past couple of years I have been reading your magazine with a great deal of interest and have built many of your projects. And I feel I must write to you on a subject I am sure many other readers have had their say on.

The subject? Well it is simple, why do you not print the circuits in p.c.b. fashion?

I personally loath working on matrix boards and prefer the easier p.c.b.s. I have even gone to the length of designing my own p.c.b.s (when I have the time to do so) from your circuit diagrams which I must admit I do enjoy doing immensely, as it is a great mental stimulant. But there are times, that due to work pressure I am either forced to use the matrix or shelve a project for some months.

I would also like to take this opportunity to ask any of your readers if they would like to correspond with me, and exchange any ideas we may have, and to help solve problems that we both encounter in any projects.

E. Shearer,  
Canley Vale, Australia

## Why no p.c.b.s?

Every month I read with great interest E.E. and make up a lot of projects.

In August issue *Auto Lighting-up Warning* I find you include a printed circuit board diagram, this is a nice change. I wonder why you nearly always specify Veroboard or matrix board. I find these difficult to get on with compared to printed circuits which are very simple to make for anything but complex circuits. I find matrix untidy and Veroboard, well it's very hard not to miss an occasional hole.

Is there any possibility of including both printed circuit diagrams as well as one of the others, giving your readers an alternative. I realise I am asking a lot, but all the USA and Australian circuits are all p.c.b.s.

As far as E.E. goes it's Tops as I have told you before and my best wishes for its continued success.

Ron Lockerbie,  
Merimbula, Australia

## A Matter of Cost

May I draw your attention to the October issue 1980—project *Bicycle Alarm*. The cost was approximated as £8.00, but on checking with Tandy's catalogue it would cost £13.00.

Another incident where the quoted approximate cost is shown as £4.50, is the *Reaction Timer*, issue November 1980. Having bought a number of the parts, my nephew now finds the final total will be £10.50, an enormous excess for a school-boy enthusiast, which has now to be shelved until he has more funds to carry on with this project.

Your comments would be appreciated.

C. J. Jones (Mrs),  
Kidderminster

We have now carried out a further and detailed costing of the two projects you mention. Referring to the catalogues of two

different suppliers, we arrived at the following figures:

1. *Bicycle Alarm*  
Magenta Electronics £10.30  
Watford Electronics £7.74

Another advertiser in this magazine is now offering a complete kit for this project for an inclusive price of £9.25.

2. *Reaction Tester*  
Magenta Electronics £8.12  
Watford Electronics £6.84\*

\* P.C.B. and fascia board NOT included.

From these figures it would appear that our published cost of £8.00 in respect of item (1) is not far off the mark. With regard to item (2) however, we appear to be adrift by a fairly considerable amount with our suggestion of £4.50. However, Tandy's prices which you quote are considerably higher than any of those we have now arrived at.

I think it is a fair comment to make that Tandy's prices are, in general, 25-50 per cent above most other component suppliers. Although again here one must be cautious, since there are some instances where Tandy do quote a lower price than others for identical parts.

A possible explanation could be in the fact that certain small components are available from Tandy in packs only. Maybe you have included the pack price for resistors and capacitors, rather than the unit cost. This would of course help inflate the total cost arrived at.

I hope the above information will illustrate what a difficult problem it is in trying to establish a realistic cost for any project. We never claim that the price published is in any way an exact figure. We give these prices purely as a general indication as to the order of cost, and quite obviously the actual price will vary from supplier to supplier.

Where we do err on the low side this is perhaps to the advantage of the reader, since advertisers will endeavour to match the quoted price as closely as they can. Should we attempt to play safe and quote "high", apart from discouraging the reader, there is a danger that some suppliers might rise to the occasion!

It is advisable to acquire a number of catalogues from different suppliers, then one can make one's own costings from the items listed, and then decide which supplier to order the parts from.

I hope this experience has not been too discouraging to your nephew. Considering today's prices in general, I am sure he will find that the hobby of electronics is a very economical one when considering the amount of enjoyment and also the useful pieces of equipment that can be built from one's own efforts.—Ed.

## The Best

I have been a reader of E.E. since issue No. 1 and have all the copies published since. I have always found the magazine most interesting and enjoyable.

I have made quite a number of projects which have appeared over the years. The best of these was undoubtedly the *EE 2020 Tuner Amplifier*.

It may be of interest to you to know that since making the 2020 this has had quite a lot of use and has given no problems at all. A really splendid project.

I. B. Morris,  
Liverpool

## Radio Control System

\*With regard to the *Everyday Electronics Radio Control System* (November '79 to April '80) there are certain problems I have yet to overcome.

A switch S1 is shown in the circuit diagram of the transmitter to operate the seventh channel on the receiver but there is no on/off type switched control. Also I have not been able to locate the ZN458T 2.45V reference, the MC14051 and MC14024 CMOS Motorola integrated circuits. In the receiver I could not obtain any of the Toko i.f. transformers (types 4827, L238 and 4828).

Apart from these few setbacks I have found the project an interesting and challenging one. Before I read your project I had no feelings of becoming a *Radio Control Enthusiast*, now I am a full-hearted one.

Andrew Lord,  
Malvern College, Malvern

The On/Off switch (channel 7) can be used for various control functions, for example: Aircraft—Undercarriage Up/Down; Gliders—Air brakes; Boats—Water Jet (on fire tender).

We understand that all components for this project are available from *Cheadle Model Supplies Ltd.*, 55 Cheadle Road, Cheadle Hulme, Cheshire.

We are very glad to learn that through this magazine you have acquired another absorbing interest.

## Oldest Reader?

I am 80 years old and probably one of your oldest readers. Believe it or not, my radio experience goes back to 1913, when a cadet in our school O.T.C. unit, and our signal section constructed a wireless transmitter and receiver and established 2-way communication over a distance of 15 miles! The basis of the transmitter was a home made induction coil which gave a 1 inch spark when the key was depressed.

Truly we were gay young "sparks" in those early days, but I am a bit out of touch now with all these I.C.s, T.T.L.s, CMOS etc.

F. W. Blakeley,  
Wrexham, Clwyd



'A computer made him redundant—it showed how much he'd been embezzling'.

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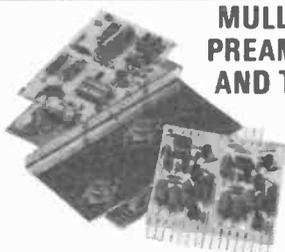
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AS FEATURED IN PRACTICAL ELECTRONICS OCTOBER ISSUE

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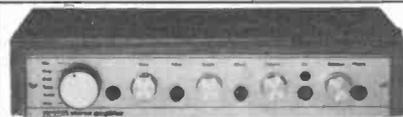


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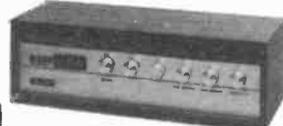
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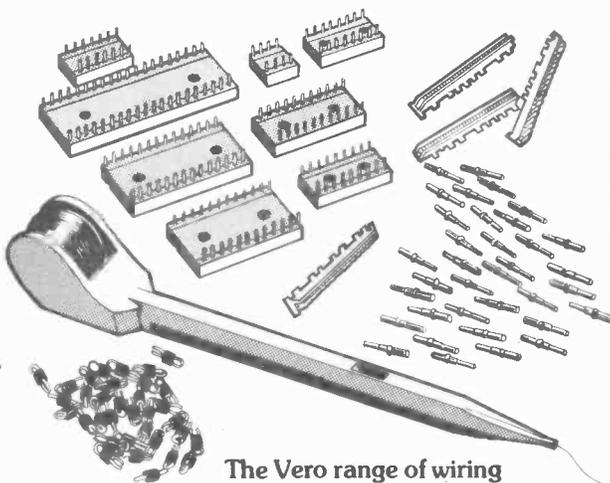
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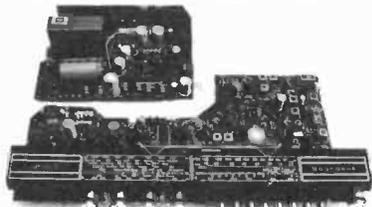
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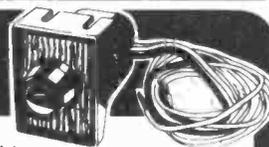
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# I Can't Do Maths!

BY GEORGE HYLTON

**DON'T DESPAIR. THIS FOUR-PART SERIES PROVIDES A GUIDE TO BASIC CONCEPTS**

## 4 - BITS AND PIECES

**VULGAR FRACTIONS.** The phrase has a suggestion of snobbery about it, as if halves, quarters, fifths and so on were too insignificant for a person of refinement to bother about.

But they have their uses, and a knowledge of how to handle them leads straight on to the handling of fractions in algebraic form, which crop up in electronics.

Know how to manipulate the ordinary vulgar fractions and you are half way to coping with the algebraic ones.

Vulgar fractions are often not easy to add. It is all very well when they are all the same kind; two-fifths plus one-fifth obviously makes three-fifths. But what happens when they are different? What is  $\frac{2}{5} + \frac{3}{5} + \frac{1}{2}$ ?

The answer is certainly not obvious. In these days of the pocket calculator it is possible to sidestep the problem, by turning each vulgar fraction into its equivalent decimal fraction.

However, this trick of turning vulgar fractions into decimal fractions is no help when you come to algebra. There is no decimal equivalent of  $xy/ab$ . To handle that sort of expression you need to master the traditional methods of handling vulgar fractions.

So let's look at them. Like all maths they are just common sense plus a bit of low cunning. Here is a typical problem:

$$\frac{2}{5} + \frac{3}{5} = ?$$

Not being a mathematician myself but a journalist I find that a knowledge of the meanings of words helps, in maths as in other things.

"Fraction" is connected with "fracture". To fracture is to break, and a fraction is what is produced by breaking: "fraction" means "broken-off piece".

The number which gets broken is generally the number 1. As everybody who has broken one plate knows, it is always possible to take one of the pieces and break it into still smaller pieces. The same applies to fractions.

A half can be broken into (for instance) two quarters, or three sixths, or four eighths, and so on. A half can also be broken into bits of assorted size.

It is obvious, I think, that bits of the same size can easily be added. Halves to halves, quarters to quarters, and so on. Thus one sixth plus two sixths makes three sixths.

In numbers:

$$\frac{1}{6} + \frac{2}{6} = \frac{3}{6}$$

But what if the bits are of assorted sizes? The last example contains the vital clue. You may have noticed that  $\frac{2}{6} = \frac{1}{3}$ , so the sum could have been written,  $\frac{1}{6} + \frac{1}{3} = ?$

Evidently the trick is to break the larger fractions (here,  $\frac{1}{3}$ ) into smaller ones so that they can be added to the rest of the smaller ones in the sum.

In the present case, thirds conveniently break into sixths so the process is quite easy. But in many cases the sizes are less conveniently assorted. For example,  $\frac{1}{2} + \frac{1}{3} = ?$  Halves can't be broken into thirds. But both halves and thirds can be turned into sixths:

$$\frac{1}{2} + \frac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{5}{6}$$

Before going on to more interesting vulgar fractions there is just one thing to be said about the forms in which fractions are written down.

To make life easier for himself the typist and in his steps the printer usually adopts the style of writing  $1/4$  instead of  $\frac{1}{4}$ , and so on.

This makes it easy to type or typeset a fraction like  $7/16$ , because it now comes all on one line instead of one bit below the rest. The snag is that it is no longer sensible to talk about the "top" or "bottom" of a fraction.

Instead you have to use the mathematician's long words, "numerator" and "denominator". The "denominator" (at the bottom) tells you what kind of "—ths" you are dealing with. In sixteenths the denominator is the 16 at the bottom.

The "numerator" tells you how many of them there are. Thus in seven sixteenths the numerator is 7.

To get back to practical cases, we've seen that:

$$\frac{1}{2} + \frac{1}{3} = \frac{5}{6}$$

Note that if you multiply together the two denominators (bottom numbers) in the problem you get the denominator of the answer, in this case 6. It always works. If the sum is  $\frac{1}{5} + \frac{1}{8} = ?$ , then the "numbers at the bottom" tell you that the answer can be obtained by turning both fractions into fortieths, since  $5 \times 8 = 40$ :

$$\frac{1}{5} + \frac{1}{8} = \frac{8}{40} + \frac{5}{40} = \frac{13}{40}$$

Sometimes this trick leads you to use smaller "—ths" than are strictly necessary, but it always works. Here's a more difficult case:

$$\frac{5}{8} + \frac{3}{5} = \frac{25}{40} + \frac{24}{40} = \frac{49}{40}$$

which raises another point. Expressions like  $\frac{49}{40}$ , where the numerator (top) is bigger than the denominator (bottom) are called Improper Fractions. Despite their name (more snobbery?) improper fractions can be more useful than proper ones.

The number, Pi, which keeps cropping up in calculations, is roughly three and one-seventh. But in using it you'll find that it's generally more convenient to turn it into the improper fraction,  $\frac{22}{7}$ .

Vulgar fractions can be used to solve a series-capacitance problem. The textbooks say that the three capacitances add up to one single equivalent capacitance,  $C$  whose value is found by the formula:

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

Don't be put off by the fact that this gives  $1/C$ , not  $C$ . Putting in actual values gives:

$$\frac{1}{C} = \frac{1}{2} + \frac{1}{3} + \frac{1}{5} = \frac{15}{30} + \frac{10}{30} + \frac{6}{30} = \frac{31}{30}$$

To turn  $1/C$  back into  $C$  the fraction is "turned upside down", that is the numerator and the denominator are made to change places.

So when  $1/C = \frac{31}{30}$ ,  $C = \frac{30}{31}$ . The three capacitances in series are the same as one of  $30/31 \mu\text{F}$  or a little less than  $1 \mu\text{F}$ .

In this article I've had space only to deal with adding fractions. Subtracting them follows commonsense lines:

$$\frac{3}{5} - \frac{1}{6} = \frac{18}{30} - \frac{5}{30} = \frac{13}{30}$$

# WORKSHOP MATTERS

By Harry T. Kitchen

## Component Buying

Long experience has convinced me that the only way to buy components is in bulk. Why? Well, components in tens are usually slightly cheaper than in one's, and these days every little helps. More importantly, it increases your chances of commencing almost any project without first having to order the components for it.

Sitting here thinking about it, the only hindrance that I can foresee for myself is something special; a transformer perhaps, or a special i.c. or transistor. Very little else. So what is my buying philosophy?

## Resistors

Unless it is something very special or very expensive, I invariably buy in tens. Let's take resistors and capacitors for example. Mostly,  $\frac{1}{4}$  Watt or  $\frac{1}{2}$  Watt resistors will be adequate, whilst the general tolerance of 5 per cent will also generally suffice.

Using the universal E12 range we should have everything between 10 ohms and 10 megohms in stock, or more precisely 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 75, 91 ohms and their decades. A lot of resistors indeed, but they will fulfil most of your requirements. To these we should add others, as funds allow.

It is too much to advocate, neither have I done it myself, to buy wire wound resistors on the same scale, but a random selection, on a as-and-when basis can be adopted by buying an extra resistor each time. The same philosophy can be adopted towards potentiometers, or more accurately variable resistors.

Whilst I have never bought surplus, or seconds, or unmarked semi-conductors, I have bought jobs lots of ex-computer, but unused, resistors and have found them to be of the very highest quality. A great deal depends where you buy them, and if the source is not known to you I would suggest that you do as I do; buy a few to check and, if they are satisfactory, buy a lot.

Stipulate that they must be of the same quality, and if they are not the firm concerned must accept them back and refund your money. This philosophy should apply with any unknown components.

## Capacitors

I have adopted a modified approach to the purchase of capacitors, and this is necessary since capacitors have specific maximum working voltages, and to stock them all is quite impossible; and quite unnecessary. You have to make two basic decisions: the working voltage, and the mounting; radial or axial. This is particularly important with circuit boards.

In my own case, I found that I very rarely required a working voltage in excess of some 15 volts, and so I standardised

on the 16 volt Seimens range, though other reputable makes are just as good. Most of my capacitors are axial ended, though a few are radial ended. I settled for a capacitance range that spanned  $4.7\mu\text{F}$  to  $1,000\mu\text{F}$ , based on experience.

So far we have been looking purely at electrolytic capacitors, hence the need to consider working voltages. Let us look at some of the others available; polystyrene, polyester, silvered mica, tantalum, and ceramic.

All have their uses, but as a general purpose capacitor, within its capacitance range, the polyester is probably the most suitable. For my own work I have standardised on the Mullard C280 series with radial leads. This has a working voltage of 250V, with a capacitance range spanning  $0.01\mu\text{F}$  to  $2.2\mu\text{F}$ .

## Semiconductors

You may expect to keep a large variety of semiconductors in stock, but with care a handful will suffice.

Let's look at diodes. Three or four basic types will do all that you require.

For low level work the 1N914 makes an excellent choice with a p.i.v. (peak inverse voltage) of 100 and a current rating of 75mA maximum. For medium power work the 1N4007 is excellent, with a p.i.v. of 1,000 at 1A. Higher still the 1N5407 will accept 800 p.i.v. at 3A. You can get lower p.i.v. in these two families, but the saving is small, and you can use them for all mains rectification purposes.

All the preceding diodes are silicon. Amongst the germanium diodes the OA90 makes a useful r.f. rectifier, and the OA91 and OA95 are useful general purpose diodes with p.i.v. ratings of 115 volts and a current rating of 50mA.

## Transistors

Similarly a small handful of transistors will suffice for most normal work. The BC109 is the low power low noise transistor par excellence. Higher up the 2N3053 or BFY50 will cope well, and still higher the 2N3055 and its plastic coated relatives, the MJE3055 and TIP3055 excell.

General purpose f.e.t.s are exemplified by the 2N3819, and the 2N2646 fills a similar position amongst the unijunction breed.

Amongst op-amps the 741 is an excellent choice as it is free from vice, as is the timer i.c. the NE555 and its dual version the NE556. Digital i.c.s proliferate, and here probably the best bet is to buy as you require.

From the foregoing you will see that, unless you are into exotic circuits, you will cope very well with a small selection of components, though their numbers may be many. By judicious purchase you

can build your collection into an extensive one, as I have, even though it will take you time to do so, as it did me.

## Records

Earlier I write of the necessity of keeping records of work done. So too should records be kept of components in stock so that as the quantities drop they can be replaced, either directly or with something better.

The more components you have, the more constructional work you do, the greater the need for keeping records. It requires a certain amount of self-discipline but the effort is well worth while.

I myself use an A5 notebook divided up into sections: resistors, capacitors, transistors, diodes and miscellaneous. The smaller the component the more need to document it as it is more easily overlooked. Well kept records, like a well kept diary, are useful pointers about your progress, and sometime in the future you will almost certainly be glad that you made the effort.

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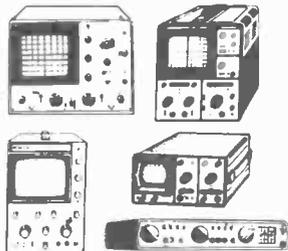
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C01303D 5mHZ, 10mHZ, 7 x 7cm display	£109 25
SC110 10mHZ Battery portable, 10mV, 3-2 x 2-6cm display (Optional case £8-80, Nicads £7-95, Mains unit £4-00)	£149 95
LB0512A 10mHZ, 10mV, 5" display	£195 50
CS1559A 10mHZ, 10mV, 5" display	£198 50
V151 15mHZ 1mV 5" display	£241 50

### OPTIONAL PROBES (ALL MODELS)

X1 £6-50, X10 £8-50, X100 £12-95, X1-X10 £10-95

ALL SCOPES NOW WITH FREE PROBE(S)

### DUAL TRACE (UK c/p etc £3 50)

CS1562A 10mHZ, 10mV, 5" display	£227 00
CS1575 5mHZ, 1mV, 5" display	£270 00
Hm 312-8 20mHZ, 5mV, 8 x 10cm display	£253 00
CS1566A 20mHZ, 5mV, 5" display	£323 15
LB03085 70mHZ, 2mV, 5 x 6-3cm display, Battery/Mains portable, built in Nicads	£482 00
Hm 412-4 20mHZ, 5mV, 8 x 10cm display plus Sweep Delay	£399 50
CS1577A 35mHZ, 2mV, 5" display	£455 40
CS1830 30mHZ, 2mV, 5" display plus Sweep Delay	£507 15
Hm 512-8 50mHZ, 5mV, 10 x 8cm display, Delay Sweep	£667 00
LB0514 10mHZ, 1mV (5mV), 5" display	£294 00
V152 15mHZ 1mV 5" display	£326 60
V302 30mHZ 1mV 5" display	£447 35
V350 50mHZ 1mV 10 x 8cm Delay sweep + 3 channel display	£799 25

## GENERATORS

(UK c/p £1-75)



TRIO ● LEADER ● CSC  
● SINCLAIR

RF SG402 100KHZ-30mHZ with AM modulation	£64 40
LSG16 100KHZ-100mHZ (300mHZ on Harmonics)	£56 50
SG2030 250KHZ-100mHZ low cost range	£46 95
ARF300 18HZ-200mHZ Low cost range	£76 95
AUDIO and RF PULSE	
2001 1HZ-100KHZ (Function)	£86 00
TG105 5HZ-5mHZ	£92 50
4001 0-5HZ-5mHZ	£105 00
A range of Signal Generators to cover Audio, RF and Pulsing. Mains operated (TG series Battery).	
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AG202A 20HZ-200KHZ	£65 55
LAG226 20HZ-200KHZ	£69 00
AG203 10HZ-1mHZ Sine/Square	£120 75
LAG120A 10HZ-1mHZ	£137 00

### LOGIC PROBES/MONITORS

Logic probes indicating high/low, etc, states that scopes can miss. All circuit powered for all IC's.	
LP3 50 mHZ logic probe	£55 95
LPI 10 mHZ logic probe	£35 50
LP2 1 1/2 mHZ logic probe	£19 95
LMI Logic monitor	£33 00
LDP 50 mHZ Logic probe with case	£51 00

### PRO MULTIMETERS

M1200 100K/Volt 30 range plus AC/DC 15 amp	£67 00
K1400 20K/Volt 23 range large scale AC/DC 10 amp	£79 95
M1500 20K/Volt 42 range plus AC/DC 10 amp	£53 50
(UK c/p £1-20)	
K2000 38 range FET 10m ohm input 20Hz to 30mHz	£95 00

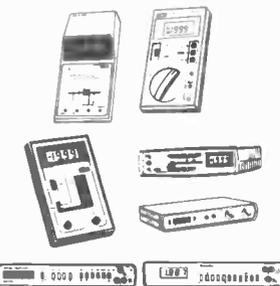
### SWR/FS AND POWER METERS



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## DIGITAL MULTIMETERS

KAISE ● SINCLAIR ● LASCAR ● THURLBY



### HAND HELD (UK post etc 85p)

TM352 3 1/2 Digit LCD plus 10ADC and Hfe checker	£54 95
PDM35 3 1/2 Digit 16 range LED (no AC current)	£32 95
ME502 3 1/2 Digit LED plus 10A DC and Hfe checker	£43 95
LM2001 3 1/2 Digit LCD 2 amp AC/DC 0-1%	£51 70
6200 3 1/2 Digit LCD 0-2A AC/DC, Auto range	£39 95
6220 As 6200 plus 10A AC/DC	£49 95
6100 As 6200 plus Cont. test/ range hold	£59 95
6110 As 6100 plus 10A AC/DC	£74 95

A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors—some with optional Nicads. All supplied with batteries and leads.

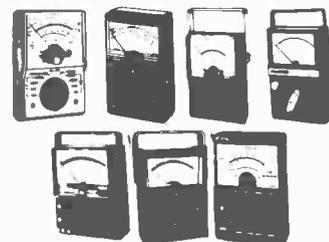
### BENCH PORTABLES (UK c/p £1-00)

DM235 3 1/2 Digit LED 21 ranges, 0-5% AC/DC 2A	£56 50
DM350 3 1/2 Digit LED 34 ranges, AC/DC 10A	£78 50
TM353 3 1/2 Digit LCD AC/DC 2 amp	£86 50
TM351 3 1/2 Digit LCD AC/DC 10 amp	£107 95
LM100 3 1/2 Digit LCD AC/DC 2 amp	£86 50
DM450 4 1/2 Digit LED 34 ranges, AC/DC 10 amp	£107 95
1503 4 1/2 Digit LCD 28 ranges, AC/DC 10 amp include Mains adaptor	£159 85

(DM series options: Carry case £8-80, Nicads £7-95, Mains adaptor £4-00.)

## MULTIMETERS

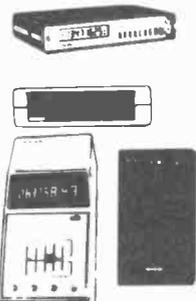
(UK post etc 75p)



KRT101 1K/Volt 10 range pocket	£4 50
ATM1/LTI 1K/Volt 12 range pocket	£5 95
NH55 2K/Volt 10 range pocket	£6 95
ATI 2K/Volt 12 range pocket de luxe	£7 95
NH56 20K/Volt 22 range pocket	£10 95
YN360TR 20K/Volt 19 range pocket plus hfe test	£13 95
AT1020 20K/Volt 19 range de luxe plus hfe test	£16 95
7081 50K/Volt 36 range plus 10 amp DC	£19 95
TMK500 30K/Volt 23 range plus 12A DC/Cont. test	£21 50
AT20 20K/Volt 21 range de luxe plus 10A DC and SKV DC	£21 95
AT205 50K/Volt 21 range de luxe plus 10A DC	£24 95
7080 20K/Volt 26 range large scale, 10A DC plus 5KV AC/DC	£26 95
AT2050 50K/Volt 18 range de luxe plus hfe test	£28 50
AT210 100K/Volt 21 range de luxe 12A AC/DC	£29 95
360TR 100K/Volt 23 range plus hfe checker and AC/DC 10 amps	£34 95

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CSC ● SINCLAIR ● SPC ● OPTO ELECTRONICS

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MAX50 100HZ to 50mHZ 6 Digit LED	£61 00
MAX550 30KHZ to 550mHZ 6 Digit LED	£106 00

### BENCH PORTABLES (UK c/p £1-00)

MAX100 8 Digit LED 5 HZ to 100mHZ	£89 00
TF200 8 Digit LCD 10HZ to 200mHZ	£158 95
7010A 9 Digit LED 10HZ to 600mHZ	£169 00
200SPC 6 Digit 100mHZ LED built into 0-002HZ to 5-5mHZ pulse generator	£437 00
TP600 600mHZ Prescaler for TF200	£41 00

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EXP300	£5 95	EXP600	£6 50

KITS:  
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PB101 £17-95  
(UK c/p—EXP's 30p. KITS 55p)

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Mains Drill	£13 95
Mains Drill plus 20 tools	£21 50

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### MOSFET

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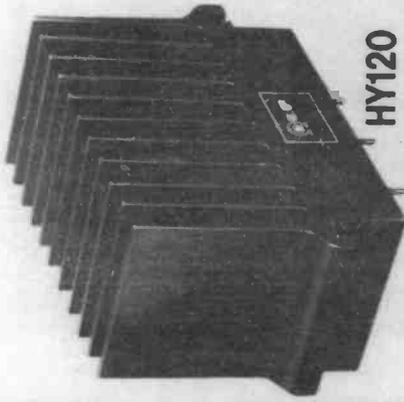
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

### BIPOLAR

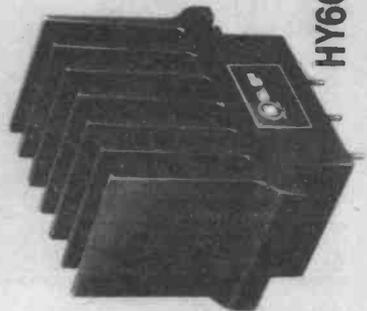
**(Standard o/p transistors)**

**CHOOSE AN I.L.P. BIPOLAR POWER AMP** where power and price are first considerations while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P. Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated bipolar transistors within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via five pins on the underside and without the need for pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77

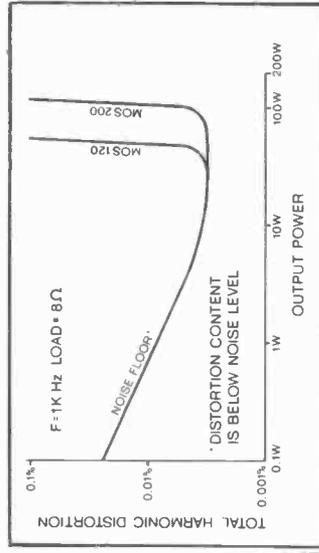


HY120

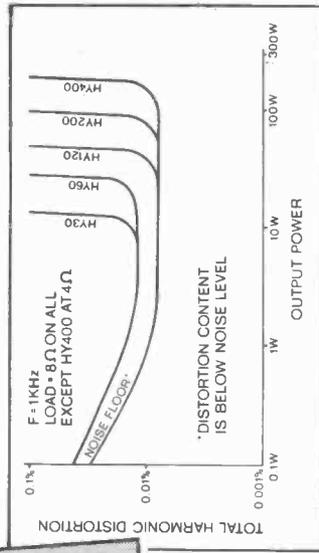


HY60

**I.L.P. POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE**



Load impedance both models 4Ω-∞ Input sensitivity both models 100KΩ  
Frequency response both models 15Hz-100KHz-3dB



Load impedance all models 4Ω-∞ Input impedance all models 100KΩ  
Input sensitivity all models 500mV 15Hz-50KHz-3dB

### THE NEW PROFILE EXTRUSIONS

The introduction of standard heatsink extrusion for all I.L.P. power amplifiers achieves many advantages: - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for higher thermal conductivity. Extrusions vary in size according to module number.



# I.L.P. PRE-AMPS

HY6 (mono) and HY66 (stereo) are new to I.L.P.'s range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P. power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes - HY6 - 45 x 20 x 40 mm. HY66 - 90 x 20 x 40 mm. Active Tone Control circuits provide  $\pm 12$ dB cut and boost. Inputs Sensitivity - Mag. PU - 3mV; Mic - selectable 1-12mV; All others 100mV. Tape O/P - 100mV; Main O/P - 500mV; Frequency response - D.C. to 100KHz - 3dB.

HY6 mono £6.44 + 97p VAT Connectors included  
 HY66 stereo £12.19 + £1.83 VAT Connectors included  
 B6 Mounting Board for one HY6 78p + 12p VAT  
 B66 Mounting Board for one HY66 99p + 15p VAT

# I.L.P. POWER SUPPLY UNITS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P. power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P. amps and pre-amps with types to match whatever I.L.P. power amps you choose.

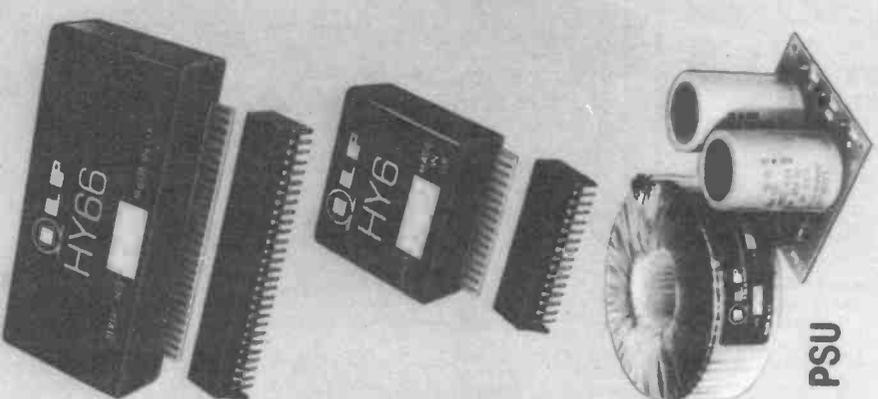
- PSU30  $\pm 15$ V at 100mA to drive up to 12 x HY6 or 6 x HY66 £4.50 + 0.68p VAT
- THE FOLLOWING WILL ALSO DRIVE I.L.P. PRE-AMPS £8.10 + £1.22 VAT
- PSU36 for use with 1 or 2 HY30's
- ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS
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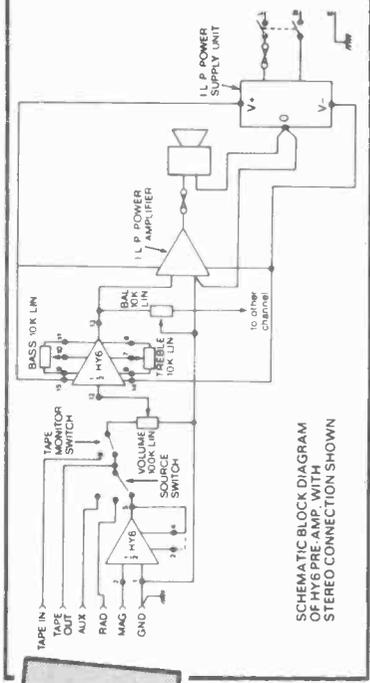
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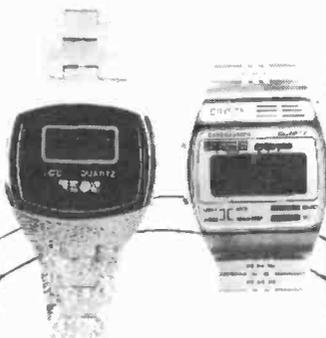
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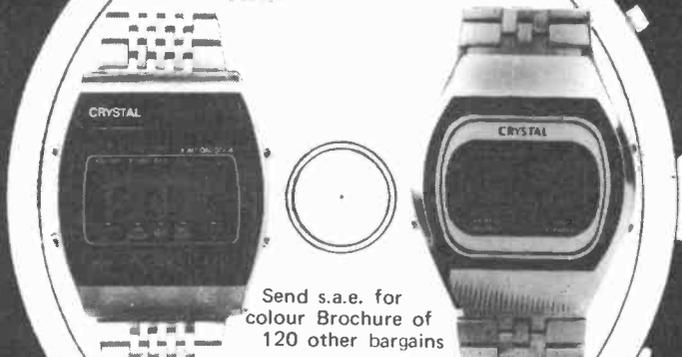
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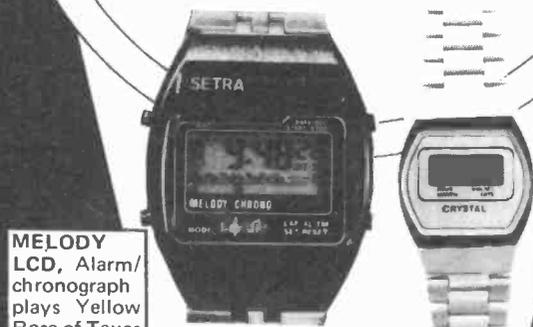


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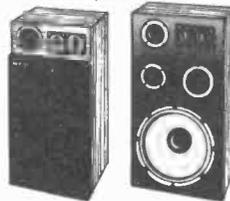
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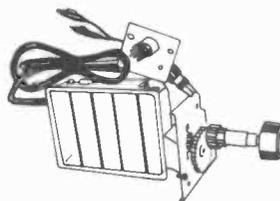
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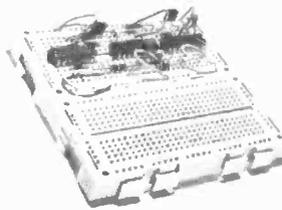
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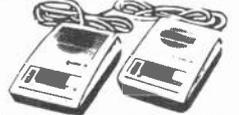
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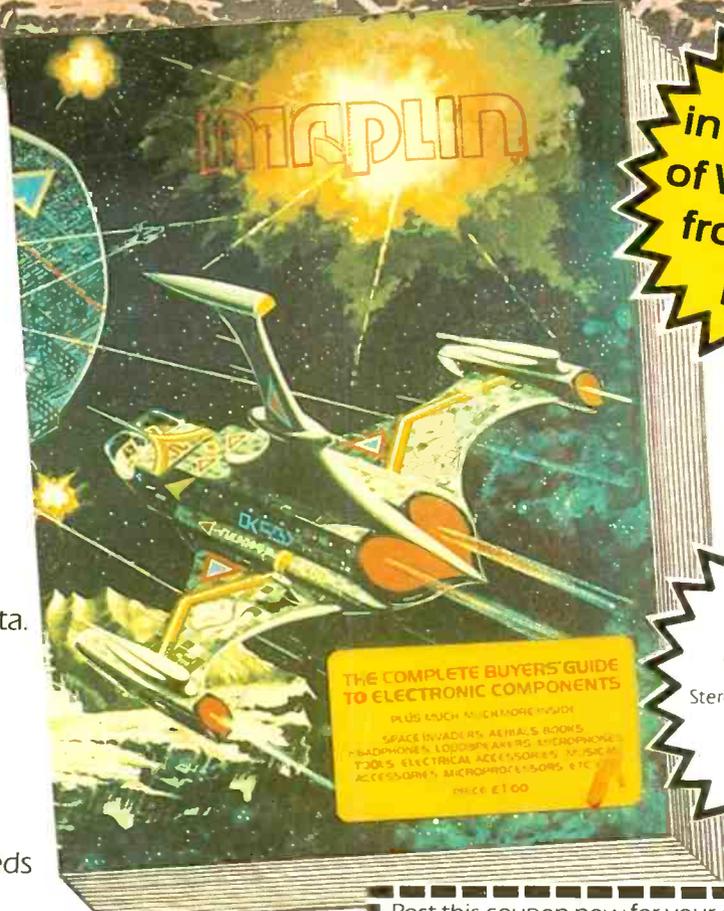
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