Easy to build projects for everyone

Everyday ELECTRONICS

198

SEPT. 80

50p

TTL POWER SUPPLY UNIT

LOGIC PROBE • DUO-DECI TIMER

Australia $1·00 New Zealand $1·10 Malaysia $3·50

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.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p 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. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type (Values are in μF)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10m, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n, **24p**; 330n, 470n **41p**; 680n **52p**; 1μF **64p**; 2μ **82p**.
160V: 39μF, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1μF **22p**; 1μ5, 2μ2 **32p**; 4μ7 **36p**.
1000V: 10nF, 15n, **20p**; 22n **22p**; 47n **26p**; 100n **38p**; 470n **80p**; 1μF **175p**.

POLYESTER RADIAL LEAD CAPACITORS (250V)
10nF, 15n, 22n, 27n, **5p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1μF **22p**; 1μ5 **30p**; 2μ2 **34p**.

RECTANGULAR LEDs
Red, Green or Yellow with Clips 30p only

ELECTROLYTIC CAPACITORS: (Values are in uF) 500V: 10 **50p**; 47 **78p**; 250V: 100 **65p**; 63V 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, **8p**; 10, 15, 22, **11p**; 47, 32, 50 **12p**; 63, 100 **27p**; 50V 50' 100, 220, **25p**; 470 **32p**; 1000 **80p**; 40V: 22, 33, **9p**; 100 **12p**; 2200, 3300 **85p**; 4700 **98p**; 35V: 10, 33 **8p**; 330, 470 **32p**; 25V: 10, 22, 47, 100 **8p**; 160, 220, 250, **15p**; 470 **25p**; 640, 1000 **35p**; 1500 **40p**; 2002 **52p**; 3300 **77p**; 4700 **85p**; 16V: 10, 40. 47 **7p**; 100, 125 **8p**; 220, 330 **14p**; 470 **20p**; 1000, 1500 **30p**; 2200 **36p**; 10V: 100 **7p**;
TAG-END TYPE: 450V: 100μF **180p**; 70V: 4700 **165p**; 64V: 3300 **150p**; 2500 **110p**; 50V: 4700 **150p**; 3300 **135p**; 2200 **99p**; 40V: 4700 **130p**; 4000 **92p**; 3300 **98p**; 2500 **85p**; 2200 **85p**; 2000 + 2000 **120p**; 30V: 4700 **110p**; 25V: 15000 **195p**; 6400 **120p**; 4700 **100p**; 3000 **85p**; 2200 **60p**.

TANTALUM Bead Capacitors
35V: 0·1μF, 0·22, 0·33, 0·47, 0·68, 1·0, 2μ2, 3·3μ, 4·7, 25V: 10, 20V: 6μ8, 16V: 2μ2, 4μ7, 10. **20p.**
16V; 22μ **32p**; 47, 100 **58p**; 220 **70p**.
10V: 15μ, 22, 33, **30p**. 3V: 100 **32p**.

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01μF **6p**
0·015, 0·02, 0·04, 0·05, 0·056μF **7p**
0·1μF **8p** 50V: 0·47 **12p**

MINIATURE TYPE TRIMMERS
2-5·6pF, 3-10pF, 10-40pF **22p**
5-25pF, 5-45pF, 60pF, 88pF **30p**

COMPRESSION TRIMMERS
3-40pF, 10-80pF **30p**; 25-190pF **33p**
100 500pF **45p** 1250pF **58p.**

POLYSTYRENE CAPACITORS
10pF to 1nF **8p**; 1·5nF to 10nF **10p.**

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 **11p each**
220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **16p each**
1000, 1200, 1800, 2000, 3300 **25p each**

CERAMIC CAPACITORS: 50V
0·5pF to 10nF **4p**; 22n to 100n **7p.**

EURO BREADBOARD £5·30.

POTENTIOMETERS: (ROTARY)
Carbon Track. 0·25W Log & 0·5W Linear Value.

500 Ω, 1 K & 2K (Lin. only) Single	29p
5K-2 MΩ single gang	29p
5K-2 MΩ single with DP switch	69p
5K-2 MΩ double gang	88p

SLIDER POTENTIOMETER
0·25W log and linear values 60mm

5K Ω-500K Ω single gang	60p
10K Ω-500K Ω dual gang	80p
Self Stick Graduated Bezels	36p

PRESET POTENTIOMETERS
Vertical & Horizontal

0-1W 50 Ω—5MΩ Miniature	7p
0-25W 100 Ω—3·3M Ω Horiz	10p
0-25W 200 Ω—4·7MΩ Vert	10p

RESISTORS: Carbon Film, High Stability, Low Noise, Miniature Tolerance 5%.

Range	Val.	1–99	100+
¼W 2Ω2–4M7	E24	2p	1p
½W 2Ω2–4M7	E12	2p	1p
1W 2Ω2–10M	E12	5p	4p
2% Metal Film 10Ω–1M		6p	4p
1% Metal Film 51Ω–1M		8p	6p

100+ price applies to Resistors of each value not mixed.

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

OPTO ELECTRONICS
LEDs plus clips

TIL209 Red	13
TIL211 Grn	17
TIL212 Yellow	18
·2" Red	14
2" Yellow Green	18
Square LED	36
OCP71	120
ORP12	83
ORP61	85
2N5777	45

7 Seg Displays

TIL312 C An 3"	105
TIL313 C Cth 3"	105
TIL321 C An 5"	115
TIL322 C Cth 5"	115
DL704 C Cth 3"	99
DL707 C.A. ·3"	99
DL747 C.A. ·6"	180
FND357	120
MAN3640	175
·3" Green C.A.	180
·6" Green C.A.	225
LCD 3½ Digit	875
TIL32 Inf. Red	58
TIL78 detector	70

Opto Isolators

IL74	48
TIL111, 112,	75p.
TIL116, 117	100p.

Bargraph Red.
Ten segment 225p

VOLTAGE REGULATORS*

1A	TO3	+ve		−ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		—
18V	7818	145p		—

1A	TO220 Plastic Casing			
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p

100mA	TO92 Plastic Casing			
5V	78L05	30p	79L05	65p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

CA3085	95	LM325N	240	TDA1412	150
LM300H	170	LM326N	240	78H05	595
LM305H	140	LM327N	270	78H05+5V/5A	595
LM309K	135	LM723	39		
LM317K	350	TAA550	50	78HG 5V to 25V	
LM323K	625	TBA625B	95		650

SLIDE 250V:

1A DPDT	14p
1A DP c/off.	15p
½A DPDT	13p
4 pole c/over	24p

PUSH BUTTON
Spring Loaded

SPST on/off	65p
SPDT c/over	70p
DPDT 6 Tag	85p

SWITCHES
TOGGLE 2A 250V

SPST	28p
DPDT	38p

SUB-MIN TOGGLE

SP changeover	59p
SPST on/off	54p
DPDT 6 tags	70p
DPDT c/off	79p
DPDT Biased	115p

SWITCHES Miniature Non-Locking
Push to Make 15p Push to Break 25p
ROCKER: SPST on/off 100A 250V 30p
ROCKER: Illuminated (Black)
Lights when on: 3A 240V 70p
ROTARY: (ADJUSTABLE STOP) 1 pole/ 2-12 way 2p/2-6W, 3p/2-4W, 4p/2-3W. 43p
ROTARY: Mains 250V AC, 4 Amp 52p

DIL SOCKETS (Low Profile – Texas)
8 pin 10p; 14 pin 12p; 16 pin 13p; 18 pin 43p; 20 pin 22p; 24 pin 30p; 28 pin 35p; 40 pin 40p.

JACKSONS VARIABLE CAPACITORS

Dilicon 100/300pF	205p
500pF	250p
6 1 Ball Drive 4511/DAF	145p
Dial Drive 4103 6 1/36 1	775p
Drum 54mm	55p
0-1·365pF	325p
00 2 365pF	395p
0 2 365pF with slow motion Drive	450p
00 208/176	395p
,, ,, with slow motion drive	410p
C804-5pF 10 15 25 50 pF	250p
100, 150pF	335p
'L' 3 x 310pF	725p
00·3 x 25pF	550p

DENCO COILS
'DP' VALVE TYPE

Range 1 to 5 Bl., Rd., Yl. Wht.	106p
6-7 B.Y.R.	95p
1·5 Green	130p
'T' 1 to 5 Bl., Yl., Rd., Wht.	128p
B9A Valve Holder	35p
RDT2	120p
RFC 5	120p
RFC 7 (19mH)	133p
IFT 13; 14; 15; 16; 17	110p
IFT 18/1·6	116p
IFT 18/465	132p
TOC 1	92p
MW5FR	112p
MW/LW 5FR	134p

VEROBOARD

	0·1 (copper clad)	0·15 (copper clad)	0·15 (plain)
2½ × 3¾	66p	59p	42p
2½ × 5	75p	69p	—
3¾ × 3¾	75p	—	—
3¾ × 5	86p	72p	65p
2½ × 17	240p	—	—
3¾ × 17	296p	260p	—
4¾ × 17	387p	—	280p

Pkt of 35 pins	20p
Spot face cutter	107p
Pin insertion tool	147p

DIODES

AA129	20
BA100	10
BA102	30
BY126	12
BY127	12
CRO33	158
OA9	45
OA47	18
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

We stock a wide selection of Electronic Books and Magazines

ZENERS
Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V. 1·3W 15p each

NOISE
Z5J 180

BRIDGE RECTIFIERS
(plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	60

DIAC
ST2 25

SCRs
Thyristors

1A/50V	37p
1A/100V	42p
1A/400V	55p
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A/700V	195p
2N4444	140p
2N5062	28
2N5064	35
BT106	150
C106D	38
TIC44	25
TIC45	45

TRIACS

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	130p
16A100V	95
16A500V	150
25A800V	295
25A1000V	480p
T28000D	120

TTL 74		74126	55	LS54	30	LS673	750	4095	105	ICM7217A	790
7400	11	74128	74	LS55	70	LS674	850	4096	105	ICM7555	89
7401	12	74132	70	LS63	150			4097	350	LD130	452
7402	12	74136	65	LS73	40	CMOS		4098	115	LF356	98
7403	14	74141	85	LS74	40	4000	18	4099	190	LM10	395
7404	14	74142	195	LS75	48	4001	18	4160	125	LM300H	170
7405	18	74143	350	LS76	45	4002	24	4161	125	LM301A	23
7406	48	74144	350	LS78	45	4006	92	4162	125	LM308	70
7407	48	74145	90	LS83	105	4007	22	4163	125	LM318	205
7408	22	74147	180	LS85	105	4008	82	4174	130	LM324	45
7409	22	74148	145	LS86	45	4009	40	4175	120	LM339	70
7410	19	74150	150	LS90	50	4010	48	4194	125	LM348	90
7411	25	74151	75	LS91	125	4011	24	4408	790	LM380	80
7412	20	74153	75	LS92	75	4012	24	4409	790	LM381	145
7413	33	74154	140	LS93	75	4013	45	4410	790	LM382	125
7414	52	74155	75	LS95	115	4014	85	4411	1020	LM1458	40
7416	31	74156	80	LS96	180	4015	85	4412F	1520	LM3900	60
7417	31	74157	75	LS107	45	4016	42	4412V	1520	LM3909N	70
7420	19	74159	185	LS109	75	4017	82	4415F	850	LM3911	125
7421	38	74160	99	LS112	80	4018	88	4415V	850	LM3914	240
7422	26	74161	99	LS113	85	4019	48	4419	320	LM3915	240
7423	32	74162	88	LS114	49	4020	99	4422	570	M253AA	795
7425	30	74163	99	LS123	85	4021	105	4432	1050	MC1310	149
7426	44	74164	120	LS124	180	4022	95	4435	1050	MC1312P	105
7427	32	74165	120	LS125	60	4023	25	4440	999	MC1488	85
7428	35	74166	155	LS126	60	4024	75	4450	350	MC1489	90
7430	20	74167	240	LS132	95	4025	25	4451	350	MC1494	595
7432	28	74170	230	LS136	55	4026	180	4452		MC1495	350
7433	38	74172	420	LS138	70	4027	48	4490F	750	MC1496	82
7437	35	74173	120	LS139	90	4028	82	4490V	750	MC1710	78
7438	30	74174	105	LS151	96	4029	105	4501	28	MC3340P	120
7440	20	74175	82	LS153	85	4030	60	4502	125	MC3360P	120
7441	74	74176	90	LS155	96	4031	225	4503	75	MC3401	52
7442	71	74177	90	LS156	96	4032	125	4506	75	MC3403..	135
7443	120	74178	149	LS157	76	4033	175	4507	60	MFC6040	97
7444	116	74180	90	LS158	85	4034	210	4508	325	MK50398	635
7445	116	74181	290	LS160	120	4035	125	4510	99	MM5307	1275
7446	132	74182	88	LS161	98	4036	365	4511	150	MM57160	620
7447	99	74184	145	LS162	110	4037	115	4512	98	NE518	210
7448	99	74185	145	LS163	100	4038	118	4520	115	NE543	210
7450	20	74188	299	LS164	115	4039	360			NE544	185
7451	20	74190	135	LS165	155	4040	105	LINEAR IC's		NE555	22
7453	20	74191	135	LS168	210	4041	80	702	75	NE556	55
7454	20	74192	135	LS170	288	4042	80	709C 14 pin	35	NE560	325
7460	20	74193	135	LS173	105	4043	95	710	67	NE561	385
7470	41	74194	105	LS174	147	4044	95	741C 8 pin	17	NE562	410
7472	31	74195	110	LS175	110	4045	175	747C	78	NE564	425
7473	40	74196	130	LS181	295	4046	130	748C	36	NE565	120
7474	34	74197	90	LS183	298	4047	98	753	185	NE566	160
7475	56	74198	195	LS189	120	4048	65	810	159	NE567	170
7476	41			LS190	120	4049	45	2102	120	NE570	395
7480	55	74LS		LS191	120	4050	48	2112	110	NE571	420
7481	120	LS00	13	LS192	125	4051	80	2114	295	S556B	275
7482	75	LS01	13	LS193	125	4052	80	81LS97	140	SAB3209	425
7483	94	LS02	15	LS194	125	4053	80	AY-1-0212	580	SAB3210	275
7484	113	LS03	15	LS196	120	4054	130	AY-1-1313A	660	SN76003	210
7485	121	LS04	20	LS197	120	4055	135	AY-1-1320	315	SN76013	170
7486	33	LS05	23	LS199		4056	135	AY-1-5050	190	SN76023	170
7489	215	LS06	23	LS200	345	4057	2850	AY-1-5051	160	SN76033	240
7490	57	LS09	23	LS202	345	4059	575	AY-1-6721/6	210	SN76477	175
7491	85	LS10	20	LS221	120	4060	130	AY-3-8500	390	TBA120S	70
7492	59	LS11	32	LS240	225	4061	1225	AY-5-1224A	235	TBA641	250
7493	59	LS12	32	LS241	225	4062	995	AY-5-1230	450	TBA800	90
7494	95	LS13	40	LS242	232	4063	120	CA3018	68	TBA810	96
7495	71	LS14	75	LS244	225	4066	58	CA3023	170	TCA965	120
7496	95	LS15	40	LS245	270	4067	430	CA3028A	80	TDA1008	310
7497	180	LS20	21	LS247	135	4068	26	CA3035	235	TDA1022	575
74100	130	LS21	32	LS251	130	4069	26	CA3043	275	TDA1024	105
74104	62	LS22	40	LS253	130	4070	30	CA3046	71	TDA2020	320
74105	62	LS26	48	LS257	115	4071	25	CA3048	214	TLO61	54
74107	35	LS27	45	LS258	120	4072	25	CA3060E	65	TLO71	45
74109	60	LS28	48	LS259	160	4073	25	CA3081	190	TLO74	140
74110	54	LS30	24	LS261	450	4075	25	CA3085	85	TLO81	42
74111	68	LS32	30	LS266	75	4076	99	CA3089E	215	TLO83	95
74112	150	LS33	39	LS273	180	4077	48	CA3090AQ	375	TLO84	120
74116	198	LS37	39	LS279	88	4078	30	CA3123E	150	UAA170	175
74118	99	LS38	39	LS280	250	4081	28	CA3130	85	UAA180	175
74119	125	LS40	28	LS299	420	4082	28	CA3140	48	Z80CPU	990
74120	105	LS42	80	LS324	200	4085	90	ICL7106E	795	ZN414	95
74121	42	LS47	85	LS367	65	4086	90	ICL7107	975	ZN424E	130
74122	55	LS48	120	LS368	65	4089	150	ICL8038	340	ZN425E	415
74123	95	LS49	120	LS373	180	4093	89	ICM7205	1150	ZN1034	200
74125	45	LS51	25	LS670	270	4094	240	ICM7216	1950	ZN1040E	685

TRANSISTORS

				BDY17	195	MJ491	175	TIP36A	170	2N2905A	22
AC125	35	BC172	11	BDY56	170	MJ2955	90	TIP36C	199	2N2906	22
AC126	25	BC173	11	BDY60	110	MJE340	54	TIP41A	55	2N2926G	10
AC127	22	BC177	15	BDY61	185	MJE370	70	TIP41B	60	2N3053	19
AC128	20	BC178	15	BF115	26	MJE371	70	TIP42A	72	2N3054	55
AC141	27	BC179	15	BF154	25	MJE2955	99	TIP42B	82	2N3055	48
AC142	28	BC181	10	BF156	28	MJE3055	70	TIP2955	60	2N3121	40
AC176	25	BC182	10	BF167	30	MPF102	66	TIP3055	60	2N3133	43
AC188	24	BC182L	10	BF173	25	MPF103	38	TIS43	30	2N3135	33
ACY17	60	BC183	10	BF177	24	MPF104	36	TIS44	45	2N3250	30
ACY18	60	BC183L	10	BF178	25	MPF105	40	TIS88A	50	2N3442	140
ACY19	60	BC184	10	BF179	30	MPF106	40	TIS90	30	2N3663	14
ACY20	53	BC184L	10	BF180	30	MPSA05	22	TIS91	32	2N3702	10
ACY21	60	BC187	25	BF194	10	MPSA06	24	ZTX107	11	2N3703	10
ACY22	60	BC212	9	BF195	11	MPSA12	29	ZTX108	11	2N3704	10
ACY28	60	BC212L	9	BF196	12	MPSA55	29	ZTX109	11	2N3705	10
ACY39	80	BC213	9	BF197	12	MPSA56	29	ZTX300	13	2N3706	18
AD140	70	BC213L	9	BF198	16	MPSU05	50	ZTX301	15	2N3707	10
AD149	75	BC214	10	BF199	18	MPSU06	56	ZTX302	20	2N3708	11
AD161	42	BC214L	10	BF200	29	MPSU56	60	ZTX303	25	2N3709	11
AD162	42	BC307	14	BF224A	18	OC28	120	ZTX304	17	2N3710	10
AF114	75	BC308	16	BF244B	24	OC35	125	ZTX314	24	2N3711	10
AF115	60	BC327	12	BF244	30	OC36	130	ZTX326	45	2N3713	215
AF118	95	BC328	12	BF245	30	OC41	125	ZTX341	20	2N3771	179
AF139	40	BC338	12	BF256	60	OC42	48	ZTX500	15	2N3772	195
AF178	75	BC441	30	BF256B	45	OC43	55	ZTX501	15	2N3773	283
AF180	70	BC461	30	BF257	35	OC44	55	ZTX502	17	2N3819	20
AF186	50	BC447	35	BF258	35	OC45	40	ZTX503	15	2N3820	45
AF239	42	BC477	35	BF259	35	OC46	28	ZTX504	25	2N3882	130
BC107	11	BC547	10	BF274	42	OC70	40	ZTX531	25	2N3823	70
BC107B	11	BC548	7	BF594	30	OC71	35	ZTX550	25	2N3866	90
BC108	11	BC549C	10	BF595	20	OC72	40	2N696	36	2N3903	20
BC108B	11	BC557	15	BFR39	25	OC74	50	2N697	25	2N3904	18
BC108C	12	BC558	15	BFR40	28	OC76	45	2N698	40	2N3905	18
BC109	11	BC559C	15	BFR41	24	OC77	76	2N699	30	2N3906	17
BC109B	12	BCY70	14	BFR79	24	OC81	36	2N706	19	2N4037	52
BC109C	12	BCY71	18	BFR80	24	OC82	50	2N708	19	2N4058	17
BC117	20	BCY72	20	BFR81	24	OC83	48	2N918	33	2N4061	17
BC119	23	BD131	42	BFX29	28	OC84	45	2N930	18	2N4859	65
BC137	20	BD132	42	BFX81	45	OC140	110	2N961	61	2N5135	42
BC140	26	BD133	50	BFX84	26	OC170	85	2N1131	22	2N5136	42
BC142	26	BD135	40	BFX85	28	OC171	45	2N1132	24	2N5138	20
BC143	26	BD136	40	BFX86	28	OC202	95	2N1302	35	2N5179	60
BC147	9	BD137	40	BFX87	28	TIP29A	36	2N1303	50	2N5180	80
BC148	8	BD138	40	BFX88	28	TIP29C	60	2N1304	50	2N5191	70
BC149	9	BD139	40	BFY50	24	TIP30A	48	2N1305	35	2N5305	40
BC153	20	BD140	40	BFY51	21	TIP30C	58	2N1671B	120	2N5457	32
BC154	13	BD142	68	BFY52	21	TIP31A	45	2N2160	350	2N5458	32
BC157	10	BD145	175	BFY56	32	TIP31C	55	2N2219A	22	2N5459	32
BC158	10	BD205	110	BFY71	20	TIP32A	48	2N2220A	23	2N5485	35
BC159	11	BD222	75	BRY39	39	TIP32C	60	2N2222	20	2N5777	45
BC160	28	BD378	70	BSX20	20	TIP33A	65	2N2369	15	2N6027	40
BC167A	11	BD434	32	BSY65	30	TIP33C	78	2N2476	125	3N128	112
BC168	10	BD517	70	BSY95A	18	TIP34A	74	2N2484	25	3N140	112
BC169	10	BD659A	65	BU105	170	TIP34C	80	2N2646	48	40360	43
BC170	15	BD695	85	BU205	170	TIP35A	160	2N2894	30	40361	50
BC171	11	BD696A	85	BU208	215	TIP35C	185	2N2904	24	40673	95

GMT ELECTRONICS

Freepost C Birmingham B19 1BR
021·233·2400

- FREEPOST ON ORDERS
- VAT INCLUSIVE PRICES
- ADD 30p P&P
- 24 HR PHONE ANSWERING SERVICE
- ACCESS
- VISA
- CASH
- CHEQUE

ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

C·M·O·S (BUFFERED)

HEF4000	22	HEF4044	105	HEF4512	136
HEF4001	22	HEF4046	133	HEF4516	127
HEF4002	22	HEF4047	109	HEF4517	478
HEF4006	119	HEF4049	57	HEF4518	118
HEF4007	22	HEF4050	57	HEF4519	69
HEF4008	100	HEF4051	87	HEF4520	118
HEF4011	22	HEF4052	90	HEF4521	235
HEF4012	22	HEF4053	90	HEF4528	124
HEF4013	57	HEF4066	62	HEF4532	150
HEF4014	105	HEF4067	475	HEF4534	638
HEF4015	100	HEF4068	22	HEF4539	138
HEF4016	57	HEF4069	22	HEF4585	122
HEF4017	100	HEF4070	22	HEF4724	214
HEF4018	100	HEF4071	23	HEF40097	113
HEF4019	58	HEF4072	23	HEF40098	92
HEF4020	112	HEF4073	23	HEF40106	78
HEF4021	107	HEF4075	23	HEF40160	149
HEF4022	103	HEF4076	130	HEF40192	149
HEF4023	22	HEF4077	22		
HEF4024	78	HEF4078	23		
HEF4025	22	HEF4081	23		
HEF4026	244	HEF4082	23		
HEF4027	57	HEF4085	80		
HEF4028	89	HEF4086	80		
HEF4029	113	HEF4093	63		
HEF4030	58	HEF4094	219		
HEF4031	250	HEF4104	208		
HEF4035	138	HEF4502	114		
HEF4040	107	HEF4505	714		
HEF4041	94	HEF4508	230		
HEF4042	83	HEF4510	135		
HEF4043	100	HEF4511	157		

Voltage Regulators

LM309DA(K)	119
UA723CN	42
UA7805CU	78
UA7812CU	78
UA7815CU	78
UA7912CU	97
UA7915CU	97
UA78L05CS	38
UA78L12CS	38
UA78L15CS	38

LINEAR

CA3046	84
CA3080E	77
CA3130E	99
CA3140E	48
CA3189E	293
LM301AN	34
LM339N	78
LM380N	104
LM381AN	198
LM3900N	75
MC3403P	156
NE531	131
NE536T	259
NE555N	28
NE556N	66
NE566N	171
NE570N	485
NE571N	505
RC4136	146
TBA120S	88
TDA1022	713
TDA1034B	239
TL081CP	84
TL084CN	156
UA741CN	20
UA741CT	47

Zener Diodes

400mW C4V7-C33
BZY88/BZX79
+ Voltage 9

SEMICONDUCTORS

IN914	5	BC182L	12
IN4001	5	BC184	11
IN4002	5	BC184L	12
IN4004	7	BC212	11
IN4007	9	BC212L	12
IN4148	4	BC214	11
IN5402	15	BC214L	12
2N2369	21	BC547	13
2N2646	46	BC548	11
2N2926G	13	BC549	12
2N3053	19	BC557	15
2N3054	55	BC558	15
2N3055	55	BCY70	15
2N3702	9	BCY71	15
2N3704	9	BD131	39
2N3705	10	BD132	39
2N3773	297	BD139	39
2N3819	22	BD140	39
2N3820	39	BFR90	333
2N3904	9	BFX85	29
2N5457	39	BFY50	17
2N5459	35	BFY51	17
40673	88	BRY39	50
BC107	14	BSX20	21
BC108	14	CL8960	2850
BC108C	18	TIP31	48
BC109	14	TIP32	54
BC109B	19	TIP41C	76
BC109C	20	TIP42C	76
BC148	10	TIP2955	75
BC158	10	TIP3055	60
BC177	17	TIS43	36

GMT SELL P.A. EQPT.

PLEASE SEND AN SAE FOR DETAILS

CAPACITORS

Electrolytic Axial

−10% to +50% Tol. Order Code Cap 015 + μF

μF \ V	16	25	40	63
1.0				9
1.5				9
2.2				9
3.3				9
4.7				9
6.8			9	10
10		8		10
15	8		9	11
22		8		13
33	8		9	
47		8	11	13
68	9			
100		9	13	
150	9	10		31
220	13		26	36
330			30	40
470		23	32	47
680	21	30	39	54
1000	26	30	59	
1500	35	39		
2200	42			

Polyester Radial Leads

Dipped Type, C280/352 Style — Order Code Cap 352
Moulded Type, 10.2mm Pitch — Cap 360 + Value

μF	352	360	μF	352	360
.001		7	.1	7	9
.0015		7	.15	8	10
.0022	6	7	.22	9	11
.0033	6	7	.33	11	
.0047	6	7	.47	14	
.0068	6	7	.68	17	
.01	6	8	1.0	21	
.015	6	8	1.5	30	
.022	6	8	2.2	35	
.033	6	8			
.047	6	8			
.068	7	8			

Electrolytic Radial Leads

−10% to +50% Tol. Order Code Cap 034 + μF

μF \ V	10	16	25	35	40	50	63
.47							7
.68							7
1.0							7
1.5							7
2.2							7
3.3							7
4.7					7		8
6.8			7			8	9
10		7			8		9
15		7	8			9	11
22	7	8			9	11	
33		8	9		11		
47	8	9		11			
68		9	11				
100	9						
150	11						

D.I.L. Sockets

8 Pin Low Profile Socket Tin	12	DIL SKT 8
14 Pin Low Profile Socket Tin	14	DIL SKT 14
16 Pin Low Profile Socket Tin	16	DIL SKT 16

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying 69

RESISTORS

		Order Code
Carbon Film, Fixed		
0.25W, E24 Values IRO-10M, 5% Tol.	2 each 100/100 (Mult 10/Value)	Res RDX
0.5W, E12 Values IRO-4M7, 10% Tol.	3 each	Res ROX + Value
Metal Film, Fixed		
0.5W, E24 Values, SRI-IM, 2% Tol.	8 each	Res MR30
2.5W, E12 Values, 10R-27K, 5% Tol.	16 each	Res PR52 + Value
Metal Glaze, Fixed		
0.5W, E24 Values, IM-33M, 5% Tol.	16 each	Res VR37 + Value

		Order Code
Skeleton Presets, Miniature		
0.1W, E3 Values, 100R-IM, Lin, Vertical Mounting	8	Min. Preset V
0.1W, E3 Values, 100R-IM, Lin, Horizontal Mount	8	Min. Preset H + Value
Skeleton Presets, Standard		
0.3W, E3 Values, 100R-4M7, Lin, Vertical Mounting	11	Std. Preset V
0.3W, E3 Values, 100R-4M7, Lin, Horizontal Mount	11	Std. Preset H + Value
Potentiometer, Rotary		
0.5W, E3 Values, 1K-2M2 Lin.	39	Ro Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	39	Ro Pot Log + Value
Potentiometer, Slider		
0.5W, E3 Values, 2K2-470 . Lin.	45	Sl Pot Lin
0.25W, E3 Values, 1K0 - 1M0 Log	45	Sl Pot Log + Value

SEND A LARGE S.A.E. FOR OUR 'FLOG LIST' & OTHER INFO.

MAINS TRANSFORMERS

Order Code

Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA — Clamp Type Construction 235 each
Approx. 18% Regulation F.C. 54, H36, W35

0-4.5V, 0-4.5V Secondaries — Trans 6VA
0-3V, 0-6V
0-12V, 0-12V
0-15V, 0-15V
0-20V, 0-20V

20VA — Clamp Type Construction 360 each
Approx. 16% Regulation F.C. 70, H48, W46

0-4.5V, 0-4.5V Secondaries — Trans 20VA
0-6V, 0-6V
0-12V, 0-12V
0-15V, 0-15V
0-17.5V, 0-17.5V
0-20V, 0-20V

Plastic Boxes — Boss Industrial Mouldings

Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W82 D31	99	Case BIM2003 OR
L150 W80 D50	131	Case BIM2005 OR
L190 W110 D80	223	Case BIM2006 OR

Plastic Boxes with Metal Lids

Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	112	Case BIM4003 OR
L111 W71 D42	150	Case BIM4004 OR
L161 W96 D53	208	Case BIM4005 OR

Diecast Boxes

Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W83 D31	124	Case BIM5003 NA
L152 W82 D50	215	Case BIM5005 NA
L192 W113 D61	334	Case BIM5006 NA

VERO ELECTRONICS PRODUCTS

2.5" × 5" .1" pitch Veroboard	71	200-21069J
3.75" × 5" .1" pitch Veroboard	79	200-21072D
2.5" × 1" .1" pitch Veroboard (5)	85/Pack	200-21076C
3.75" × 5" .1" pitch Plain Board	68	200-21078H
5.82" × 2.9" .1" pitch V-Q DIP Board	135	200-21084E
Spot Face Cutter	107	203-21013A
Pin Insertion Tool for .040 type pin	147	203-21015F
DS Pins .040 (100)	44/Pack	200-21087G
SS Pins .040 (100)	44/Pack	200-21017B
Verowire Kit (1-pen, 2-wire, 25-comb)	454/Kit	200-21341D
Verowire Combs (25)	109/Pack	200-21339F
Verowire Wire (2)	109/Pack	200-21340G

SWITCHES

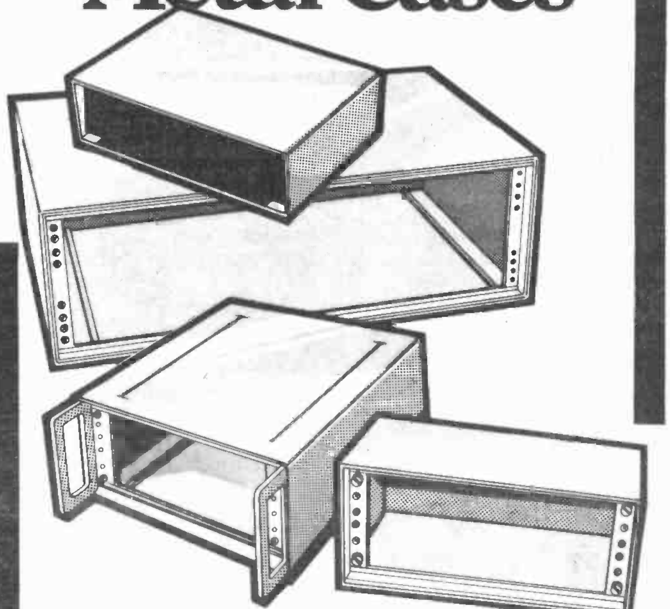
			Order Code
Miniature Toggle — Honeywell			
SPDT		67	SW 8A1011
SPDT	C/Off	81	SW 8A1021
SPDT	Double Bias To Centre	90	SW 8A1041
DPDT		99	SW 8A2011
DPDT	C/Off	111	SW 8A2021
Miniature Push — C & K			
SP	Push To Make, Momentary	62	SW 8531
SP	Push To Break, Momentary	62	SW 8533

G.M.T. ELECTRONICS KITS.

FULL TELETEXT KIT (Free-standing unit- no internal connection to T.V.)	£199-90
TELETEXT DECODER + REMOTE CONTROL KIT (For wiring into existing television)	£135-90
PAL ENCODER/MODULATOR KIT	£ 22-90
DOPPLER RADAR ALARM KIT	£ 44-90
F.E.T. POWER AMPLIFIER OUTPUT MODULE KIT	£ 27-50
ONE AMP POWER SUPPLY MODULE KIT - FIVE VOLTS	£ 6-00
ONE AMP POWER SUPPLY MODULE KIT - TWELVE VOLTS	£ 7-50
MODEL INERTIA CONTROLLER MK 1 - SLOT RACER	£ 30-00
MODEL INERTIA CONTROLLER MK II - TRAIN (HAND UNIT)	£ 25-00
MODEL INERTIA CONTROLLER MK III - TRAIN (CONSOLE UNIT)	£ 25-00

vero vero vero

Metal Cases



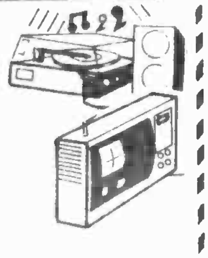
Our catalogue contains small metal enclosures for every application including the attractive new G range cases, with unique integrated chassis and sloping visor front and the inexpensive kit-form Veropak. We've also got circuit boards, accessories, module frames and plastic boxes — all to the highest standard to give your equipment the quality you demand. Send 40p to cover post and packing and the catalogue's yours.

vero

VERO ELECTRONICS LTD RETAIL DEPT.
Industrial Estate, Chandler's Ford, Hampshire SO5 3ZR
Tel: (04215) 62829

RUN YOUR HOME BY REMOTE CONTROL

How many times have you considered building a remote control project for the home but were put off by the dozens of ICs, special coils, lenses and other hard to get components, not to mention the need for a well equipped lab. to set the unit up, T. K. ELECTRONICS have changed all that. Three ICs can build a sophisticated system that requires only a capacitor and resistor to set the clock frequency (which can drift by up to 20% without affecting performance). Control radios, hi-fi (including bass, treble and volume), lighting, toys, garage doors, etc. Still not convinced? Then look at the prices!



LD271	IR Emitting Diode	36p
SFH205	Photodiode Detector	95p
SL480	IC Pulse Amplifier	£1·70
SL490	Keyboard Controlled Encoder/Transmitter	£2·40
ML922	10-channel Receiver & 3 Analogue Outputs	£4·20
ML926	16-channel Receiver (4 Momentary binary outputs)	£1·40
ML928	16-channel Receiver (4 latched binary outputs)	£1·40
Data sheets (per device)		5p

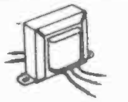
These ICs can also be used with ultrasonic and radio links, depending on range, cost and speed of operation. For more details, why not give us a ring—or send sae. We will be pleased to advise you.

NEW KIT ★★★ NEW KIT ★★★ NEW KIT

If you do not require a sophisticated multi-channel remote control, we have developed a simple single-channel ON/OFF infra red transmitter and receiver. The transmitter unit comes complete with a hand held box and requires a PP3 (9V) battery. The receiver includes a triac capable of switching up to 500W at 240V a.c. and comprises a reamplifier bistable latch and a mains power supply, making the unit completely self-contained. The small size of the receiver enables the unit to be "built into" all kinds of equipment from lamps to tape recorders. The minimum range is 20 feet. A suitable box for the receiver is available if required.

ONLY **£12.00**

MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	71p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p

TK's SPECIAL OFFERS OF THE MONTH

Orders must be received by 30/9/80.

5X TIC 106D 5A/400 V SCR	£1·75
5X TIC 206D 3A/400V TRIAC	£2·00
5X TIC 226D 8A/400V TRIAC	£2·50
10X Rectangular Green LED	£1·75
10X Rectangular Yellow LED	£1·75
5X 78 L15 12V 100mA regulator	£1·10
5X 7805 5V 1A regulator	£2·25

All components brand new and to specification. Add V.A.T. AT CURRENT RATE TO ABOVE PRICES PLUS 35p P. & P. Mail Order. Callers welcome by appointment.

BARCLAYCARD VISA Access

T.K. ELECTRONICS (PE) 106 Studley Grange Road, London W7 2LX Tel: 01 579 5794

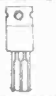
DISPLAY LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto-isolated audio input.

DL1000K
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. £14·60

DLZ1000K
A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. £8·00
Optional Opto Input DLA1 60p

TRIACS



400V Plastic Case (Texas)

3A	49p	16A	90p
8A	58p	20A	165p
12A	70p	25A	190p
6A with trigger	80p		
8A isolated tab	82p		
Diac	18p		

MINI KITS

These KITS form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB short instructions and all components.

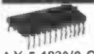
TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. PCB (4 cm.sq.) potentiometer, plus all other components included with instructions.
500W £3·20 1KW £3·50.

SOLID STATE RELAY
Ideal for switching motors, lights, heaters etc. from logic. Opto isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. £2·60

BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indictors etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4·75

BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA 1024 Zero Voltage Switch this kit contains all the components required to make a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0·5°C.
1·5KW £5·25 3KW £5·55

INTEGRATED CIRCUITS



555 Timer	21p
741 Op. Amp	19p
AY-5-1224 Clock	£2·60
AY-5-1230/2 Clock/Timer	£4·20
AY-3-1270 Thermometer	£8·20
ICL7106 DVM (LCD drive)	£7·00
LM377 Dual 2W Amp	£1·45
LM379S Dual 6W Amp	£3·50
LM380 2W Audio Amp	80p
LM382 Dual low noise preamp	£1·00
LM386 250mW low voltage amp	75p
LM1830 Fluid Level Detector	£1·50
LM2907 f-v Converter	£1·40
LM3909 LED Flasher/Oscillator	55p
LM3911 Thermometer	£1·20
LM3914 Dot/Bar Driver	£2·10
MM57160 (stac) Timer	£5·90
MM74C911 4-digit display controller	£6·50
MM74C915 7-segment-BCD converter	96p
MM74C926 4-digit counter with 7-seg outputs	£4·50
S566B Touchdimmer	£2·50
S9263 Touchswitch 16-way	£4·35
TBA800 5W Audio Amp	58p
TBA810AS 7W Audio Amp	85p
TDA1024 Zero Voltage Switch	£1·00
TDA2020 20W Audio Amp	£2·85
ZN1034E Timer	£1·80

All ICs supplied with data & circuits. Data sheets only 5p.

LIGHTING CONTROL KITS

Directly replace conventional light switch and control up to 300W of lighting. No mains rewiring. Insulated touchplates. Easy to follow instructions.

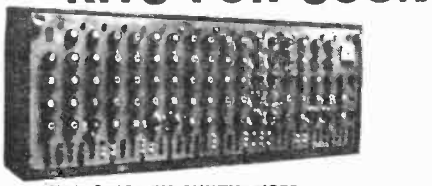
TD300K TOUCHDIMMER. Single touchplate with alternate action. Brief touch switches lamp on and off, longer touch dims or brightens lamps. Neon lamp helps find the switch in the dark. £6·50
TDE/K Extension kit for TD300K for 2-way switching etc. £1·50
TSD300K — TOUCHSWITCH & DIMMER. Single touchplate, small knob controls brightness. £6·50
TSA300K — AUTOMATIC. Single touchplate. Time delay variable 2 secs. to 3½ mins. £4·30
LD300K — LIGHTDIMMER KIT. £2·90

24hr CLOCK/APP. TIMER KIT

Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0·5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit £14·90
CT1000KB with white box (56/131 × 71mm) £17·40
Ready Built £22·50

KITS FOR SOUND EFFECTS AND OTHER PROJECTS



PHONOSONICS

DEPT EE88, 22 HIGH STREET, SIDCUP, KENT DA14 6EH

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

P.E. MINISONIC MK2 SYNTHESISER
A portable mains operated miniature sound synthesiser with keyboard circuits. Although having slightly fewer facilities than the large Formant and P.E. synthesisers the functions offered by this design give it great scope and versatility.
Set of basic component kits (excl. KBD R's & tuning pots—see list for options available) and PCBs (incl. layout charts) KIT 38-25 £80·12
"Sound Design" booklet £1·00

P.E. 128-NOTE SEQUENCER
Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable.
Basic comps, PCBs and charts KIT 76-7 £35·56
Set of text photocopies £1·36

P.E. GUITAR EFFECTS PEDAL
Modulates the attack, decay and filter characteristics of a signal from most audio sources, producing 8 different switchable effects that can be further modified by manual controls.
Basic parts, PCB & chart KIT 42-3 £10·37
Text photocopy ·28

P.E. GUITAR OVERDRIVE
Sophisticated versatile fuzz unit including variable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Can be used with other electronic instruments.
Basic parts, PCB & chart KIT 56-3 £11·82
Text photocopy ·68

P.E. GUITAR SUSTAIN
Maintains the natural attack whilst extending note duration.
Basic comps, PCB & chart KIT 75-1 £6·73
Text photocopy ·38

P.E. WAH-WAH UNIT
Can be controlled manually or by integral automatic control.
Set of basic components, PCB & chart KIT 51-1 £4·93

P.E. AUTO-WAH UNIT
Automatic Wah or Swell sounds with each note played.
Basic comps, PCB & chart KIT 58-1 £9·68
Text photocopy ·58

ELEKTOR CHOROSYNTH
A 2½-Octave Chorus synthesiser with an amazing variety of sounds ranging from violin to cello and flute to clarinet, amongst many others. Experienced constructors can readily extend the octave coverage.
Basic comps, PCBs & charts KIT 100-8 £44·39
Text photocopy ·70

ELEKTOR FUNNY TALKER
Incorporates a ring modulator, chopper and frequency modulator to produce fascinating sounds when used with speech and music signals.
Basic comps, PCB (as publ.) KIT 99-1 £9·60
Text photocopy ·40

ELEKTOR FREQUENCY DOUBLER
For use with guitars and other electronic instruments to produce an output 1 octave higher than the input. Inputs and outputs may be mixed to give greater depth.
Basic comps, PCB (as publ.) KIT 98-1 £5·48
Text photocopy ·20

P.E. SPLIT-PHASE TREMOLO
Simple but effective substitute for a rotary cabinet. An internal generator is phase-split and modulated by the music input signal and fed to 1 or 2 amplifiers. Suitable for electronic guitars and other instruments.
Basic comps, PCB & chart KIT 102-3 £17·58
Text photocopy ·65

P.E. PHASER
An automatic 6-stage phasing unit with integral oscillator.
Set of basic comps, PCB & chart KIT 88-1 £10·69
Text photocopy ·68

ELEKTOR PHASING & VIBRATO UNIT
Includes manual and automatic control over the rate of phasing & vibrato, and has been slightly modified to also include a 2-input mixer stage.
Set of basic comps, PCB & layout chart KIT 70-2 £21·87
Text photocopy ·67

P.E. PHASING UNIT
A simple but effective manually controlled phasing unit.
Set of basic comps PCB & chart KIT 25-1 £4·06
Text photocopy ·28

P.E. SWITCHED TONE TREBLE BOOST
Provides switched selection of 4 preset tonal responses.
Set of basic components, PCB & chart KIT 89-1 £4·34
Text photocopy ·78

P.E. SMOOTH FUZZ
Set of basic components, PCB & chart KIT 91-1 £6·40
Text photocopy ·55

P.E. TUNING FORK
Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying beat-note adjustments.
Set of basic comps, PCB & chart KIT 46-3 £23·32
Text photocopy ·97

P.E. CONSTANT DISPLAY FREQUENCY COUNTER
An improved version of the project published in P.E. Readout does not count visibly or flicker due to blanking.
Set of basic components & PCB KIT 79-4 £31·35
Text photocopy ·78

DYNAMIC NOISE LIMITER
Effectively reduces tape-recording hiss. Stereo Unit.
Set of basic components, PCB & chart KIT 97-1 £8·07
Text photocopy ·75

MANY MORE KITS
for synthesisers, Rhythm Generators, Electronic Pianos and other projects, big, small, simple or complex, are available, plus a range of keyboards, separate components and accessories. Details in our lists.

COMPONENT SETS incl all necessary res, caps, s/cs, pots, t/formers. Hardware such as cases, skts, knobs, kbds, etc. are not incl, but most can be bought separately. Fuller details in lists.

ADD: POST & HANDLING
U.K. orders; under £1 add 35p, under £20 add 70p, over £20 add £1. Recommended insurances against postal mishaps: add 50p for cover up to £50, £1 for £100 cover, etc., pro-rata, must be added to credit card orders. **N.B. Eire, C.L., B.F.P.O.** and other countries are subject to higher rates.

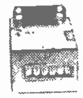
ADD 15% VAT
(or current rate if changed). Must be added to full total of goods, post & handling on all U.K. orders. Does not apply to exports, or to photocopies.

LIST: Send stamped addressed envelope with all U.K. requests for free list giving fuller details of our goods. Europe send 35p, other countries send 75p, or equivalent in international reply coupons

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

Access BARCLAYCARD VISA AMERICAN EXPRESS

SIX DIGIT COUNTERS

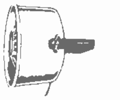


One pulse moves one digit—Type 1 for 230v AC not resettable. Price 80p—Type 2 for 48v DC or 115v AC and resettable £1·35.

PUNCHED TAPE EQUIPMENT

for controlling machine tools etc. motorised 8 bit punch with matching tape reader. Ex-computers, believed in good working order, any not so would be exchanged. £15 the pair. Carriage £3.

SIREN OR BLEEPER



American Delta mechanical type, works on 6 to 12v to DC or 12 to 24v AC. Price 75p or £60 per 100. Electronic Bleeper **TH3S** emits high pitched wailing note of varying pitch. In red plastic case with fixing bracket. £5·00.

CASSETTE PLAYER/RECORDERS

With record and playback heads, all electronics, switches and speaker. Price £9·95 (surely this must be the bargain of the year). Music centre replacement stereo with heads but not electronics. £14·95.

FRUIT MACHINE HEART

4 wheels with all fruits, motorised and with solenoids for stopping the wheels, with a little ingenuity you can defy your friends getting the "jackpot". £9·95 + £4 carriage.

DESOLDERING PUMP

Ideal for removing components from computer boards as well as for service work generally. Price £6·35.

4 CORE FLEX CABLE

White pvc for telephone extensions, disco lights etc. 10 metres £2, 100 metres £15. Other multicore cable in stock.

HEADPHONE AMPLIFIER (STEREO)

With volume, tone and balance control 9v operation. All made up ready to go. Price £4·50.

MUGGER DETERRENT

A high note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2·50 complete kit.

RELAYS

Open type with 2, 10 amp c/o contacts—single screw fixing £1·25 each, please state the coil voltage you require.

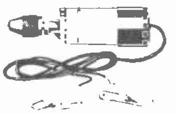
HUMIDITY SWITCH

American made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive micro-switch, very sensitive—breathing on it for instance will switch it on. Micro 3 amp. at 250V a.c. Only £1·15.

SAFE BLOCK

Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit £1·95.

VERSA DRILL



A 12 volt battery operated power drill, not just suitable for printed circuit boards but will do all the jobs and is powerful enough to perform all the functions and operations normally expected of Black & Decker and other mains drills. Its chuck accepts up to ¼" drills. Size approx. 150mm × 50mm. Price £16·75.

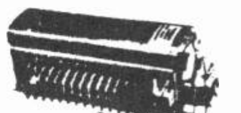
TWIST DRILLS

Precision Swiss made—normal price 50p each 10 diff. sizes covering $\frac{1}{16}$"–¼". £1·99 the lot—don't miss this super bargain.

V3 MICROSWITCHES

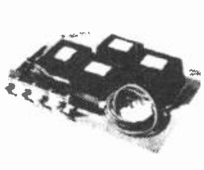
Over 50,000 in stock all 250 AC working, with 3 silver contacts for c/o circuits—10 amp 25p each or £20 per 100, 15 amp 35p each or £30 per 100.

MOTORISED DISCO SWITCH



With 10 amp changeover switches. Multi adjustable switches are rated at 10 amps. This would provide a magnificent display. For mains operating. 8 switch model £6·25. 10 switch model £6·75. 12 switch model £7·25.

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 £16 including VAT and postage.

FREE GIFT—Buy this month and you will receive a pair of Goodman's elliptical 8" × 5" speakers to match this amplifier.

NEW KITS

5 WAVE BAND SHORT WAVE KIT Bandspread covering 13·5 to 52 metres. 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 or a pair of high resistance headphones. Special price is £11·95 inc.

SUB-MIN MICROPHONE
Size only ½" × ¾" × 3/16" so small enough for a bugging device, ex-hearing aids but guaranteed. Price £1·50.

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox—all electronic parts and circuit. £2·00.

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6·50.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £3·45

Made up model £1·00 extra

VENNER TIME SWITCH mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2·95. These are new but without case, but we can supply plastic cases (base and cover) £1·75 or metal case with window £2·95. Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2·30.

THIS MONTH'S SNIP

MULLARD STEREO DECODER MODULE

Mullard Reference No. LP 1401. This ready made-up and tested unit is suitable for almost any tuner or radio, feeding a stereo amplifier. £2·00 + 30p (complete with connection diagram. Beacon lamp indicator can be supplied at an extra 50p.

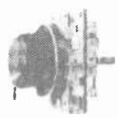
SOUND AND LIGHT UNITS

3 CHANNEL SOUND TO LIGHT KIT Complete kit of parts for a three channel sound to light unit controlling over 2000 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 ¼" 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 £13·50 in kit form or £16·50 assembled and tested.

REMOTE CONTROL for Sound to Light (ours or any other circuit) saves connecting to speaker or amp—kit consists of 1 watt amplifier, crystal mike, case, sundries and diagram. Price £3·95.

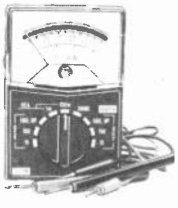
LIGHT EXPANDER AND LATCH for Sound to Light, enables 3000 watts of lighting to be controlled by single channel or each channel and enables lights to be latched on. Kit consists of latching relay, control switch, case, sundries and diagram. Price £4·25.
SINGLE CHANNEL KIT still available. Price £5·18

DELAY SWITCH



Mains operated—delay can be accurately set with pointers knob for periods of up to 2½ hrs. 2 contacts suitable to switch 10 amps—second contact opens a few minutes after 1st contact. £1·50.

MINI-MULTI TESTER



Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges.
Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.
Unbelievable value only £6·75 + 50p post and insurance.

FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one, send £2·50.

TERMS: Cash with order—but orders under £10 must add 50p to offset packing, etc.
BULK ENQUIRIES INVITED. PHONE: 01-688 1833.
ACCESS & BARCLAYCARD ACCEPTED.

J. Bull [ELECTRICAL] Ltd.

(DEPT. (EE7)
34-36 AMERICA LANE,
NEW ENGLAND ROAD,
HAYWARDS HEATH SUSSEX.
RH16 3QU

BURGLAR ALARM CONTROL PANEL
Contains labelled connection block, latching relay, test switch and removable key control switch. Simplifies the whole installation, all you have to do is to take wires to pressure pads and to alarm bell. Price £6·00 + 90p. With complete diagram.

PRECISION MAINS OPERATED CLOCK
For only £1·50 + 22p. Sounds unbelievable but that's what you can have if you send your order right away. The clocks which have large clear dials were made by the famous Smiths Company for use with their domestic cooker switch and are brand new and guaranteed.

15-0-15v @ 2 AMP MAINS TRANSFORMER
Mains transformer, upright mounting primary and secondary wound on separate bobbins with fixing lugs. Price £3 + 45p. Post 60p.

25-0-25v @ 750 mA MAINS TRANSFORMER
Mains transformer C core construction, heavily varnished for dead quiet operation. Upright mounting with fixing lugs. Price £2·75 + 41p. Post 50p.

25 WATT MID-RANGE SPEAKER 5¼"
Made by Goodmans so there's none better. 4 ohm coil. Price £3·50 + 45p. Post £1·00.

8 OHM TWEETER
Made by Goodmans. 3½" square, 4" across fixings. Price £1·50 + 22p. Post 30p.

ROTARY SOLENOID
As most customers know we have solenoids of the normal types for pulling and pushing through a magnetic assembly. We have now acquired some which have a rotating action, D.C. operated. A shaft which comes out of the centre, rather like a motor spindle, travels approx. 90°. Price £5 + 75p.

WATERPROOF HEATING WIRE
As used for electric blankets, etc. This has dozens of other applications—in gloves or socks for people with poor circulation are obvious uses. One unusual use suggested by a customer is a 'grow' bag heater. The wire which consists of an element wound on glass fibre then PVC covered has a resistance of 60 ohms per yard. The price is 20p + 3p per yard.

TELEPHONE PICK-UP coil attaches by suction to phone body, enabling conversation to be recorded, put through amp or headphones. Price £1 + 15p.

TRANSDUCERS
As used remote control T.V. receivers. Price £1·50 + 22p.

LIGHT CHASER
Gives a brilliant display—a psychedelic light show for discos, parties and pop groupds. These have three modes of flashing, two chase-patterns and a strobe effect. Total output oower 750 watts per channel. Complete kit. Price £14 + £2·10. Ready made up for £4 extra.

PRINTED CIRCUIT KIT
4 copper plated boards and the chemical for etching the printed circuits, also 50 interesting designs of all sorts of electronic gadgets which can be made on these boards. Price £1·70+30p.

MAINS TRANSISTOR POWER PACK to operate transistor radio, cassettes, amplifiers, etc., take the place of any of the following batteries, PP1, PP3, PP4, PP6, PP9 and others. You can make voltage output anything from 3v to 16v at up to 300 mA. Complete kit but no case £1·75 + 26p. Case 75p + 13p.

TELESCOPIC AERIAL
5 sections, 21" when extended. Nickel plated superior make, one nut fixing, folds over for FM. Price 95p + 15p.

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 loudspeaker emits a shrill note. Kit. Price £4 50+68p.

6 WAVEBAND SHORT WAVE RADIO KIT
Brandspread covering 13·5 to 52 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. Special price to get this kit off the ground. is £11·95 inc VAT and postage.

3" EDGEWISE PANEL METER
0·25 MA moving coil made for the G.P.O. A very useful instrument especially when panel space is limited. £2·50 + 38p.

U.V. LAMPS
Can add a touch of novelty to a party or disco. We have in stock the Atlas 175 watt U.V. Lamps. These plug straight into a lampholder and need no control or starter gear. This is a black lamp about the size of the old-fashioned 200 watt lamp. Price £9·00 + £1·35p.

PANEL METER 0·1mA
Japanese made full vision perspex front, flush mounting. Price £3 + 45p.

12v SUBMERSIBLE PUMP
Our drill pump is useful, but this new one is even more so. Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive, non-corrosive liquid. One use if you are a camper, make yourself a shower. Price £6 + 90p. A free gift, first 100 purchasers will get tap with built in switch and length of plastic tubing.

E.H.T. MAINS TRANSFORMER with inductance control, normal primary, secondary output by our equipment, 3·5 kv 3 mA. E.H.T. voltage can be varied by applying a DC voltage to the lower normally unused bobbin. We are not sure how much the voltage may be increased or decreased but using a 9 volt battery we seem to get a rise or fall of about 50 volts. Ex unused P.S.U.'s. Price £2 + 30p. Post 40p.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginners model. Price £2 + 30p. Crystal earpiece 57p + 8p. High resistance headphones (give best results) £3·25 + 50p. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy way to fault find—start at the aerial and work towards the speaker—when signal stops you have found the fault. Complete kit £4·25 + 65p.

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 + 30p.

EDITOR
F. E. BENNETT

ASSISTANT EDITOR
B. W. TERRELL B.Sc.

PRODUCTION EDITOR
D. G. BARRINGTON

TECHNICAL SUB-EDITOR
S. E. DOLLIN B.Sc.

ART EDITOR
R. F. PALMER

ASSISTANT ART EDITOR
P. A. LOATES

TECHNICAL ILLUSTRATOR
D. J. GOODING

EDITORIAL OFFICES
Kings Reach Tower,
Stamford Street,
London SE1 9LS
Phone: 01-261 6873

ADVERTISEMENT MANAGER
R. SMITH
Phone: 01-261 6671

REPRESENTATIVE
N. BELLWOOD
Phone: 01-261 6865

CLASSIFIED MANAGER
C. R. BROWN
Phone: 01-261 5762

MAKE-UP AND COPY DEPARTMENT
Phone 01-261 6615

ADVERTISEMENT OFFICES
Kings Reach Tower
Stamford Street,
London SE1 9LS

Projects... Theory... and Popular Features...

This month TTL logic provides a link between three different projects. These projects moreover illustrate how self-supporting, and even self-sufficient, our hobby can be. So let's consider each in turn.

First there is the *Duo-Deci Timer*. A useful item of equipment and a typical "end-product" of a building session. This instrument will find many applications around the home, perhaps in the kitchen or maybe in the photographer's darkroom, but there are numerous other uses of course.

Whilst building this timer it would be helpful or, at least instructive, to check out the operation of the logic circuitry. But the constructor does not have to go and buy an expensive instrument, he simply sets to and makes one. For the second project in our TTL linked trio happens to be a TTL *Logic Probe*.

This handy little instrument will prove indispensable to all who build and experiment with TTL logic circuits. It enables one to ascertain the state of the logic ("high" or "low") at any point, under working conditions. Worthy also of a mention is the homely touch introduced by the adaptation of a Multicore solder dispenser as the probe case. (How's that for conservation as well as self-sufficiency!)

Now the *Duo-Deci Timer*, like many other projects, is designed to operate from a battery. But if one prefers, a mains power supply unit can be used instead. That is just one possible use for the remaining item of our trio, the TTL *Power Supply Unit*.

Designed to provide the maximum voltage needed for TTL devices, this compact unit will be an asset on the workbench, especially when running dynamic tests on TTL circuit hook-ups, or on completed projects. Or it may be employed as a permanent source of power in place of a battery.

Test equipment and power supplies are essential ancillaries in the hobbyist's workshop. They play their part during the creation of other—perhaps more imposing and more splendid—projects, destined in all probability for use away from the workshop and by "non-electronics" persons.

The fact that they are home-made gives added cause for pride of possession, and substantiates the claim that electronics is to a considerable degree self-supporting.

Sorry to finish on this note, but the price of EE will regrettably be increased to 60p as from the next issue (October). This is necessary because of increasing costs affecting the publishing business in general.

Fred Bennett

Our October issue will be published on Friday, September 19. See page 569 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.

ELECTRONICS

VOL. 9 NO. 8 SEPTEMBER 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

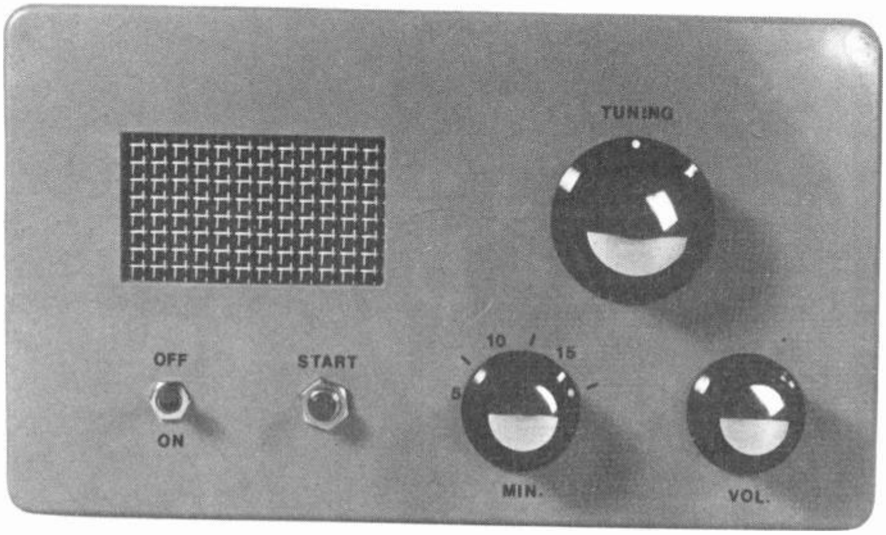
Back Issues
Certain back issues* of EVERYDAY ELECTRONICS are available worldwide price 70p inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability 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
Annual subscription for delivery direct to any address in the UK: £9·00, overseas: £10·00. Cheques should be made payable to IPC Magazines Ltd., and sent to Room 2613 Kings Reach Tower, Stamford Street, London SE1 9LS.

I.C. SPECIAL
next month is a must
~see page 569

By R. A. PENFOLD



BEDSIDE RADIO

THIS two i.c. medium wave radio is primarily intended for use as a bedside set, although it can provide sufficient volume for normal domestic use.

There is an optional one i.c./one transistor timer circuit which can be used to automatically switch off the receiver after a switch-selected delay of 5, 7½, 10, 12½, 15, or 17½ minutes. This gives a simple "snooze" facility of the type fitted to many clock radios and other receivers these days.

THE CIRCUIT

Fig. 1 shows the complete circuit diagram of the receiver including the timer circuitry. The range circuitry is shown in the inset of Fig. 1.

The r.f. and detector stages use a ZN414 i.c. (IC1) in a standard configuration. A tuned circuit is formed by L1 and C3. One end of this is coupled to earth by C2 and the other end couples into the input of IC1.

The low impedance coupling winding on the ferrite aerial is not needed because the ZN414 device has a buffer stage at the input which produces a high input impedance, and gives good results with direct connection to the ferrite aerial. The buffer stage is followed by three stages of amplification which provide a considerable amount of gain.

These are in turn followed by a transistor detector stage which has R2 as its load resistor and C4 to provide the necessary r.f. filtering. R1 is a bias resistor. The ZN414 has a simple a.g.c. (automatic gain control) action which reduces the gain on strong signals so as to reduce the possibility of overloading and to provide a more consistent audio output level.

A nominal supply potential of 1·3V is required for the r.f. and detector circuitry. This is derived from the main 9 volt supply using a simple shunt stabiliser incorporating R3, D1, and D2, the two silicon diodes being forward biased to produce a voltage drop of 0·65V across each. The supply is decoupled by C1 and C6.

AUDIO STAGE

A TBA820 i.c. (IC2) is used in the audio amplifier section of the receiver, and this is a type which can have its input direct coupled to the volume control. In this case the input is coupled to volume control VR1 via R4, this resistor forming an r.f. filter in conjunction with C7.

There was found to be a small amount of r.f. breakthrough and consequent instability without this additional r.f. filtering. Capacitors C9, C10, C12, plus R6 are also needed in order to ensure good stability. The audio output from IC1 to the volume control is coupled by C5 and this also provides d.c. blocking.

The output signal is coupled to the loudspeaker by way of d.c. blocking capacitor C11 and the break contact of phone socket SK1. This break contact automatically switches out the loudspeaker when an earphone is in use. Both crystal and magnetic earphones are suitable.

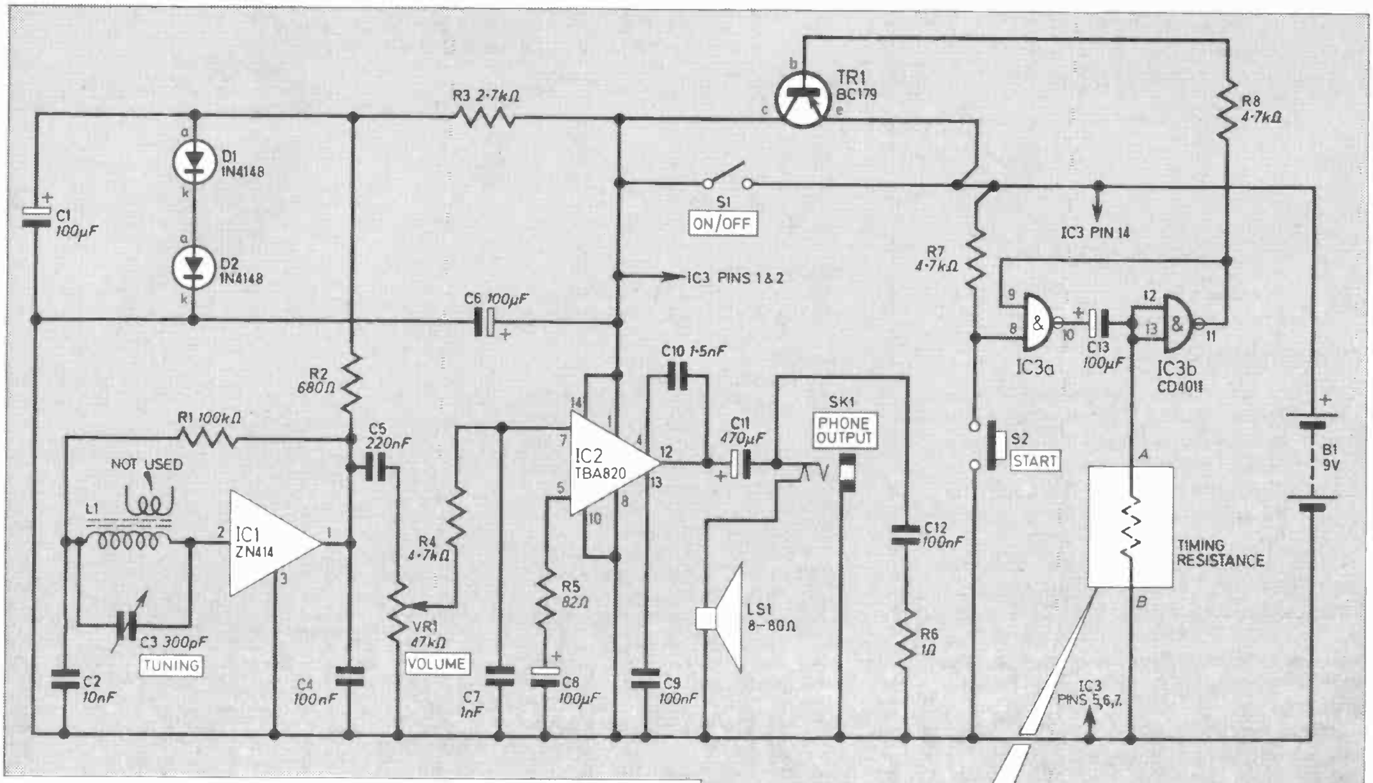
The voltage gain of the amplifier is controlled by R5, and the specified value actually gives a gain of approximately 73 times. This is sufficient to fully drive the amplifier from the signal level of about 30mV r.m.s. produced at the output of IC1.

The maximum output power is about 200mW r.m.s. or so, although it is somewhat less than this when using speakers of more than about 35 ohms impedance. The circuit will work well with any normal speaker having an impedance in the range 8 to 80 ohms.

TIMER

It is important for the timer circuit to have a very low quiescent current consumption since it is permanently connected to the battery supply, and unlike the rest of the receiver is unaffected by on/off switch S1.

A CMOS i.c. has therefore been used as the basis of the timer as it has a stand-by current consumption of only a fraction of a microamp, and will not significantly affect battery life. Two of the four gates in a 4011 two-input NAND gate package are used in a conventional CMOS monostable circuit. The inputs of the unused gates are connected to one of the supply lines to prevent them from being spuriously operated by stray pick-up, but these gates are otherwise ignored.



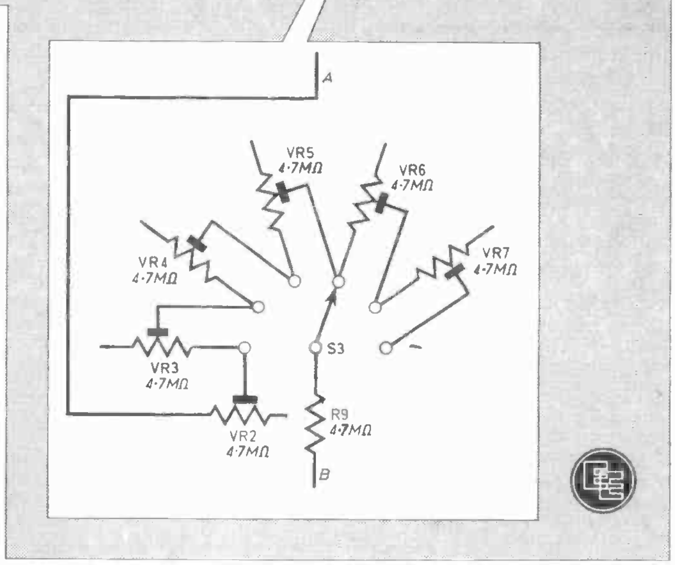


Fig. 1. Complete circuit diagram of the Bedside Radio. The resistive network which controls the time period for the automatic switch off is contained in the inset and is connected into the main circuit at the points A and B. It can also be seen that the small coupling winding on the tuning coil is not used in this design. The unused pins of IC3 are tied to the power lines to prevent spurious triggering.

OPERATING PRINCIPLE

The two inputs of gate 2 are connected in parallel so that it works as an inverter, and its output is high since the input is taken low by the timing resistance. Transistor TR1 is fed from the output of the monostable, and is cut off when the output is in the high state.

The output of gate 1 is low because one input is taken high by R7, and the other is taken high by the output of the monostable. If either or both its inputs are taken low, however, gate 1 output will go high.

Momentarily operating S2 will indeed take one input of gate 1 low, causing its output to go high. This signal is coupled to the input of gate 2 by C13, causing its output to go low and switch on TR1 with the base current it supplies via R8. TR1 then effectively connects the positive battery terminal to the radio circuitry, and the set becomes operational.

The voltage at the negative terminal of C13 now gradually falls as this component charges up through the timing resistance. Eventually the voltage here will fall below the transition voltage of gate 2, resulting in the output reverting to the high state and the radio being switched off.

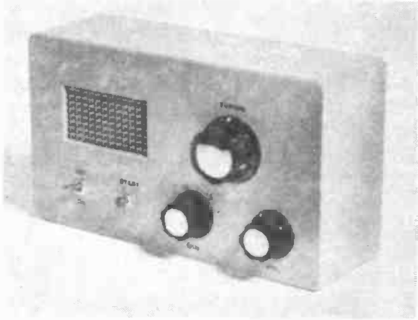
Both inputs of gate 1 are then back at the high state once again, and its output therefore returns to the low state. The circuit is now back in its original state and is ready to be started on another timing run by briefly operating S2 once again.

TIMING RESISTANCE

It is possible to control the time for which the set is switched on by means of the timing resistance, with the switch on time being roughly proportional to the value of this resistance.

Switch S3 provides six different resistance values, and presets are used so that these resistances can be trimmed to give the six nominal times specified at the beginning of this article.

Of course, on/off switch S1 must be in the "off" position when using the timer or S1 will keep the set switched on regardless of the timer circuit.



Front view of the Bedside Radio.

CONSTRUCTION starts here

COMPONENT PANEL

Most of the components are assembled on a 0·1 inch matrix stripboard having dimensions of 37 holes by 24 strips ($3\frac{3}{4}$ x $2\frac{1}{2}$ inches). This is a standard size in which the board is sold. The component layout is shown in Fig. 2.

Drill the 3·3mm diameter mounting holes for the panel and the ferrite aerial, and make the 22 breaks in the copper strips before inserting and connecting the components. Be careful not to omit any of the 10 link wires.

The CMOS chip IC3 is the last component that is connected, and it should be left in its protective packaging until it is time to fit it onto the board. It should either be soldered into place using an iron having an earthed bit or it should be fitted into an i.c. socket. Handle the device as little as possible.

The Ambit ferrite aerial used in the prototype has plastic mounting clips which enable it to be easily mounted on the component panel using a couple of short M3 or 6BA bolts and fixing nuts.

A Denco MW5FR aerial also works well in this circuit, and can be mounted on the panel using a couple of 9·5mm "P" type cable clips.

CASE

A plastics box measuring about 190 × 110 × 60mm is used as the case for the prototype. The case cannot be much smaller than this if it is to comfortably accommodate all the components, and a metal type is not suitable as it would screen the ferrite aerial and virtually eliminate any signal pick-up.

The component panel is mounted on the removable rear section of the case using a couple of M3 or 6BA fixings, but it is not finally bolted into place until it has been wired up to the rest of the receiver.

The layout of the front panel can be seen from the photographs. The rectangular cutout for the speaker can be cut using a fretsaw or a miniature file. Alternatively a grill of small holes can be drilled. A piece of speaker cloth or fret is glued over the rear of the cutout and the speaker is carefully glued onto this taking

COMPONENTS

Resistors
R1 100kΩ
R2 680Ω
R3 2·7kΩ
R4 4·7kΩ
R5 82Ω
R6 1Ω
R7 4·7kΩ
R8 4·7kΩ
R9 4·7MΩ
All ¼W carbon ± 5%

See **Shop Talk** page 553

Potentiometers
VR1 47kΩ carbon log.
VR2-VR7 4·7MΩ vertical preset (6 off)

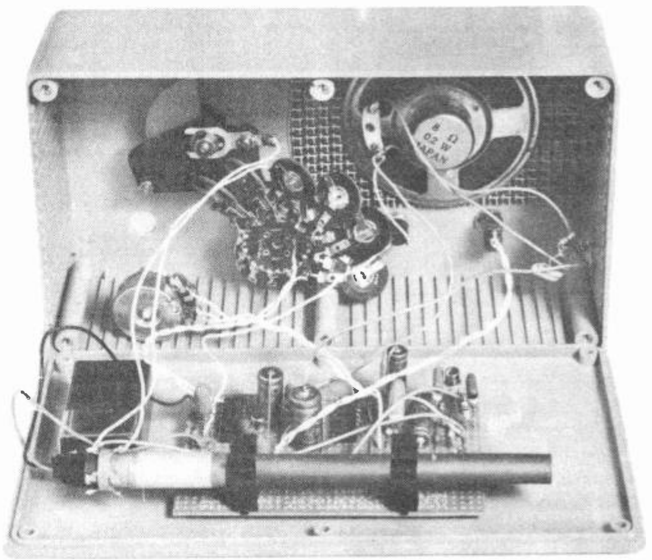
Capacitors
C1 100μF 10V elect.
C2 10nF polyester type C280
C3 300pF solid dialectric variable (Jackson Dielecon or similar)
C4 100nF polyester type C280
C5 220nF polyester type C280
C6 100μF 10V elect.
C7 1nF ceramic plate
C8 100μF 10V elect.
C9 100nF polyester type C280
C10 1·5nF ceramic plate
C11 470μF 6·3V elect.
C12 100nF polyester type C280
C13 100μF 10V elect.

COMPONENTS approximate cost £12

Semiconductors
IC1 ZN414 tuned radio frequency i.c.
IC2 TBA820 a.f. amplifier i.c.
IC3 CD4011 CMOS quad 2-input NAND gate
TR1 BC179 *npn* silicon
D1, 2 1N4148 small-signal silicon diode (2 off)

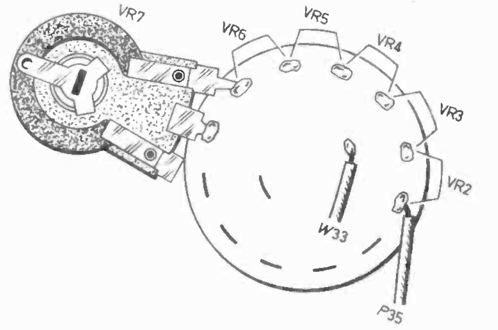
Switches
S1 s.p.s.t. miniature toggle
S2 push-to-make, release-to-break
S3 2-pole, 6-way rotary type

Miscellaneous
B1 9V type PP3
LS1 miniature moving coil loudspeaker, 8 to 80Ω impedance
SK1 3·5mm jack socket with single break contact
L1 Aerial coil, Ambit type MCW2 or Denco type MW5FR, or any other m.w. ferrite aerial coil wound on 9·5mm diameter ferrite rod with fixing clips
Case, dimensions 190 × 110 × 60mm plastic or wood; 0·1 inch matrix stripboard 37 holes × 24 strips; battery connectors; speaker fret; connecting wire.

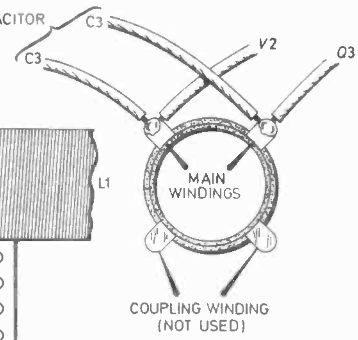


View inside the completed unit. Timing selection switch S3 can be clearly seen with its complement of variable resistors, VR2 to VR7.

BEDSIDE RADIO



Inset left shows a close-up view of the timing selection switch S3. Only VR7 has been drawn out in full but all the presets should be soldered directly to the switch tags in a similar way. Reference to the photograph opposite will make this clearer. One tag of VR2 has been soldered to the first tag of the unused portion of the switch to make a solid anchoring point for connection to R9 on the circuit board.



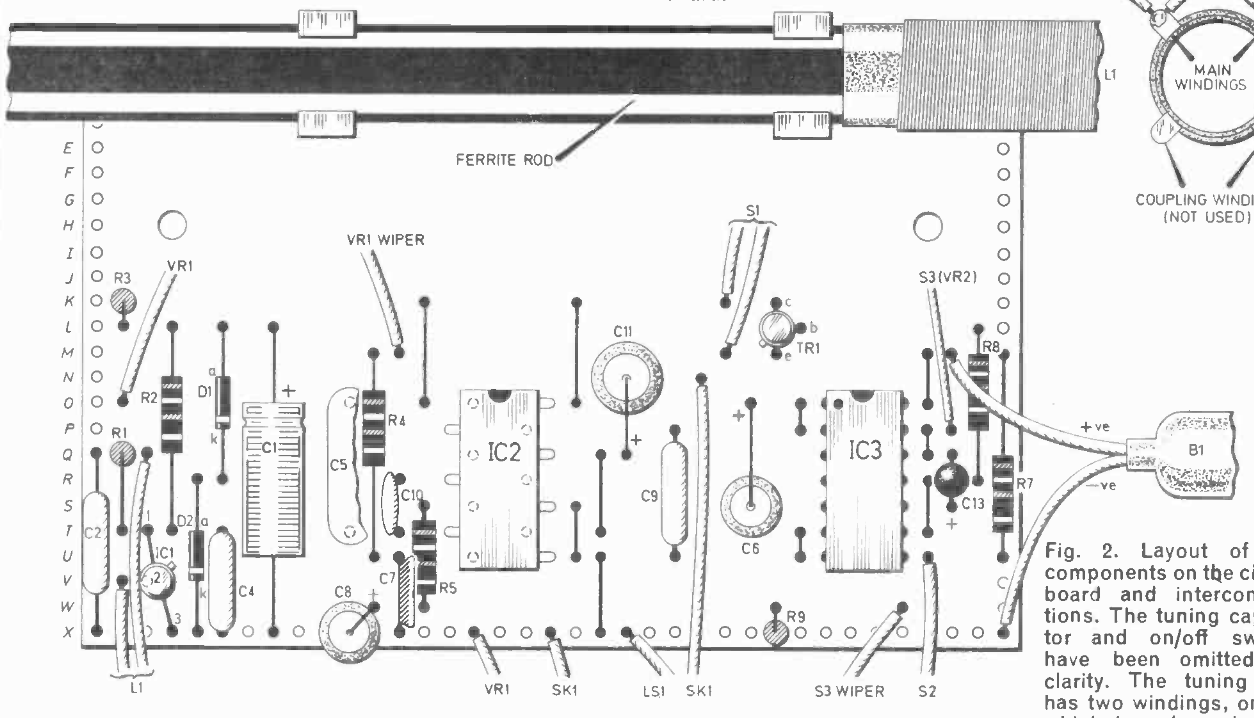
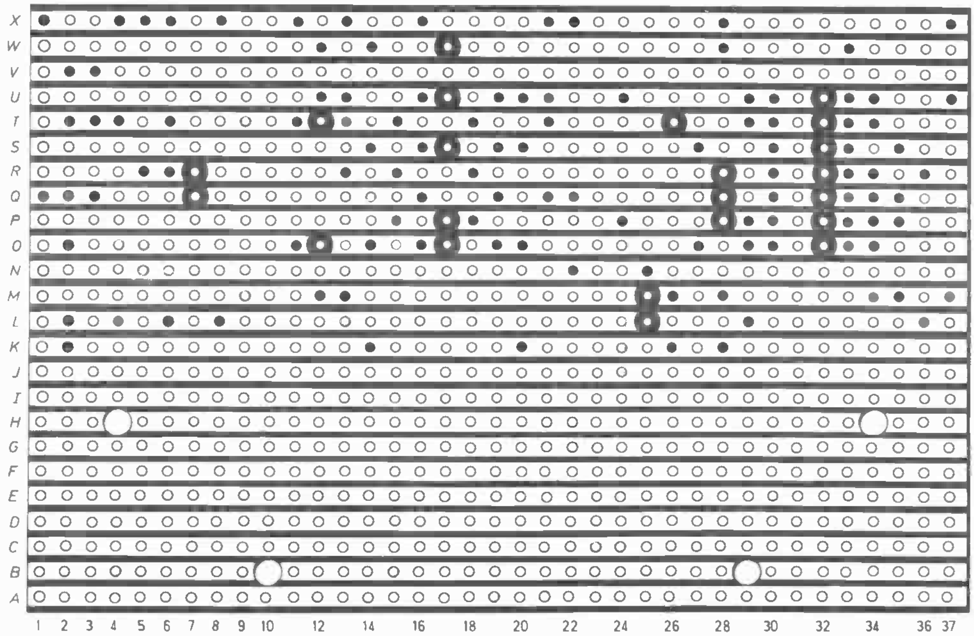
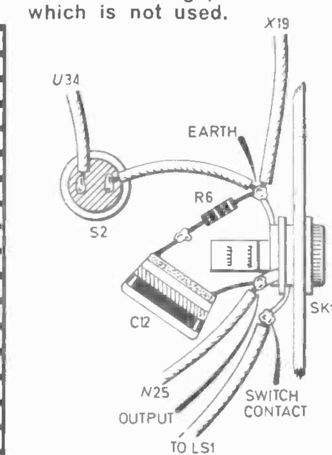
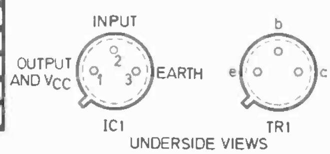


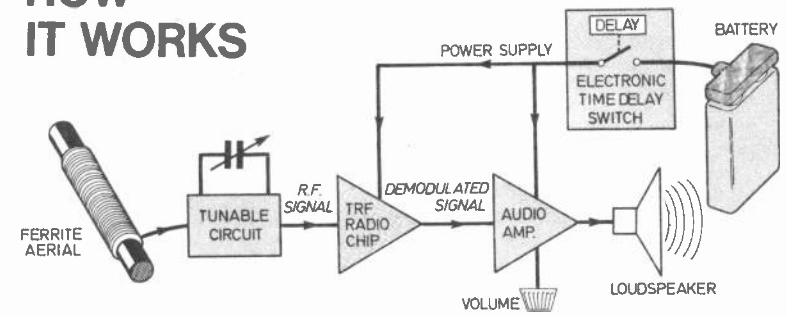
Fig. 2. Layout of the components on the circuit board and interconnections. The tuning capacitor and on/off switch, have been omitted for clarity. The tuning coil has two windings, one of which is not used.







HOW IT WORKS



Radio signals from the transmitter induce electrical signals in the ferrite aerial. A certain portion of these are selected by the tuned circuit and passed onto the t.r.f. radio chip where they are processed into a low frequency or audio signal. This is then passed into the audio amplifier i.c. the output of which is used to drive a loudspeaker.

Power to the unit passes through an electronic time delay switch. This consists of a monostable circuit which keeps the radio switched on for a preset period after the main switch has been turned off, thus allowing the listener to dose off to sleep without needing to turn off the set manually.

care not to smear any adhesive onto the diaphragm. Use a good quality adhesive such as an epoxy type.

When the other components have been fitted onto the front panel and the earphone socket has been mounted on the left hand side panel of the case, the remaining wiring can be completed. This is illustrated in Fig. 2.

ADJUSTMENT

Thoroughly check all the wiring for mistakes, and when confident that there are no errors, connect a battery and switch on. In most locations it should be possible to receive a number of stations at good volume even during daylight hours, and it should be possible to pick up more after dark.

The frequency coverage of the set depends to some extent on the position of the aerial coil on the ferrite rod. If the set cannot tune down to stations at the low frequency end of the band (the vanes of VC1 fully meshed), this can be corrected by moving the coil further onto the ferrite rod.

A lack of coverage at the other end of the band can be currected by moving the coil towards the end of the rod.

When a suitable position for the coil has been found it should be glued or taped in place to prevent it from slipping out of adjustment.

PRE-SET RESISTORS

The six preset resistors are adjusted by empirical means to give the correct time delays with a reasonable degree of accuracy, starting with VR2 which sets the 5 minute switch off delay. Resistors VR3 to VR7 are then adjusted in sequence to set the 7½, 10, 12½, 15, and 17½ minute delay times respectively.

The presets must be adjusted in this order. This is a rather time consuming task and unfortunately there is no short cut, but at least in this application a high degree of accuracy is not necessary, and it is only necessary to get the actual times within a few seconds of the specified ones. ☒

Mail Order and Books

This is a time with shortening days when the old hands will be deciding on their next project, and equally important, many new recruits will be joining their ranks. In one or two issues about this time, I usually devote some space to giving guidance on component buying and this year will be no exception.

I will commence as I usually do with pointing out that considerable use has to be made of firms who offer Mail Order facilities, and the first step is the acquisition of at least four good catalogues. It is best to accept the fact, straight away, that the number of electronic components is now so vast, that you are unlikely to be able to get all your requirements from one supplier.

Also, I think a few extra reference books would not come amiss. First of all I would suggest *Basic Electronics* prepared by Malcolm Plant for the Schools Council. It is in five parts which can be purchased separately and is modestly priced. Eventually I would suggest that *Foundations of Wireless and Electronics* by Mr. G. Scroggie is a "must".

Another book I would strongly recommend is the *Dictionary of Electronics* published by Penguin. Lastly I would suggest the *Towers International Transistor Selector.*

Blue Fingers

I am certain that many of our readers are married men and will confirm what I am about to say.

You find that within a few months of being spliced, you are being compared, always unfavourably, to Betty or Daisy's husband, Len or Bill. Compared to them you are a lazy good for nothing!

It turns out that Len or Bill, regularly clean all the windows, paint the house inside and out, and needless to say do all the gardening.

When you visit them, you are certain to have a conducted tour of the garden which is like a miniaturised but greatly improved version of Kew.

Apparently Len or Bill have what are called "Green Fingers". On the way home this will be contrasted by the little woman with her own garden which looks like an inferior version of the Matto Grosso.

However, there is another side to the coin. When a fuse blows, the toaster, or vacuum breaks down, then we electronic types come into our own, someone ought to say that we have "Blue Fingers".

Only a short while ago my wife switched on our electric cooker, there was an almighty flash and a bang and the company fuse had blown. This would have had the Lens and the Bills yelling for help and dialling 999, but did old "Blue Fingers" turn a hair? Not a bit of it! In a trice he had the back off the cooker and quickly sized up the situation.

The main supply is connected to terminals with insulators big enough to carry the National Grid. The positive terminals had been arcing across to the earthed metalwork until the heat had split the insulation into about three pieces. The negative insulator was perfectly good, so I swapped them over. I reasoned that the potential difference between the negative line and earth was minimal although this is not always the case.

An interesting sidelight on this, is the fact that the cooker is fed through a 30 amp fuse and a 60 amp before the company fuse which is rated at 120 amps. Only the 120 amp fuse had blown. This looks like a practical example of Froud's Law "A transistor protected by a fast acting fuse will protect the fuse by blowing first"!

By Dave Barrington

Vowel Power

Most of our readers will no doubt have heard of the Texas Speak and Spell education aid which lets children have fun while learning to spell. Now comes news that it has been given a bigger vocabulary.

The standard machine has a 240-word vocabulary and now by the addition of a plug-in word module a further 140 words has been added. The new plug-in word memory, called "Vowel Power", works in exactly the same way as the built-in processor but concentrates on words with difficult vowel sounds.

The new words relate to vowel sounds in four categories: short vowel sounds such as neck and much; long vowel sounds like wheel and toast; two letter or blended vowel sounds like cloud and clown; and words where the letter "r" changes the vowel sound sound—such as germ and church.

An improved voice synthesis is another feature of the Speak and Spell which retails for about £50. The plug-in word memory, which is the first of a series, retails for about £15.

Remote ICs

A couple of exciting new integrated circuits for the experimenter take the spotlight this month.

Currently not on general supply, but available from Celdis Ltd, is a two-chip remote control system comprising the Plessey SL490 pulse-transmitting remote controller and ML920 receiver.

The SL940 is a bipolar, pulse transmitting circuit. Single-pole switches are used to select the required command which is transmitted as one of 32 5-bit code words. These words can be modulated as PPM onto a single carrier frequency or transmitted as baseband pulses.

The ML920 receiver is a 24-pin PMOS/LSI integrated circuit which, after demodulation of the incoming signal, first verifies and compares two consecutive code words. The signal is then decoded to give 20 channels, three analogue controls plus six other control functions.

Features of the receiver i.c. include all timing from an on-chip oscillator and automatic error detection. Only 6μA of current is taken from the 9V supply by the transmitter on standby.

Typical applications would be the remote control of toys and models and domestic remote controls such as garage door operation, TV and hi-fi control. The transmitter and receiver can be combined to give a flexible system using as the control link a cable, sound, ultrasonics, visible light, infrared or radio frequency.

Further details, price and stockists can be obtained from Celdis Ltd., Active Components Division, Dept EE, 37 Loverock Road, Reading, Berks, RG3 1ED.

Remote Control

Talking of radio frequency, the Toko i.c.s. KB4446 and KB4445, available from Ambit International, provide the designer with the opportunity to build a 4-channel f.m. radio control receiver and transmitter on the 27MHz band.

All necessary data is contained in a comprehensive data sheet which comes with the i.c.s. Also contained in the data sheet are two circuits, one for the transmitter and one for the receiver. The system is based on the standard 27MHz band, i.e. 9·6V operation for the transmitter and 4·8V for the receiver, 1-2ms pulse width.

The transmitter i.c. (KB4445) only requires the channel and r.f. timing components together with an r.f. power transistor around it to give a practical working circuit. In the case of the receiver (KB4446) there are two input tuned coils together with a mixing coil, an i.f. ceramic filter and a detector coil, which with a sprinkling of *R's* and *C's* is all that is required. With the addition of a transistor in the r.f. input stage the sensitivity can be increased from 40μV to 2μV.

To sum up, these i.c.s. are a good buy for the home constructor wishing to develop his own radio control system.

Available from Ambit International, Dept EE, 200 North Service Road, Brentwood, Essex, CM14 4SG, the current price of the KB4445 is £2·30 and the KB4446 £2·65 including VAT. If purchased as a pair the combined cost will be £4·75. A charge of 35p post and packaging is levied.

Hooked

The versatility of the miniature EZ test hooks have often proved invaluable in the workshop when checking out experimental "lash-ups". The only criticism has been that the interconnecting wires tended to get in the way and often been more an hindrance than help.

To allow greater flexibility of movement, when making test connections, EZ Hooks have recently been introduced joined by a p.v.c. coil cord which expand from a closed position of 180mm to 915mm. The leads are available in ten colour-coded colours.

Further information on the complete range of EZ Hooks is available from the British Central Electrical Co. Ltd., Dept EE, Unit 10 Carvers Industrial Estate, Southampton Road, Ringwood, Hants, BH24 1JS.

CONSTRUCTIONAL PROJECTS

Weather Centre

This months concluding article for the *Weather Centre* project deals with the hardware. It is difficult to generalise on any supply problems as this will obviously vary from area to area and any good DIY or Hardware shop should be able to supply most items.

The TV aerial claw clamp for securing the boom to mounting pole was purchased through a Tandy store.

The only electronic items of note in this part of the Weather Centre are the infra red emitter (TIL32) and the infra red detector (TIL78). These are available from several suppliers and should not be difficult to find.

Lights Failure Monitor

No purchasing problems should be experienced with components for the *Lights Failure Monitor*.

In view of the large number of semiconductor devices required some advertisers may even be willing to quote a special price for a "semiconductor pack" for this project.

Bedside Radio

Most components for the *Bedside Radio* are generally available and should not cause concern.

However, should any readers have difficulty in obtaining the Dielecon 300pF tuning capacitor this is available from Home Radio. Also, suitable aerials are the MCW2 from Ambit International and the MW5FR from Denco Ltd., Dept EE, 355 Old Road, Clacton-on-Sea, Essex, CO15 3RN.

Precision Parking Pad

Choosing and locating a magnet for the reed switch operation could prove quite a problem for the *Precision Parking Pad*. Probably one of the Eclipse range from James Neill (Sheffield) Ltd., would prove most suitable. The Minor 801 magnet or the 811 Power Magnet would seem to be ideal. These should be stocked by any good hardware shop.

No troubles should be encountered with the rest of the components for this project as they are generally available from most advertisers.

Duo-Deci Timer

Checking through the list of components for the *Duo-Deci Timer* we cannot foresee any supply snags. People like Maplin, Watford, and Marshalls seem to stock most items.

TTL Logic Probe

No buying problems should be experienced with parts for the *TTL Logic Probe*. Most of our advertisers who specialise in semiconductors should be able to meet any orders.

TTL Power Supply

Standard parts are used throughout the *TTL Power Supply* and there should be no problems in obtaining components. The transformer should have an output of at least 6V and a rating of not less than 2A. The Universal Chassis member is available from Home Radio, catalogue number CU56A and the voltage regulator, type LM309K, can be found in most suppliers' catalogues.

DUO-DEGI TIMER

BY F. G. RAYER

THIS article describes an easy to build two-digit timer with optional decimal point.

To time an egg, develop a film or do some other process taking up to a maximum of 9·9 minutes, the "fast" range is used.

For fixing and washing film or prints, barbecuing sausages or parking time watching, the "slow" range is selected.

Operation is from a 4·5 volt battery or from a mains operated battery eliminator if the timer is used extensively.

CIRCUIT OPERATION

Fig. 1 shows the complete circuit and its operation is straight forward and easily followed. Power is applied to the circuit via S3 and no more than 5 volts should be used because of the TTL devices in the unit.

The "fast" or "slow" range is selected by means of S1. With S1 in the "0·1" position, capacitor C1 charges through VR1 and R1. When the emitter of the unijunction transistor TR1 reaches sufficient potential due to C1 charging, TR1 conducts and discharges C1.

The process is repeated over and over again, and VR1 is adjusted so that this takes place at 0·1 minute or 6 second intervals. When S1 is in the "1" position, C1 charges through VR2 and R2 so that pulses are produced at the rate of one per minute instead of one every tenth of a minute.

The decimal point on X1 is illuminated when S1b is in the 0·1 position. It will be seen that the device will read down to 0·1 minutes on the "fast" range and 1 minute on the "slow" range and it is felt that this is easily close enough for the sort of activities the author has in mind. The two-range, two-figure indication also allows considerable simplification.

Timing is not initiated until S2 is closed. When this happens S2a applies voltage to TR1 and associated components whilst S2b previously held open to keep the display at 00 closes to allow the pulses to be counted.

COUNTER

The counter i.c. IC4 is driven by the pulses from TR1 via TR2. These pulses are delivered at either 0·1 or 1 minute intervals, according to the setting of S1. The 7490 chip, IC4, is a binary coded decimal decade counter. It receives pulses at pin 14 and translates these into a binary output at pins 11, 8, 9 and 12. These binary outputs pass to pins 6, 2, 1 and 7 of the 7447 decoder-driver i.c. IC3.

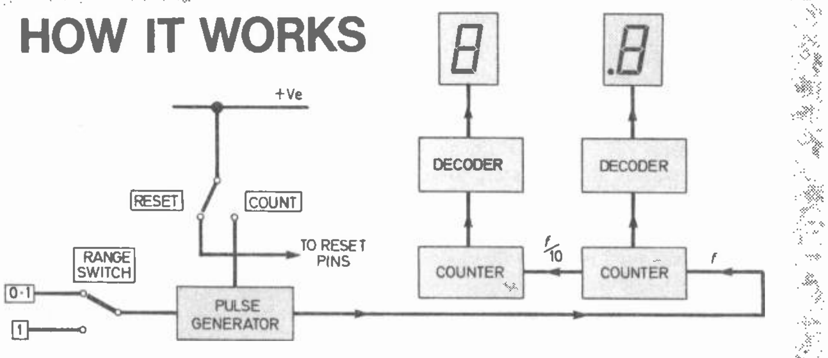
This integrated circuit decodes the binary inputs into a form that will drive the displays X1 and X2 and this appears at pins 9 to 15. Decoding is so arranged that the correct sectors of the seven-segment display are illuminated to display the numbers.

The components IC1, IC2 and X2 thus count from 0 to 9 as pulses arrive at pin 14 of IC4.

TENS AND UNITS

At the next pulse, IC4 provides an input to IC3 which is decoded to return the numeral to 0 and a pulse passes from pin 11 of IC4 to pin 14 of IC2. This then provides a binary output for the number one which is decoded by IC1 and thus the "tens" numeral is advanced.

HOW IT WORKS



An oscillator provides pulses at the rate of one every second or tenth of a second according to the setting of the range switch.

These pulses are passed on to the first counter which causes a seven-segment display to count up by one every time a pulse is received.

Every tenth pulse causes the display to return to zero and pass a single pulse on to the next stage where it is counted in the same way.

When 99 pulses have been received, the displays both return to zero and the process starts all over again.

To reset, the power is removed from the oscillator and fed to the reset inputs of the counters.

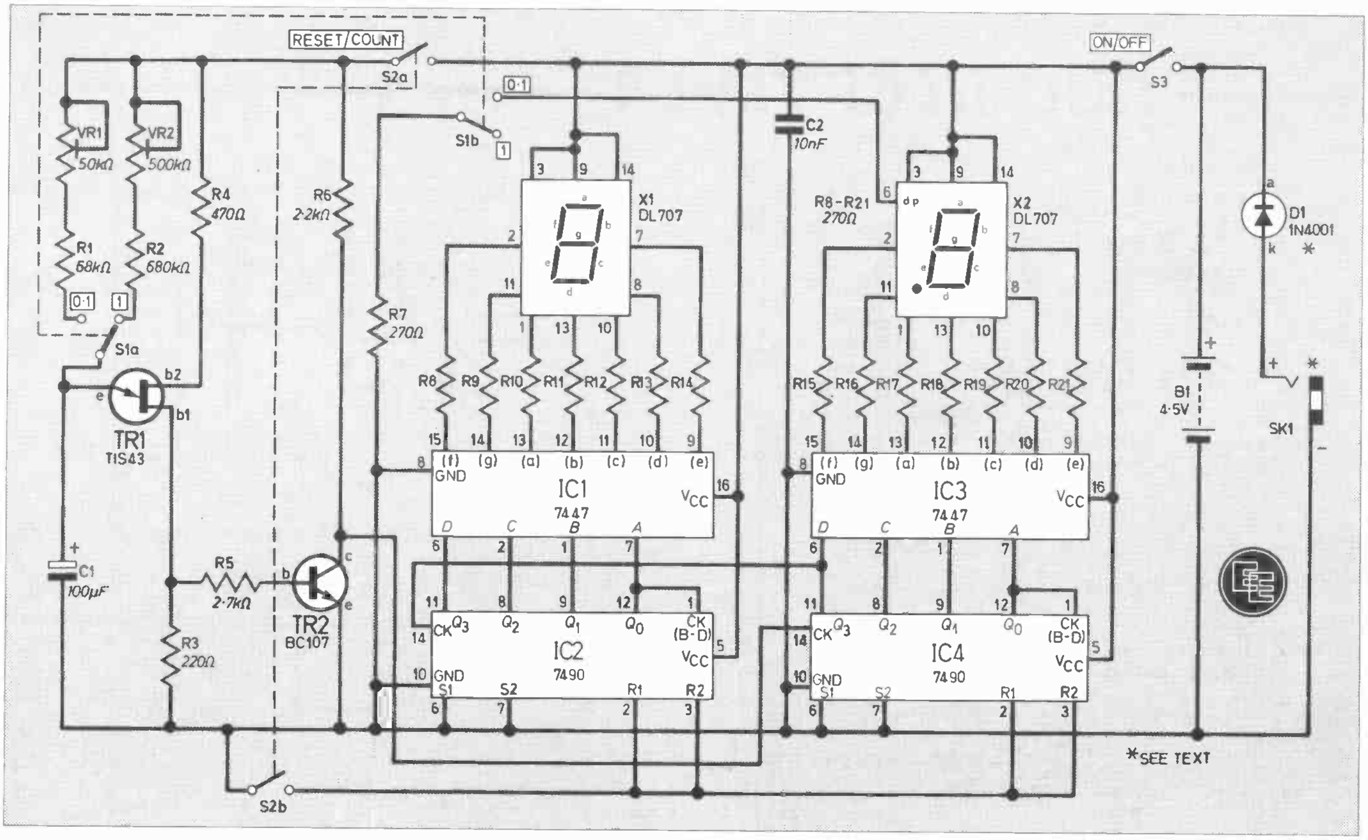


Fig. 1. Full circuit diagram of the Duo-Deci Timer.

This continues until 99 is reached. For the "fast" range, the decimal point is switched on and lies to the right of the units digit, that is between the two numbers. In fact this forms part of X2 and is illuminated when pin 6 is earthed.

If a battery eliminator is used, it should be plugged into SK1. It must be at a voltage of less than 6 volts.

Diode D1 is used to provide protection against the battery eliminator being connected the wrong way round and also drops the voltage down by about 0·6 volt thus allowing the more common kind of eliminator or even a large 6 volt battery to be used.

Outside view of completed unit.

CONSTRUCTION starts here

THE CASE

The timer is designed to fit into a case measuring 100×70×40mm, and is therefore very compact in construction.

Cut the 0·1 inch s.r.b.p. matrix board down to 76×52mm and place it against the top of the case. This will enable you to position the holes for the three 8BA mounting bolts which can be drilled through the board and the case. Once the holes have been drilled, the three 8BA bolts can be fastened in position and spacers added so that the board stands about 8mm clear of the front of the case.

Apertures are made to match the positions of the displays X1 and X2. This can be done accurately by drilling a few small holes so that a small flat file can be introduced. The holes are then filed to shape, checking as necessary that they will agree with the actual positions of the displays on the circuit board.

Afterwards, with the board removed, make three slots for the switches. Again a few small holes are drilled and the holes filed to shape. Of course you will also need to drill holes for the securing screws as well as these slots. The switches should be left off for the time being.

The battery used in this project is a three-cell flat battery type 1289 and it lies horizontally on top of the circuit board. Card or similar material is placed between the board and the battery.

THE I.C.S

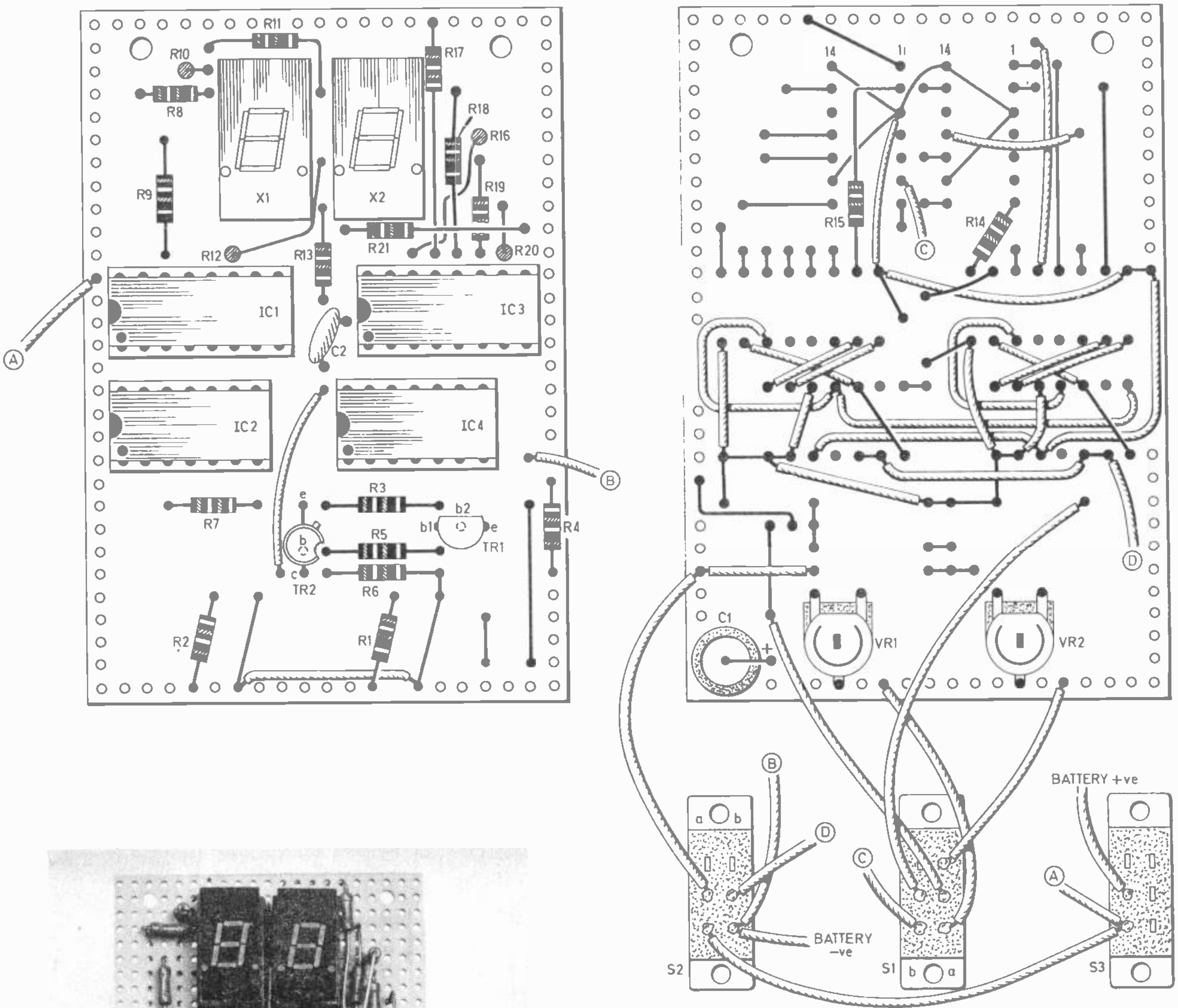
The i.c.s fit into 14- and 16-pin d.i.l. holders. Although not absolutely essential, they save a great deal of time and trouble when securing the i.c.s and there's no worry about thermal damage. This also applies to the displays X1 and X2.

Make sure you insert the i.c.s correctly when all the construction is completed. Pin one is always identified by a spot or indentation on the body.

CIRCUIT BOARD

Assembly again is fairly compact and a few points should be noted. Fig. 2 shows the top or display side and also the underside. Pre-sets VR1 and VR2 are mounted on the underside so that they can be adjusted.

DUO-DECI TIMER



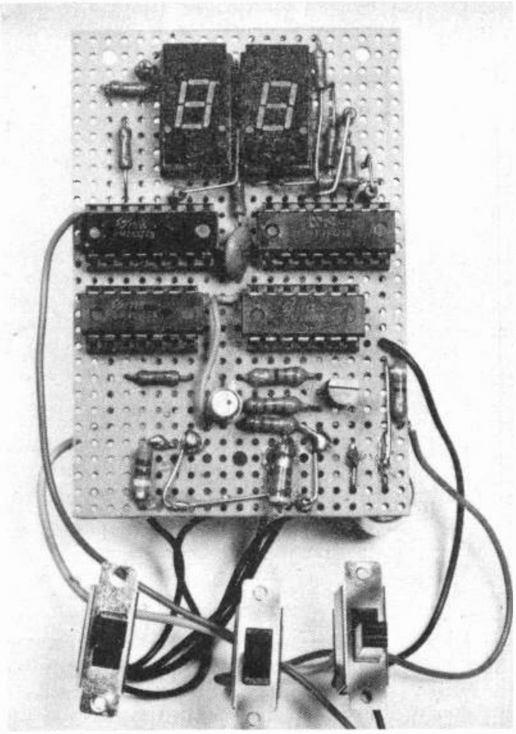
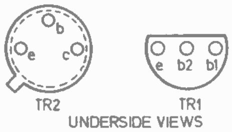


Fig. 2 *(above)* Wiring and layout details of the circuit board. Care must be taken that crossing wires are adequately insulated. Photograph left shows the circuit board from the prototype unit.



COMPONENTS approximate cost £10

When fitting the components make sure that all components are mounted lower than the top of the display chips. The transistors will therefore be very close to the board. Care must be taken to heatsink the transistors when soldering.

The resistors R7 to R21 which are in series with various segments of the displays should be as small as possible in size and $\frac{1}{8}$ watt types will be adequate.

The first job when assembling the board is to wire the power lines to the i.c.s; positive to pins 3, 9, and 14 on X1 and X2, pins 16 on IC2/4 and pins 5 on IC1/3; negative to pins 6, 7 and 10 on IC2/4, and pins 8 on IC1/3. Other connections can then be put in as shown in Fig. 2.

Positive and negative circuits are wired with thin flex or 22 s.w.g. wire, although 30 s.w.g. is strong enough elsewhere and is much more easily handled. Sleeving is added as and when required.

With R16, R20 and R21, the leads should be shaped so that no short circuits can arise, these components being near R17, R18 and R19.

It is helpful to use colour coding for some of this wiring, especially things such as red for positive, black for negative and orange for re-set line.

COMPONENTS

Resistors

R1	68kΩ
R2	680kΩ
R3	220Ω
R4	470Ω
R5	2·7kΩ
R6	2·2kΩ
R7-R21	270Ω $\frac{1}{8}$W miniature (15 off)

All $\frac{1}{4}$W carbon ± 5% unless otherwise specified

See Shop Talk page 553

Potentiometers

VR1	50kΩ miniature horizontal preset
VR2	500kΩ miniature horizontal preset

Capacitors

C1	100μF 6V elect.
C2	10nF disc ceramic

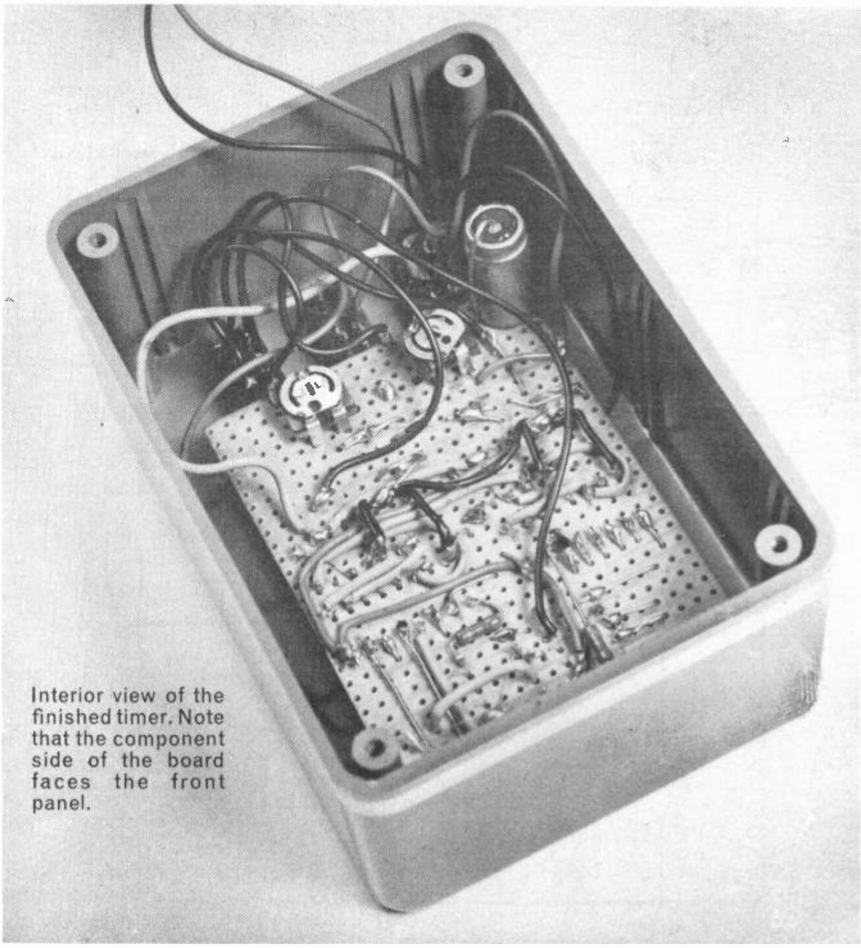
Semiconductors

TR1	TIS43 *n*-channel unijunction
TR2	BC107 *npn* silicon
IC1, IC3	7447 b.c.d. to seven segment decoder/driver (2 off)
IC2, IC4	7490 b.c.d. decade counter (2 off)
D1	1N4001 1A 50V silicon diode
X1, 2	DL707 8mm common anode seven segment display (2 off)

Miscellaneous

S1, 2, 3	d.p.d.t. slider switch (3 off)
SK1	3·5mm jack or other socket to suit battery eliminator
B1	4·5V flat pack battery type 1289

Plastics box, size 100 × 70 × 40mm; 0·1 inch perforated s.r.b.p. board, size 52 × 76mm; 14 pin d.i.l. i.c. sockets (4 off); 16 pin d.i.l. i.c. sockets (2 off); 8BA nuts, bolts and spacers; inter-connecting wire; stiff wire for battery connectors.



Interior view of the finished timer. Note that the component side of the board faces the front panel.

OFF-BOARD CONNECTIONS

The switches and battery are wired to the board using thin stranded wire. Situate the switches approximately on the front panel according to Fig. 2 and wire them to the various points on the board, leaving an inch or so of extra wire. Note that S2 and S3 are joined. Battery negative also runs from S2.

Flat clips for the battery can be made from thin metal or paper clips and soldered to the leads, so that they can be fastened to the battery. Make sure that you connect up with the correct polarity.

TESTING

This is most readily done before fitting the board or switches in the case. Initially set VR1 and VR2 at about middle position. Closing S3 should illuminate the displays and setting S1 at the 0·1 position should light up the decimal point.

With S2 closed, a count should begin to appear and run to 9·9. Meanwhile, VR1 can be adjusted so that the units change at exactly six-second intervals, or ten per minute.

Afterwards adjust VR2 for one-minute intervals. Opening S2 returns the displays to zero.

The switches can then be bolted to the case and the board located on its three bolts and fixed with nuts. The back of the case can then be screwed in position.

Experiments for

TEACH-IN 80

Part 11

EXPERIMENT 11.1:

WEIN BRIDGE OSCILLATOR

Components needed: 100kΩ ¼W resistor, 10kΩ ¼W resistors (2 off), 330Ω ¼W resistor, 0·1μF capacitors (2 off), CA3140 op-amp, BC108 transistor, BC478 transistor.

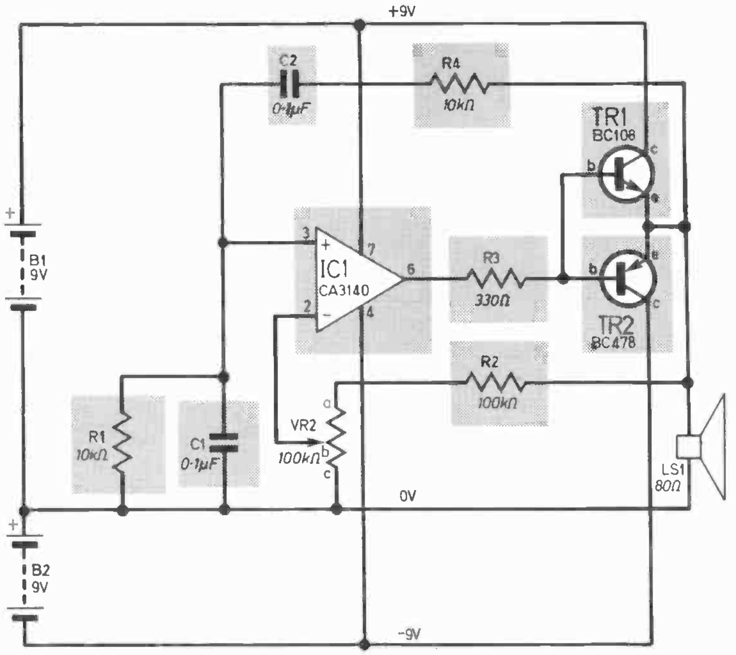
A sine wave oscillator circuit which drives a loudspeaker is shown in Fig. 11.11a with the layout of the components on the Tutor Deck in Fig. 11.11b.

Because the op-amp itself cannot supply enough current to drive a loudspeaker directly, a buffer has been added in the form of the complementary pair transistors TR1 and TR2, with the resistor R3 used to limit the output current of the op-amp.

Feedback has been taken from the point where the buffer joins the speaker and a conventional Wien Bridge circuit has been used.

The gain has been made variable by using a potentiometer VR2 to vary the voltage fed back to the inverting input.

When the circuit has been connected up note how altering the setting of the potentiometer VR2 alters the output. For part of the track there is no output: the loop gain is less than one. As the pot is turned up the oscillation begins but as it is increased the sound becomes much harsher because the output is being distorted as the voltage hits the power rail. At a smaller range of settings the sound is quite clean because a pure (or nearly pure) sine wave is being produced.



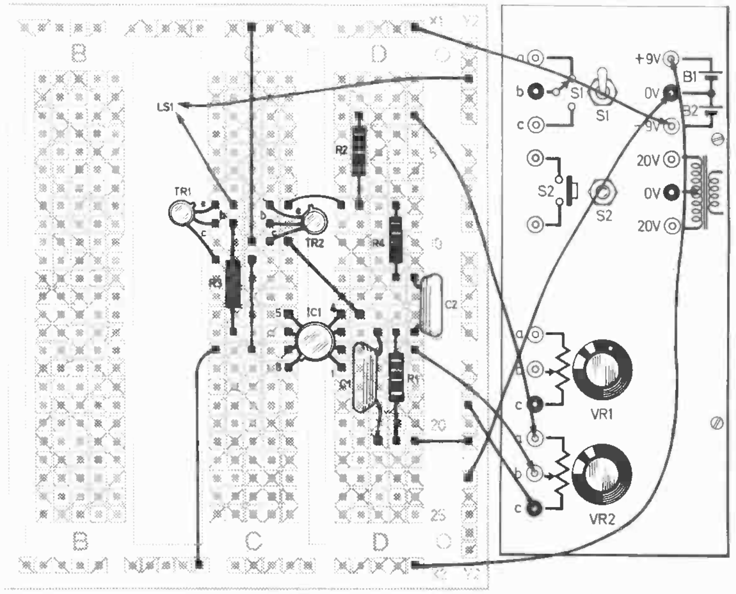


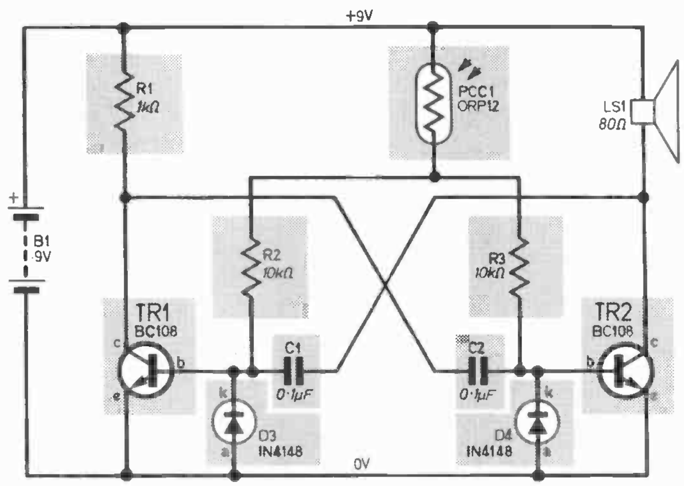
Fig. 11.11(a) *(top right)* The circuit of Experiment 11.1.
Fig. 11.11(b) The layout of Experiment 11.1 on the Tutor Deck.

EXPERIMENT 11.2:

TRANSISTOR MULTIVIBRATOR

Components needed: 1kΩ ¼W resistor, 10kΩ ¼W resistors (2 off), ORP12 light dependent resistor, 0·1μF capacitors (2 off), BC108 transistors (2 off), IN4148 diodes (2 off).

The circuit of Fig. 11.12a shows a simple multivibrator whose frequency is set by the amount of light falling on a light dependent transistor.



EXPERIMENT 11.3:
OP-AMP MULTIVIBRATOR

Components needed: 10kΩ ¼W resistors (2 off), 330Ω ¼W resistor, ORP12 light dependent resistor, 0·1μF capacitor, CA3140 op-amp, BC108 transistor, BC478 transistor.

An op-amp version of the multivibrator is shown in Fig. 11.13a with the layout on the Tutor Deck in Fig. 11.13b. Again the output buffer circuit has been used to enable the op-amp to drive a speaker.

When the output (at the speaker) is at its most positive the capacitor charges at a rate determined by the resistance of the l.d.r. The voltage at pin 3 of the op-amp will be approximately +7V.

When the voltage on C1 reaches this voltage the inverting input will be higher than the non-inverting so that the output will now swing to near the negative supply rail. The voltage at pin 3 is now −7V and C1 discharges through the l.d.r. until it reaches this voltage. The output then swings positive and the cycle starts again.

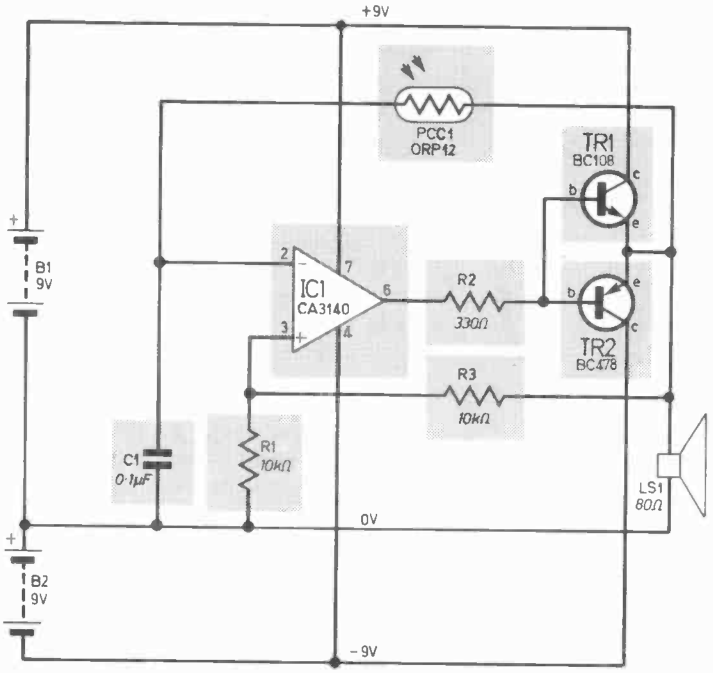


Fig. 11.13(a) The circuit of Experiment 11.3.

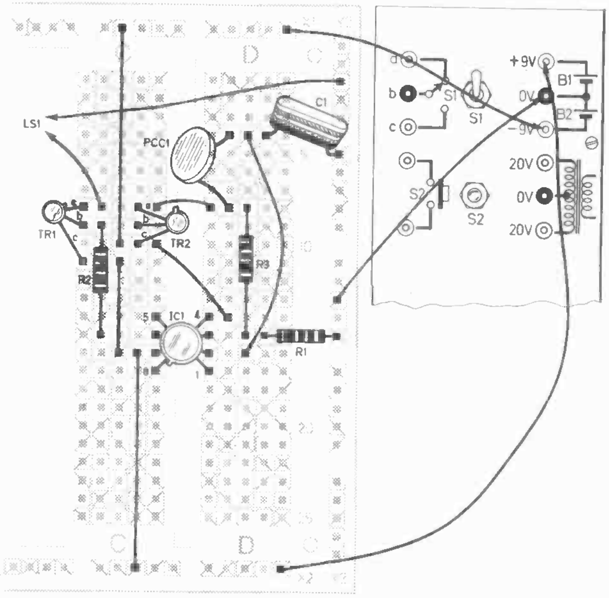
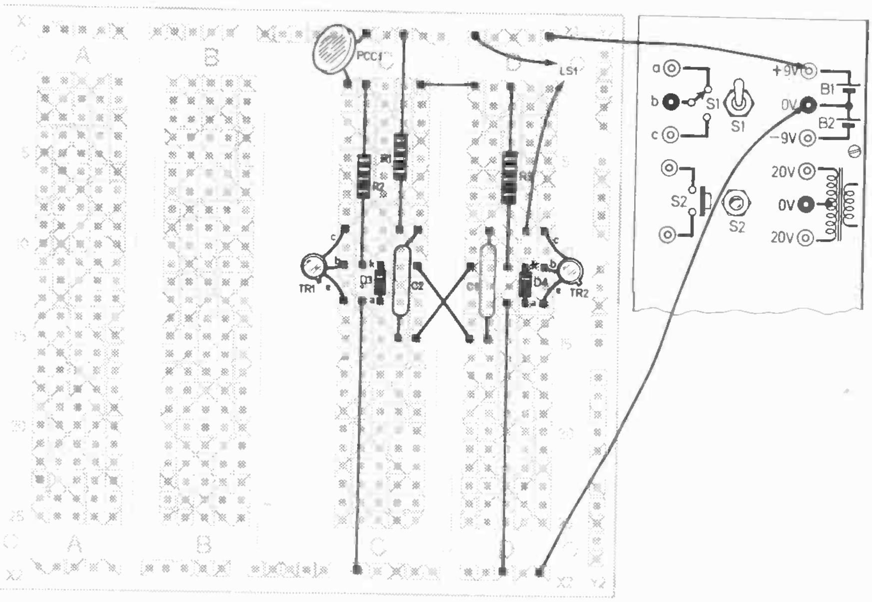


Fig. 11.13(b) The layout of Experiment 11.3 on the Tutor Deck.

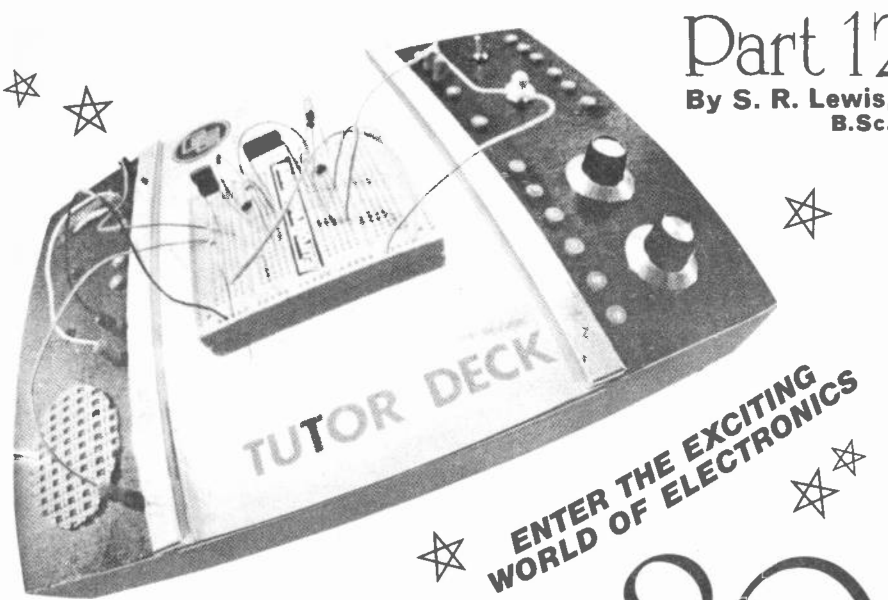


The on and off times are the same for both TR1 and TR2 since the circuit is symmetrical. The load of one of the transistors is the speaker itself which saves using a separate amplifier stage.

Moving the hand across the l.d.r. will change the note from a high pitch to a very low pitch.

Note the diodes which are placed across the base to emitter junctions of both transistors. These are required to prevent the voltage on the base being pulled to −8·3V when the collector voltage on the opposite transistor goes from 9V to 0V. If the base is pulled more than 5V negative with respect to the emitter, there is the possibility that the transistor will be damaged.

Fig. 11.12(a) *(far left)* The circuit of Experiment 11.2.
Fig. 11.12(b) The layout of Experiment 11.2 on the Tutor Deck.



TEACH-IN 80

Part 12

By S. R. Lewis, B.Sc.

NEXT to the common bipolar transistor the most important semi-conductor device must be the field effect transistor or f.e.t.

Discrete f.e.t.s are similar to ordinary transistors in that they have three terminals, one of which controls the current flow from one of the other terminals to the third. However the principles upon which f.e.t.s are based are quite different from the bipolar transistor and hence it has unique properties which enable it to be used in applications where bipolar transistors need a great deal of external components to do the same job.

The other reason why f.e.t.s. are so important is that they are by far the most widely used type of transistor in logic integrated circuits (i.c.s).

F.e.t.s can be made very small and therefore an extremely large number of logic elements can be packed together on a single chip of silicon. This has enabled the development of **microprocessors** with tens of thousands of components on a single chip at a price that is well within the grasp of amateur constructors.

THE FIELD EFFECT

The field effect principle was developed in the early fifties, just when mass manufacture of bipolar transistors was starting.

The basic idea behind field effect is superficially much easier to understand than the principles behind the bipolar transistor.

A diagram of the geometry of a junction field effect transistor is shown in Fig. 12.1. Essentially the f.e.t. consists of a chip of silicon, part of which is doped so as to be *n*-type and part of which is *p*-type. The n-type region forms a **channel** through the *p*-type region and terminals are placed at either end of this region, these being given the names **source** and **drain**.

A third terminal makes contact with the *p*-type area of the chip under which the channel passes. This terminal is the control input and is termed the **gate**.

The diagram shows the channel made of *n*-type material but a **complementary** type of f.e.t. can be made with the channel made from *p*-type material and the rest of the chip *n*-type.

The description of the action of the field effect transistor which follows assumes *n*-type **channel**, but the operation of a ***p*-channel device** is similar except that all the voltage polarities are reversed.

Fig. 12.2 shows the symbols for both *p*-type and *n*-type channel devices. As with the bipolar transistor, an arrow in the symbol distinguishes between the two types.

The channel through the f.e.t. normally has quite low resistance so that if a voltage is applied across the source and drain then a

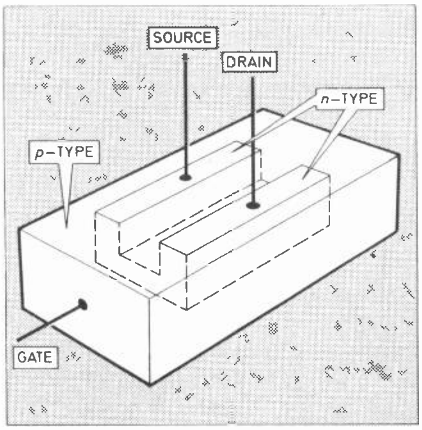


Fig. 12.1 *(left)* Diagram of the construction of an *n*-channel type junction f.e.t. The source and drain make contact with a channel which is completely surrounded by the gate region.

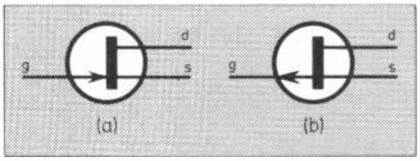


Fig. 12.2 *(below)* (a) the symbol for an *n*-channel junction f.e.t. and (b) the symbol of a *p*-channel junction f.e.t.

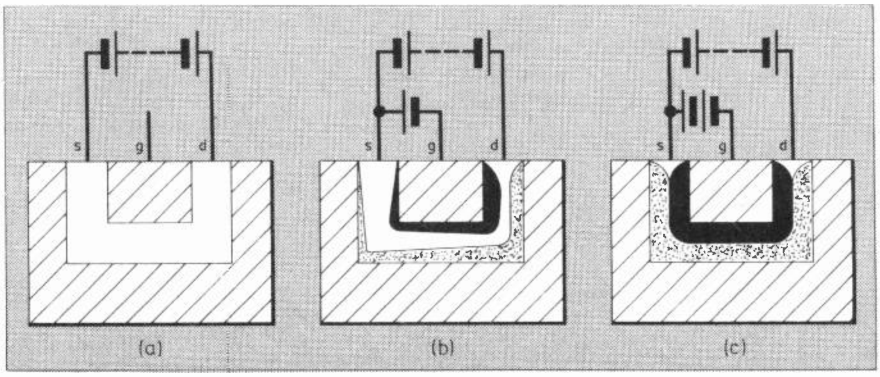


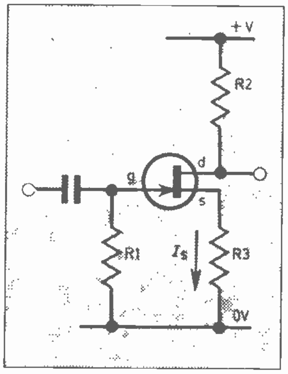
Fig. 12.3 *(below)* The reduction of the effective conductivity of the channel is shown as the gate is made progressively more negative with respect to the source. At (a) the gate is unconnected so there is no field. At (b) the gate is slightly negative thus reducing the effective cross-section of the channel and at (c) the gate is so negative that no current can flow through the channel.

current will flow. If now the gate is taken negative with respect to the source then the *p-n* junction will be reverse biased and a field will be set up within the channel.

The effect of this field is to reduce the number of current carriers in part of the channel. This effectively reduces the cross-sectional area of the channel thereby increasing its resistance. This effect is increased as the gate voltage is made more negative until a point is reached where the effective cross section of the channel has been reduced to zero making current flow from source to drain very difficult. Fig. 12.3 shows this process in diagrammatic form.

The essential point to note is that the f.e.t. is operated with its *p-n* junction **reverse biased** so that only a tiny leakage current flows through the gate terminal. They can therefore be described as **voltage operated devices** rather than current operated devices as bipolar transistors are.

It is the fact that the gate terminal of f.e.t.s has extremely high impedance that gives them their unique properties. The main application area is in the amplification of signals from high impedance sources, that is sources which cannot stand low impedances placed across them. A crystal for instance as used in high stability oscillators cannot supply current and so the high impedance of the f.e.t. is very useful.



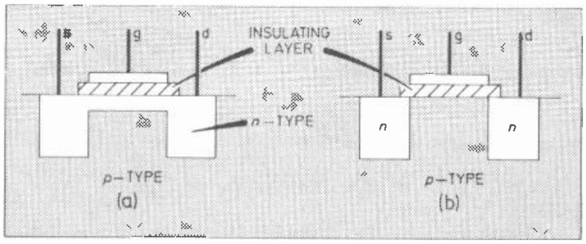


Fig. 12.4 *(left)* This circuit shows a simple way of biasing a junction f.e.t. so that the gate is negative with respect to the source. The voltage drop across R3 determines the negative bias since R1 holds the gate at 0V.

Fig. 12.5 (a) shows the construction of an *n*-channel depletion type m.o.s.f.e.t. and (b) an enhancement type m.o.s.f.e.t. The gate is separated from the silicon by an oxide insulating layer.

TABLE 12.1:
2N3819 characteristics

Type	P_{tot} (max)	I_{dss} (max)	I_{gss} (max)	V_{ds} (max)	V_{gs} (max)	V_{dg} (max)	Y_{fs}
2N3819	200mW	20mA	2nA	25V	25V	25V	4000μmho

F.E.T. CHARACTERISTICS

Table 12.1 shows the characteristics for a 2N3819 *n*-channel f.e.t. Because the device operation is different from the bipolar transistor, the parameters quoted are different.

Like the transistor we need to know the maximum current which can be passed through the f.e.t. without damaging it. This is given the name $I_{dss(max)}$. The maximum power dissipation is quoted as $P_{tot(max)}$.

The maximum drain to source voltage is $V_{ds(max)}$, and the maximum drain to gate and gate to source voltage are $V_{dg(max)}$ and $V_{gs(max)}$ respectively.

The leakage current through the gate terminal is an important parameter in f.e.t.s since the lower this is, the higher the input impedance can be. This parameter is given the name $I_{gss(max)}$.

The "gain" of an f.e.t. cannot be expressed in the same way as in a transistor since what is important is the change in current from source to drain with the change in voltage on the gate with respect to the source.

Now current divided by voltage is the inverse of resistance and is given the name **conductance**. The change in current produced by a change in voltage is therefore given the name **transconductance** and given the symbol Y_{fs}. Its units are **mhos** or **micromhos**, one mho being a change of one amp for a change of one volt.

F.E.T. BIASING

The circuitry around f.e.t.s is different from that around bipolar transistors because of the fact that virtually no current flows in the gate terminal.

In order to use an *n*-channel f.e.t. as a linear amplifier the gate must be biased negative with respect to the source. If there is only a single supply rail then a simple way of achieving this is as shown in Fig. 12.4.

Current flowing through the source resistor R3 will produce a voltage drop across this resistor which can be calculated using Ohm's Law. A resistor R1 connects the gate to the 0V line and since virtually no current flows through this resistor, the gate will be at 0V. Because of the voltage drop across R3, the gate will therefore be negative with respect to the source which is what we are trying to achieve.

The resistor connected to the gate can be made large so that the input impedance of the circuit is kept high. Values of a few megohms and upwards are common. The signal which is to be amplified can be applied using a.c. coupling to the gate and the output can be taken from the drain.

As well as the f.e.t.s which we have looked at so far which go under the name of **junction f.e.t.s** there has grown up a number of other types of f.e.t. and we will now take a look at some of the more important types.

M.O.S.F.E.T.S.

Undoubtedly the most important type of f.e.t. to the semiconductor integrated circuit manufacturer is the **metal oxide silicon** (or semiconductor) **f.e.t.**, usually abbreviated to **m.o.s.f.e.t.**

The underlying principle of the m.o.s.f.e.t. is the same as the junction f.e.t. in that an electric field is used to control the conductivity of a channel, but the construction and detailed operation are different.

Instead of the gate terminal being a connection to a part of the silicon, an insulating layer is formed over the channel, the gate being an area of metal on top of this insulating layer which completely covers the channel.

Two types of m.o.s.f.e.t. can be produced: in one the field produced by the gate to source voltage can decrease the conductivity of the channel, as in the junction f.e.t., or increase it, this being known as a

EXPERIMENT 12.1
TOUCH SWITCH

Components needed: 10kΩ ¼W resistor (4 off), 2·2kΩ¼W resistor, 1MΩ ¼W resistor, 2N3819 f.e.t., BC478 transistor, 5·1V 400mW Zener diode.

The circuit of Fig. 12.10a shows a simple touch switch that can be built using an *n*-channel junction f.e.t. type 2N3819. The f.e.t. is biased into conduction using the self-biasing arrangement as described in the text. In this state there should be only about 2V across R2 the drain resistor.

A finger has a skin resistance of around a few hundred kilohms so when it is placed across the two contacts the biasing of the f.e.t. is substantially changed causing a much greater drain current to flow and hence a greater voltage to be developed across R2.

The voltage change across R2 is detected by TR2. A 5·1V Zener diode is placed in series with the emitter so the base must be at least 5·8V (Zener voltage +V_{be}) below the positive rail before it will conduct. The load for TR2 is formed by the l.e.d. and its current limiting resistor R6.

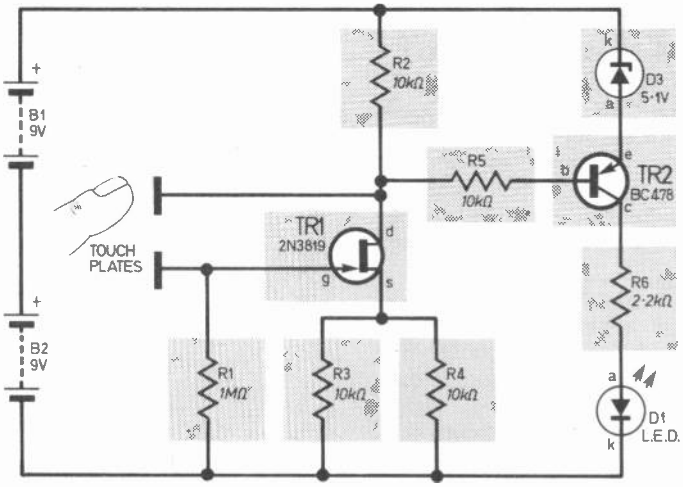
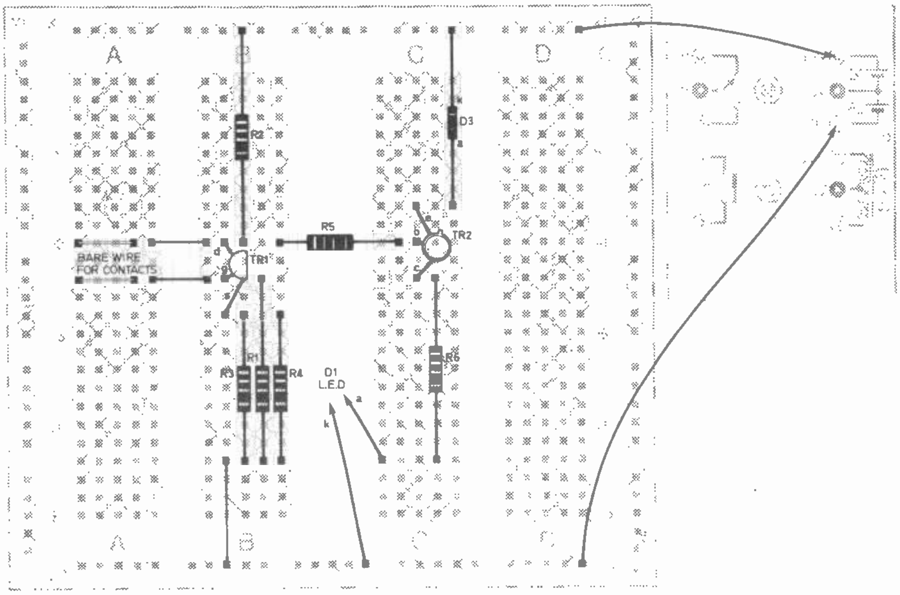


Fig. 12.10(a) *(top right)* The circuit of Experiment 12.1. Fig. 12.10(b) *(below)* The layout of Experiment 12.1 on the Tutor Deck.



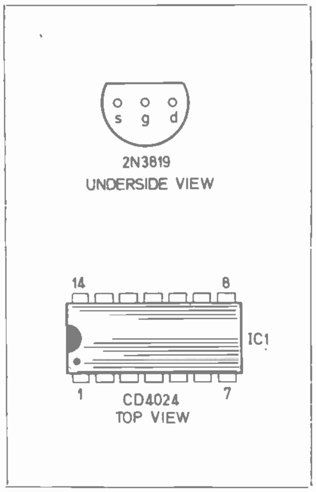
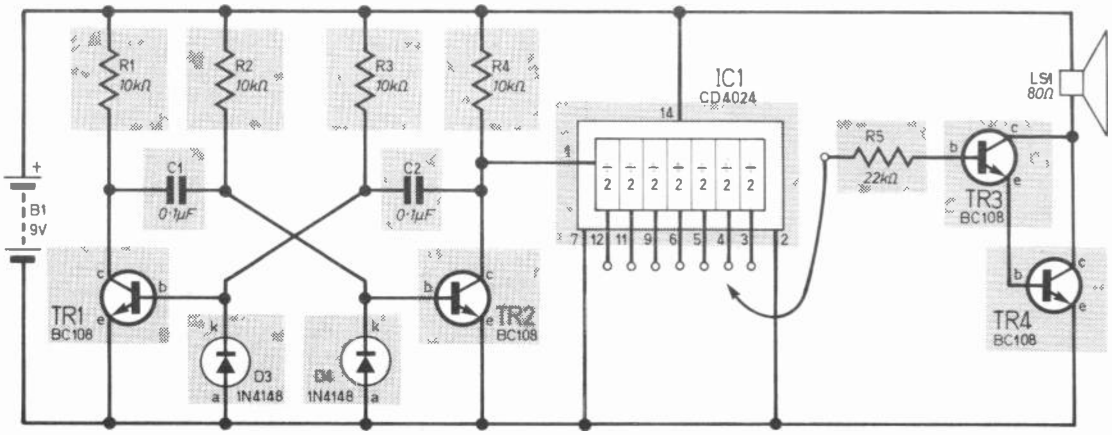


Fig. 12.12(a) The circuit of Experiment 12.3. Fig. 12.12(b) *(right)* The layout of Experiment 12.3 on the Tutor Deck.



EXPERIMENT 12.2:
TIME DELAY USING A F.E.T.

Components needed: 1MΩ ¼W resistor (2 off), 10kΩ ¼W resistor (2 off), 2·2kΩ ¼W resistor, 10µF 16V tantalum capacitor, 2N3819 f.e.t., BC478 transistor, 5·1V Zener diode.

The circuit of Fig. 12.11a shows a timer circuit using the same f.e.t. as Experiment 12·1. There is no source resistor in this circuit as we want to keep the voltage across the two 1MΩ resistors R1 and R2 as low as possible.

When the pushbutton is pressed C1 charges up to about 16V. The gate of TR1 is at a voltage of about 1·5V so about 1·5V divided by 2MΩ (0·75µA) flows through R1 and R2.

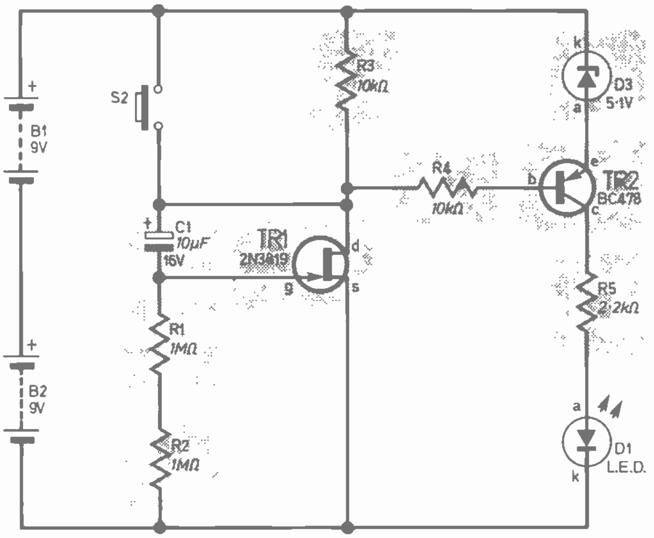
When the pushbutton is released, C1 will start to discharge. Because of the very high impedance of TR1 gate, all the discharge current flows through R1 and R2. The drain voltage will thus fall steadily until the voltage across R3 is large enough to cause TR2 to conduct when the l.e.d. will light.

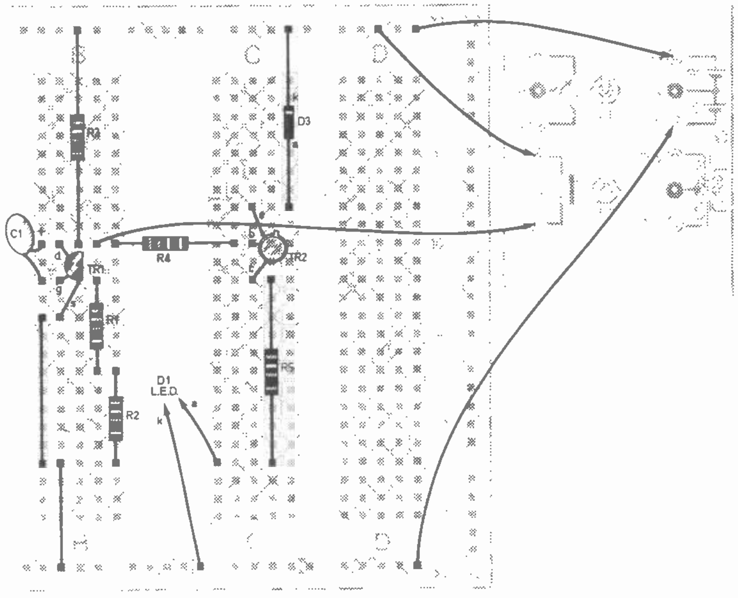
The changeover from l.e.d. off to l.e.d. on is not particularly rapid and a Schmitt trigger in place of TR2 would be advantageous.

To start the timing cycle again, press the pushbutton.

Fig. 12.11(a) *(right)* The circuit of Experiment 12.2.

Fig. 12.11(b) *(below)* The layout of Experiment 12.2 on the Tutor Deck.

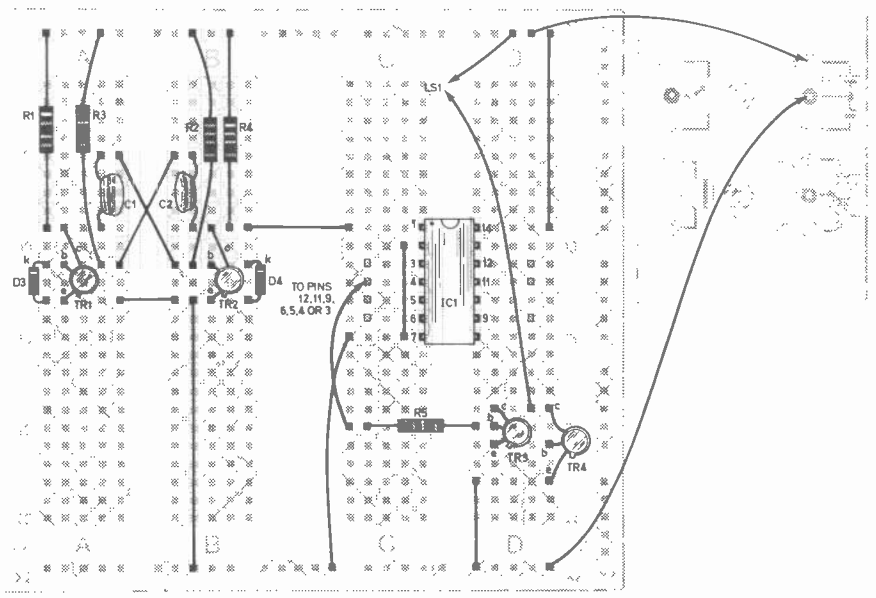




EXPERIMENT 12-3:
VARIABLE PITCH OSCILLATOR

Components needed: 10kΩ ¼W resistors (4 off), 22kΩ ¼W resistor, 0·1µF capacitors (2 off), CD4024 7-stage CMOS divider, BC108 (4 off), 1N4148 diodes (2 off).

This circuit (Fig. 12.12a) makes use of a CMOS integrated circuit type CD4024. This circuit contains seven dividers connected in series each of which will divide their input frequency by two.



TR1 and TR2 are connected to form a multivibrator as has been described in detail in a previous issue. The voltage at the collector of TR2 is a square wave of frequency about 700Hz. This is applied at the start of the divider chain.

TR3 and TR4 are connected in the Darlington pair configuration. This is so that the relatively small output current which the CMOS circuit can supply can be used to drive the loudspeaker.

The loudspeaker driver can be connected to any of the output pins of the divider. Working along the pins in sequence as shown in the circuit, the output tone will have a gradually lower pitch. In fact each step lower will be an octave below the previous note.

This circuit illustrates how integrated circuits can be used to perform complex functions which would take many discrete transistors to build. It also shows how easy it is to drive CMOS circuits since we do not have to use a precise power supply nor one of high current capability. Nearly all the current drawn from the batteries goes into the speaker.

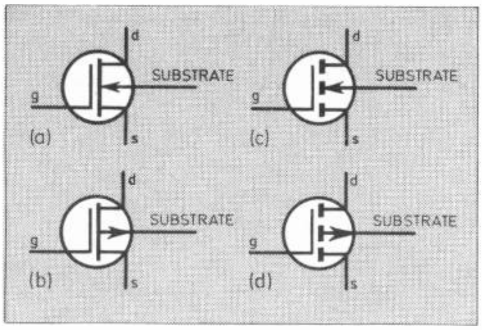


Fig. 12.6. The symbols for the various types of m.o.s.f.e.t. (a) and (b) are depletion types whilst (c) and (d) are enhancement types. (a) and (c) are *n*-channel and (b) and (d) *p*-channel.

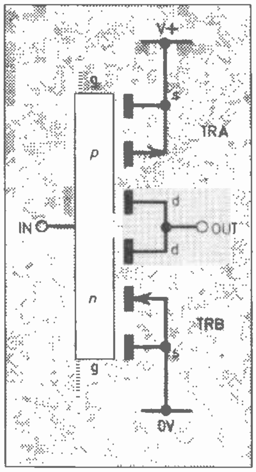


Fig. 12.7 *(right)* A CMOS inverter formed from a complementary pair of enhancement type m.o.s.f.e.t.s.

depletion type m.o.s.f.e.t.; in the other there is no channel between the drain and source until a gate voltage of a given magnitude is applied, this being known as an **enhancement type** m.o.s.f.e.t.

Fig. 12.5 shows the geometry of the two types, which, like the junction f.e.t. can either be made with a *p*-channel or an *n*-channel.

The symbols distinguish between the depletion and enhancement types by using a dotted line between the drain and source to indicate that the enhancement type needs a gate voltage to complete the path (Fig. 12.6).

The *n*-channel m.o.s.f.e.t. is an important member of the family since it can be used with a single positive power supply. The gate does not need to be biased negative with respect to the source since a positive voltage on the gate is needed to produce current flow in the drain-source circuit.

LOGIC INTEGRATED CIRCUITS AND F.E.T.S.

High density logic integrated circuits use field effect transistors almost exclusively although the technologies used vary widely.

The attraction of f.e.t.s in integration is that the actual f.e.t.s can be made very small in comparison with the area needed by bipolar types. They are also relatively simple to fabricate and consume only minimal power.

Logic circuits have been produced with an all *p*-channel m.o.s.f.e.t.s, all *n*-channel m.o.s.f.e.t.s and with both types on the same chip. This latter type of circuit goes under the name of **complementary m.o.s.** logic which is usually abbreviated to CMOS. It is outstanding for its extremely low power consumption and warrants a more detailed look.

CMOS LOGIC

Complementary m.o.s. logic circuits use both *n*-channel and *p*-channel enhancement type m.o.s.f.e.t.s on a single piece of silicon. A single CMOS switch is shown in Fig. 12.7.

Transistor A requires its gate to be negative with respect to its source in order for it to conduct. Transistor B requires its gate to be positive with respect to the source for it to conduct.

Since the two drains are connected and the two gates are connected it will be seen that when one transistor is on the other is off and vice versa.

In the off state the transistors have very high impedance so while one transistor is off and the other is on (it does not matter which) hardly any current will flow from one power supply rail to the other. It is possible for both transistors to conduct but this only happens when the gate voltage is exactly halfway between the power supply rails. If the switching voltage is rapid then this current will only flow for a very short time.

When either of the transistors is in the on state, its impedance is very low so the voltage at the common drain terminal will swing almost from one power supply rail to the other as the gate voltage is swung from low to high.

Another important feature of CMOS circuits is that they will work over a very large range of power supply voltages. Typical commercial CMOS circuits will operate with power supplies of anything from 3 to 15V. This contrasts dramatically with TTL logic circuits which will only operate with a voltage of $5V \pm 0{\cdot}5V$.

PART 12 QUESTIONS

12.1. How many *p-n* junctions are there in a junction f.e.t.:
- a) 1
- b) 2
- c) 3
- d) 4

12.2. Large scale integrated circuits are usually made with which type of transistor:
- a) bipolar
- b) junction f.e.t.
- c) m.o.s.f.e.t.

12.3. CMOS logic uses what type of m.o.s.f.e.t.:
- a) *n*-channel depletion
- b) *n*- and *p*-channel depletion
- c) *p*-channel enhancement
- d) *n*- and *p*-channel enhancement

12.4. A m.o.s.f.e.t. when suitably biased produces a change of 1·5mA drain current for a change of 0·5V in the gate voltage. What is its transconductance:
- a) 3000μmho
- b) 300μmho
- c) 3mho
- d) 0·3mho

12·5. A 2N3819 f.e.t. with a transconductance of 4000μmho is biased so as to act as a linear amplifier. What change in drain current would be produced for a 1V change in gate voltage:
- a) 4μA
- b) 4mA
- c) 40μA
- d) 2·5mA

PART 11 ANSWERS

11·1 b). 11.2 c). 11.3 a). 11.4 b). 11.5 a).

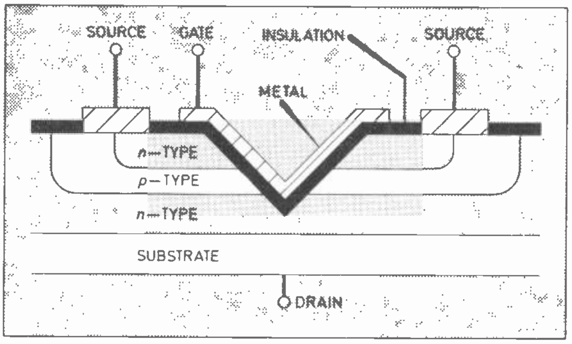


Fig. 12.8. The construction of a VMOS transistor. This differs from ordinary m.o.s.f.e.t.s in that it has a v-channel cut into the silicon.

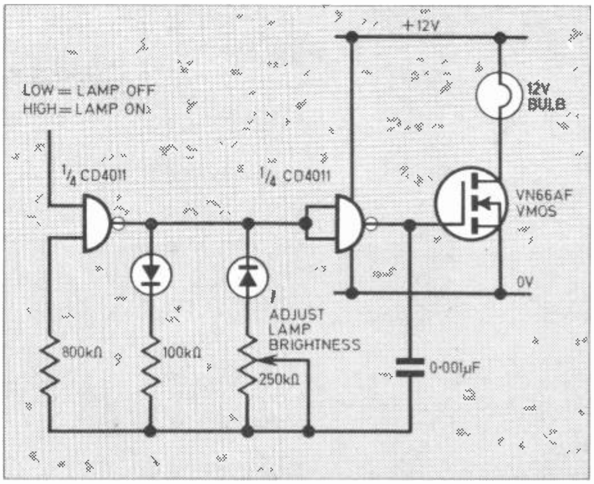


Fig. 12.9. This circuit illustrates how easy it is to interface low power logic in the form of CMOS to a high current output in the form of a lamp.

The wide operating power supply range means that the power rail does not necessarily have to be pure d.c. but a large a.c. component can also be tolerated. Thus the power supply for a CMOS circuit does not have to be well-smoothed as it does for TTL and so can be relatively uncomplicated and thus cheap.

One problem with CMOS circuits is that they can be damaged by the static voltage which is often present on the body. This is because the tiny capacitance on the gate has a very low leakage and so any charge tends to produce very large voltages which exceed the breakdown voltage of the junctions.

Try to avoid touching the leads of the i.c.s until they are in the circuit, leaving them in the conductive foam in which they are supplied.

F.E.T.S. IN LINEAR I.C.S.

In the last few years integrated circuit manufacturers have managed to combine f.e.t. and bipolar transistors on a single chip thus producing operational amplifiers with extremely high input impedances but good drive capability and speed. Usually just the input stage is f.e.t. but some op-amps are made entirely from m.o.s.f.e.t.s.

The CA3140 op-amp which has been used in past articles is a combination of m.o.s. and bipolar technologies and the figures quoted earlier testify to its extremely high input impedance.

POWER F.E.T.S.

Until the last couple of years f.e.t.s have not been produced which are capable of operating at high currents or powers. This gap has now been filled by a new breed of discrete f.e.t. known as **v-channel** m.o.s.f.e.t.s or VMOS for short.

Conventional geometry of m.o.s.f.e.t.s meant that high currents could not be achieved without huge chip area so a radically different geometry was needed. Fig. 12.8 shows a typical VMOS transistor and it will be seen that instead of simply building up layers on the surface of the silicon, a *v*-shaped groove has been cut which is used for the gate.

VMOS transistors can handle currents of 10A but even higher current types are now appearing. They tend to be of the *n*-channel enhancement type since this allows a single power supply to be used. The real attraction of these VMOS transistors is that currents of 10A can be switched by low power logic like CMOS making interfacing between logic and things like lamps or relays very simple indeed. Fig. 12.9 shows a typical circuit.

At the moment the price for these devices is very high but no doubt as the demand increases the price will fall and we will be seeing them used in EE projects. ⌑

JACK PLUG & FAMILY...

BY DOUG BAKER

TTL Logic PROBE

BY A. WHEEN

ONE of the most useful pieces of test equipment for troubleshooting digital circuits is a logic probe. The probe to be described, which is for use on TTL devices, uses three l.e.d.s to indicate the state of the logic under test; these l.e.d.s are labelled HIGH, LOW and PULSE.

The HIGH and LOW l.e.d.s indicate logic 1 and logic 0 respectively, and when the point under test is oscillating between logic 1 and logic 0 the relative brightness of these two l.e.d.s gives some idea of the mark-space ratio of the waveform.

The l.e.d. labelled PULSE flashes on for one second every time the logic level at the probe input changes state. This can be used for detecting very short duration positive or negative-going spikes, which are much too fast to be visible on the HIGH and LOW l.e.d.s.

CIRCUIT DESCRIPTION

IC1 is a quad Schmitt NAND circuit, with gates IC1a and IC1b being used as inverters and buffers. When the probe input is high (logic 1), D1 will light; similarly, when the probe input is low (logic 0), D2 will light. Since TTL regards an open-circuited input as being at logic 1, the output of gate IC1a will go low whenever the input is an open circuit.

To prevent the probe from indicating logic 1 for an open circuit input, TR1 was included in the circuit. Although a BC183 was used in the original design, any small *npn* transistor should operate satisfactorily in this circuit.

Integrated circuit IC2 is a quad 2-input exclusive-OR device, and is wired so as to produce a short negative-going pulse whenever the probe input changes state. Since gates IC2a, b and c are all acting as inverters, the two inputs to gate IC2d are at opposite logic levels, and so the output of gate IC2d is high. However, when the output of IC1a changes state, this change will not be reflected in the output of gate IC2 until about 45 nanoseconds later because of the propagation delays in gates IC2a, b and c. Thus, for about 45 nanoseconds, the inputs to gate IC2d are at the same level, causing a 45 nanosecond negative-going pulse to be produced.

This pulse sets the flip-flop formed by IC1c and d, and D3 lights to indicate that a change of state at the probe input has been detected. The flip-flop resets itself about one second later when the voltage across C1 has dropped to 0·9 volt; C1 is then charged up again via R4.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit is built on a piece of 0·1in matrix stripboard, size 9 strips by 29 holes. The i.c.s can be soldered directly to the board or mounted in Soldercon pins. If you wish to use i.c. sockets, note that some types mount the i.c. so high off the board that they will not fit in the case. Similarly, if you wish to use resistors rated at more than ¼ watt, check that they can be fitted into the spaces allocated.

The case used in the prototype was an exhausted container for Multicore solder with three holes drilled in the side and spaced so that the three l.e.d.s on the circuit board can be seen through them.

The layout of the components on the topside of the board and the breaks to be made on the underside are shown in Fig. 2. Note that there are some link wires to be connected beneath the i.c.s, and also on the underside of the board.

Begin by cutting the board to size and then filing it so that it is a little smaller than the internal diameter of the case.

Next make the cut-outs and solder in position all the link wires (above and below the board) followed by the components. Note the orientation of the l.e.d.s. These should be inserted so that the height to their tips above the board is a little more than the radius of the case. In this way, when the board is fixed in position the l.e.d.s will protrude a little allowing them to be seen more easily.

Drill three suitably sized holes in the case to align with the l.e.d.s on the board when the latter is in its final position.

Connect flying leads to the board, about 80mm to reach the probe point and about 1m for the supply lines. Red and black leads to represent "+" and "−" respectively are advised.

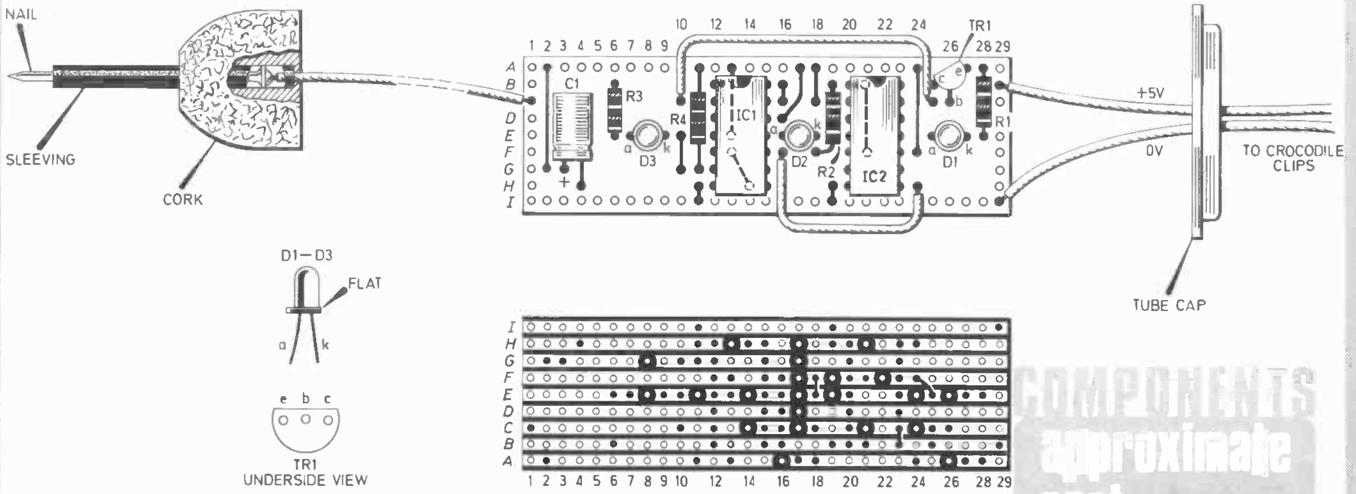
PROBE POINT

For the tip of the probe a small nail was used. The nail was driven through the centre of a cork shaped to fit the conical end of the tube and the section of the nail protruding from the cork was covered with rubber sleeving. It was necessary to enlarge the hole at the end of the tube so that the nail with its sleeving cover would fit tightly in it.

Solder the probe lead from the board to the head of the nail and cover the joint with some insulating tape.

Push the cork into the tube so that the nail protrudes through the hole in the tube. The cork can be glued in place, but in the prototype this was found to be unnecessary.

LOGIC PROBE



COMPONENTS approximate cost £2.20

Fig. 2. Circuit board layout and construction. Note that there are three wire links on the underside of the board.

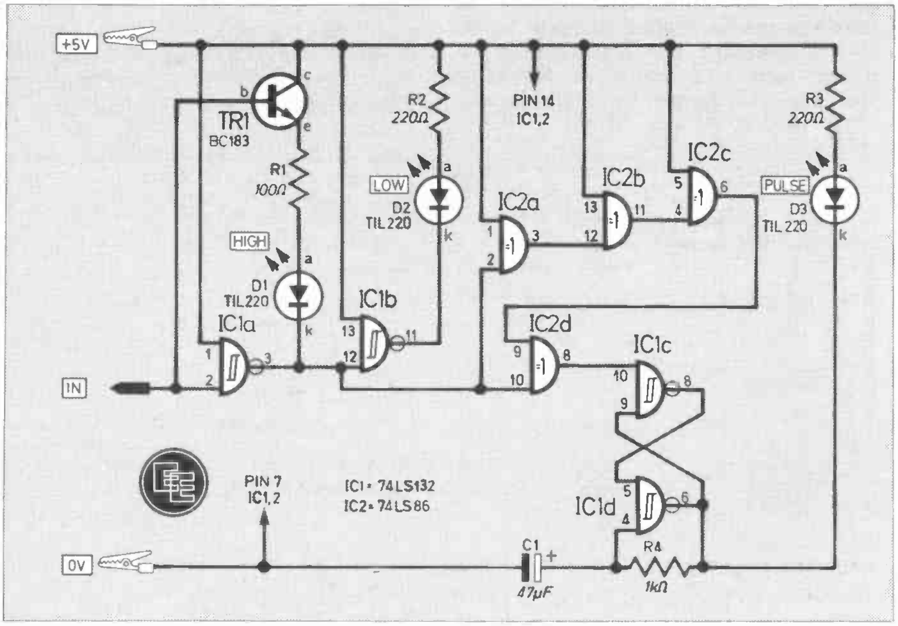


Fig. 1. Full circuit diagram of the Logic Probe.

COMPONENTS

Resistors
R1 100Ω
R2 220Ω
R3 220Ω
R4 1kΩ
All ¼W carbon ± 5%

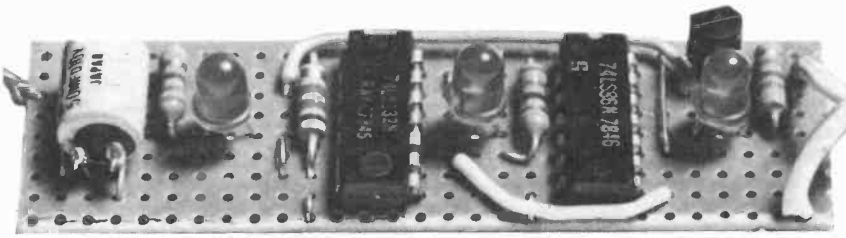
See **Shop Talk** page 553

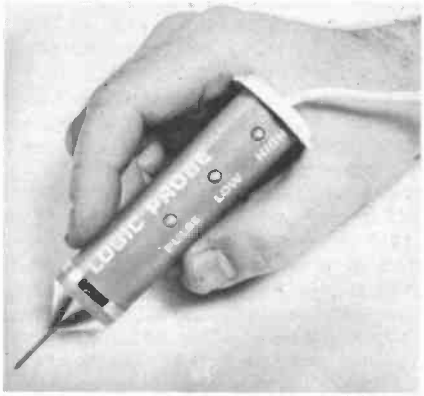
Capacitor
C1 47μF 10V elect.

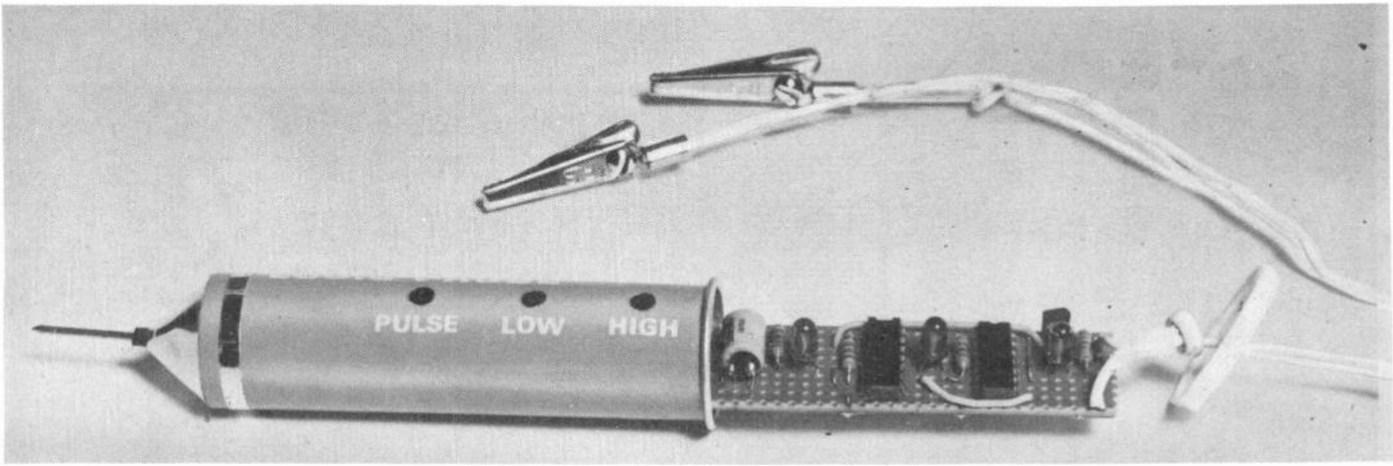
Semiconductors
IC1 74LS132 TTL quad 2-input Schmitt NAND gates
IC2 74LS86 TTL quad 2-input exclusive-OR gates
TR1 BC183 silicon *npn*

Miscellaneous
0·1 inch matrix stripboard, size 9 strips × 29 holes; Multicore solder dispenser (case); crocodile clips (2 off); stranded p.v.c. covered wire about 1 meter each red and black; cork and nail (probe tip assembly).

The photograph below shows a close up view of the circuit board. The logic probe can be seen in its case in the right hand photograph.







Exploded view of the unit showing the board ready for insertion in its case.

Next, drill a small hole in the white plastic cap which fits on the ends of the tube. Feed the supply wires through this hole and knot it inside the cap, allowing about 25mm of slack between the circuit board and the knot. The circuit board can now be fitted into the tube.

Ensure that l.e.d.s are lined up with their holes and then push the board upwards so that the l.e.d.s protrude through the holes. Secure in this position with a piece of polystyrene or foam sponge. Fit the cap on the tube and crocodile clips on the two supply wires emerging from the cap.

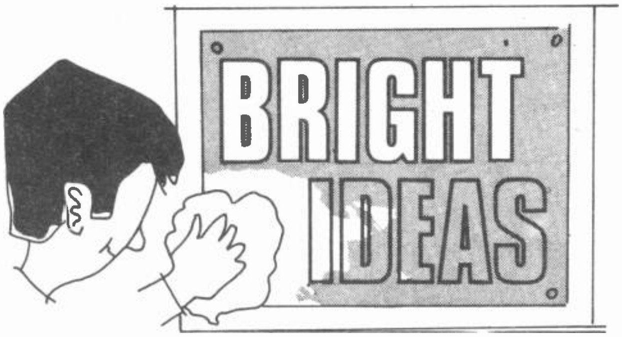
TESTING

Carefully connect the supply leads to the power rails on a TTL circuit, or a p.s.u. set to +5 volt. Touch the probe on to the positive supply rail and the probe should indicate HIGH, D1 lit. Similarly, the probe should indicate LOW (D2 lit) when touching the negative supply rail, and should not indicate anything when the probe is not touching anything.

Check that the PULSE l.e.d., D3, flashes when the probe is touched on to the negative supply rail, and once again when it is removed from the supply rail.

Note that this l.e.d. will not flash when the probe touches the positive supply.

If all is well the case may be painted and the three l.e.d.s labelled with their function as shown in the photographs. ⌑



Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

BIT REMOVAL

When one wishes to renew the copper bit of a soldering iron, one almost always finds that it is almost impossible to remove the old bit, since the surface between the bit and the bit holder has become badly corroded.

It may be possible to remove the old bit by drilling it out, but one normally adopts the easier task of replacing both the bit and the bit holder.

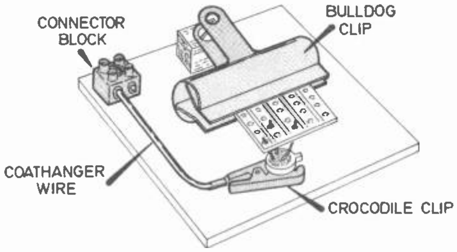
This problem can be avoided if a copious layer of silicone grease is placed on each new bit before it is placed in the bit holder. The grease should be kept well away from the tip of the bit which will be used for soldering, but the regions which will come into contact with the bit holder should be well covered.

When the soldering iron is used, the silicone grease is converted into a white coating which seems to prevent appreciable oxidation of the copper surface. The bit can be removed quite easily after the split pin has been taken out, since the white coating crumbles away.

J. B. Dance,
Alcester,
Warks.

MINI-BENCH

I have devised a simple, inexpensive circuit board holder for when you are soldering, as seen below.



To hold the circuit board I used a bulldog clip. The metal clasps could also act as heatsinks, but where delicate boards were used I stuck draught excluder tape along them. To hold the component in place coathanger wire is used with a crocodile clip attached to the end. This is held in place by a screw terminal block fitted to the base.

R. Harrison,
Witham,
Essex.

NEXT MONTH

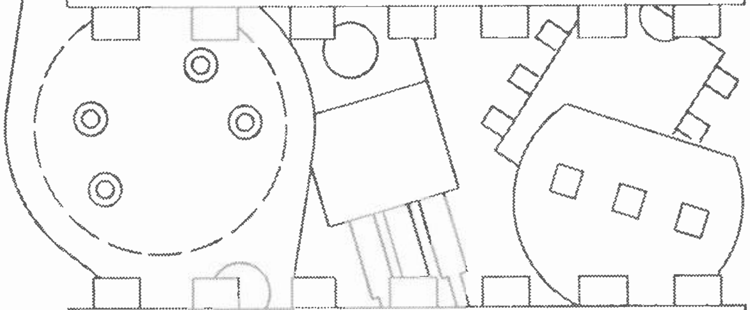
INTRODUCING MICROCIRCUITS

This special feature puts the layman in the picture concerning the silicon chip or integrated circuit. It provides a good lead-in to our NEW SERIES, commencing in the same issue.

I.C.s EXPLAINED

This series will discuss specific types of i.c.s. and illustrate typical circuit applications. The first four parts deal with LINEAR I.C.'s.

EE OPENS A NEW SEASON WITH A CLOSE LOOK AT MICROCIRCUITS



AND AS A VALUABLE BACK-UP TO THESE ARTICLES THERE'S A

free WALLCHART

GUIDE TO POPULAR LINEAR I.C.s
with every copy of the October issue

CONSTRUCTIONAL PROJECTS INCLUDE

AUDIO EFFECTS UNIT

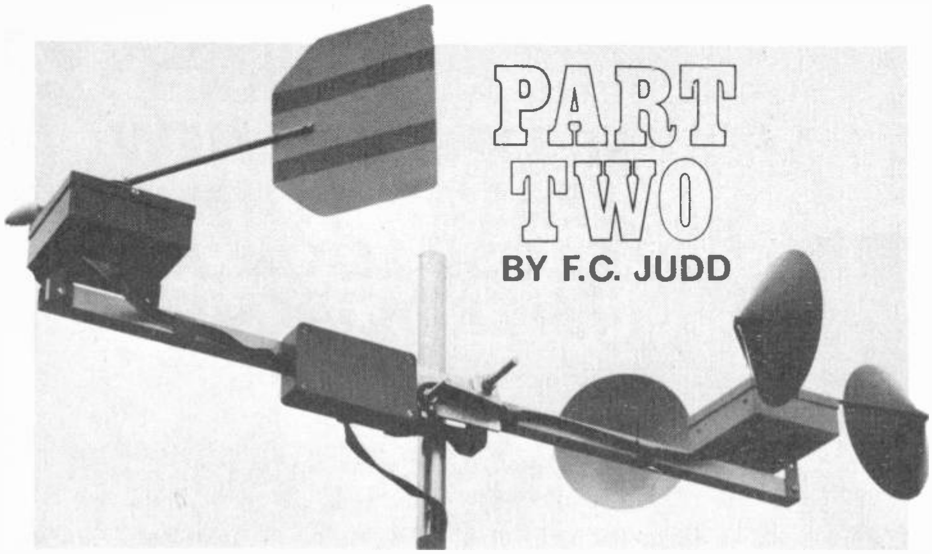
DARKROOM CONTROLLER

PHONE CALL CHARGE JOGGER

BICYCLE ALARM

Everyday ELECTRONICS

OCTOBER 1980
ISSUE ON SALE
FRIDAY, SEPTEMBER 19



PART TWO

BY F.C. JUDD

WEATHER CENTRE

THIS second part of the Weather Centre deals with the construction of the sensors and final adjustment and setting up.

The main outdoor items are the anemometer and wind direction units both of which are mounted on a boom that can be attached to a short mast on a chimney stack or similar position clear of the roof top of the home.

ANEMOMETER

The anemometer or wind speed unit is housed in an aluminium box as in the illustrations. Some mechanical work is involved in making the wind cups, chopper disc, etc, and it would be a good idea to study all the drawings and photographs before making a start.

The wind cups are first carefully cut out of aluminium sheet and folded into the required cone shape. The joins can be riveted or secured with small screws and nuts after which each cup is mounted on its arm with a 4BA screw and nut (see Figs. 13 and 14).

The three arms and cups should next be attached to the circular mounting plate (see Fig. 17). This consists of a 40mm diameter brass disc onto which a collar has been soldered. The disc is drilled through the centre with a 6mm clearance hole.

CHOPPER

The next stage is to make the circular Perspex infra-red chopper disc as in Fig. 17. Cut the material as near round as possible and slightly oversize then drill a 6mm hole through the centre.

Fit the nearly formed disc to an arbor and mount it in an electric drill which has been clamped to the bench. Using a file (for example a "Surform" type), to cut the disc edges, continue to turn the disc until it is perfectly circular and of the correct diameter.

The same method is used to turn the brass discs and also the rain protection discs, one of which is shown on Fig. 17.

The chopper disc is finished off by drilling 18 equally spaced 6mm diameter holes according to the diagram. The bushes used for the shaft are standard $^3{}_8$ inch brass types and the collars for the brass discs can be cut from standard $^1{}_4$ inch brass spindle couplers.

The disc should be given a couple of coats of paint to make it completely opaque before it is installed in the final unit.

The next step is to build the circuit board according to Fig. 11. The infra-red l.e.d. D14 and the photo-transistor TR3, should be arranged so that they stand off the board and are bent at right angles facing each other making sure that they are directly in line.

The completed board should then be mounted in position inside the aluminium box. The shaft which will take the chopper disc should be placed carefully in the bush through the bottom of the box and the chopper disc inserted between D14 and TR3. The shaft can then be pushed through the disc from beneath and tightened in position.

The top is then placed on the enclosure and the rotating assembly screwed in position. Note that there is a 6mm perspex disc between the cup assembly and the bush in the top of the case.

CABLES

The cables from the circuit board need only be about 600mm long and consist of one single screened wire and a single insulated wire. These are eventually connected to a junction box on the boom.

When assembly is complete the wind cups should rotate freely with a slight breeze on them. The cups should rotate quite easily and smoothly in a wind down to 2 m.p.h.

WIND DIRECTION UNIT

A 16-point compass wind direction indication is obtained from eight l.e.d.s on the readout display, these being activated by a series of reed relays operated by a magnet attached to a disc which is in turn fastened to the shaft of the wind vane (see Fig. 14).

As can be seen from Fig. 15, the reed relays are assembled in a circle on circuit boards and enclosed in a protective aluminium box. These circuit boards can either be printed circuit boards or plain s.r.b.p. board with Veropins at the appropriate locations.

However, whichever method is used, the reed relays are all connected together on the top board as a common return and have separate connections on the bottom board. The lead outs here are by means of 10-way ribbon cable.

The diagram in Fig. 15 shows how the unit is put together. The metal work is almost identical to that of the wind speed unit, the only difference being that the rotating chopper disc is replaced by a brass disc to which a magnet has been glued with epoxy resin.

MAGNET AND ROTOR

In assembly of the direction unit, the one point that should be noted is that the rotor assembly and bottom board must be placed in position before the top board is soldered in. If this is not adhered to, it becomes impossible to place the rotor disc with the magnet in position.

The unit is then finished off according to the illustrations and photographs.

MAIN CABLE

The main cable from the direction indicator is a 10-way flat ribbon type available in 10 or 25 metre lengths. Connections to the wind speed unit are made via a single screened cable plus one of the wires of the 10-way cable. The nine other colour coded wires to the direction indicator unit are connected as in Fig. 16.

Connections of all cables from the wind speed and direction units are terminated at a 12-way terminal block housed in a small plastic box. This is mounted on the metal boom to which the wind speed and direction units are fixed (see Fig. 16). The boom itself can be fixed to a stub mast quite easily with a standard TV aerial claw clamp.

The whole assembly must, however, be mounted reasonably clear of the house roof top and any obstruction likely to impede the flow of air or cause fluctuation in wind direction, for example, a chimney stack in the path of the wind from any direction around the units.

HARDWARE

20 or 22s.w.g. aluminium sheet for wind cups; ¼ inch (6mm) aluminium rod or thick wall tube; ¾ inch square-section aluminium tube for boom; Perspex and brass for chopper and discs as per diagrams; ⅜ inch (¼ inch bore) brass bushes (4 off); standard ¼ inch bore brass spindle couplers for making collars (4 off); aluminium boxes 4 × 4 × 1½ inch, Bi-Pak type BA2 or similar (2 off); mild steel or aluminium angle for unit supports as per diagrams; small circular or square plastic boxes for temperature sensors; zinc plated self tapping screws; TV aerial claw clamp for securing boom to mounting pole.

Connections down to the readout display are made via the junction box, and use the 10-way ribbon cable plus one run of single core screened cable.

PRELIMINARY CHECKS

When the wind speed and direction units are fully assembled on the boom the short cables from these to the junction box can be connected.

Take the whole assembly outside, preferably when there is a light wind blowing. When held horizontal at head height, the anemometer cups should rotate freely and the direction vane move to a position 180 degrees to the wind direction, that is the small arrow should point into the wind.

Further notes on setting up will be given later, but a check could be made at this stage to confirm that all the reed relays are operating by connecting an ohm-meter between the common lead and each reed relay connection.

The meter should show continuity at each main compass point, with the

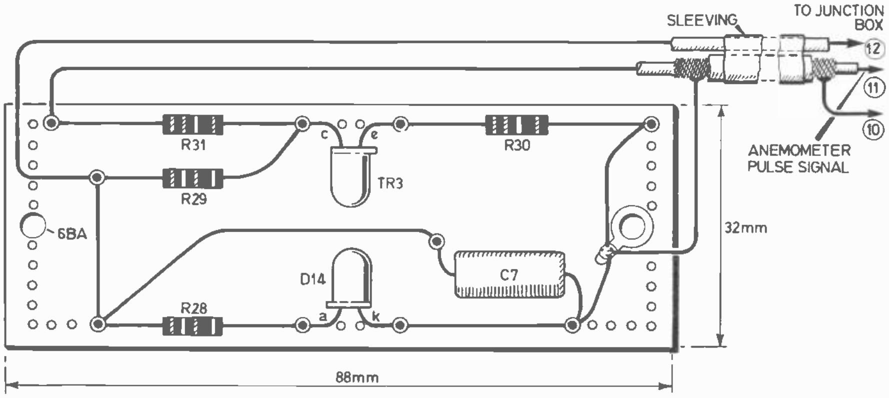
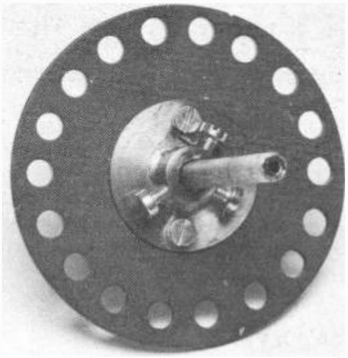
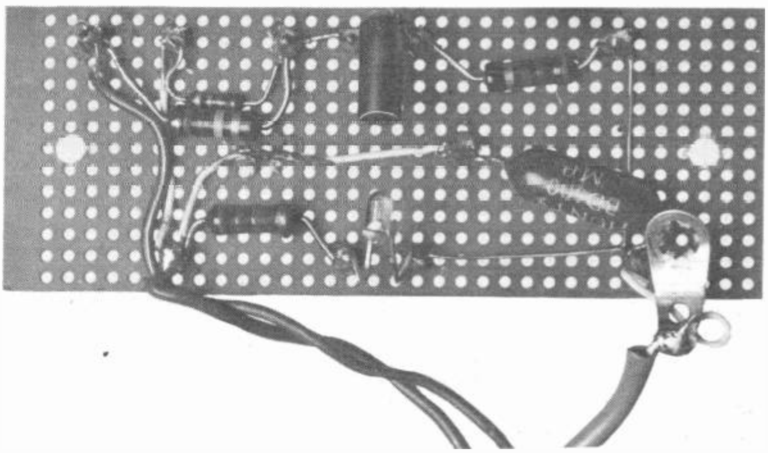
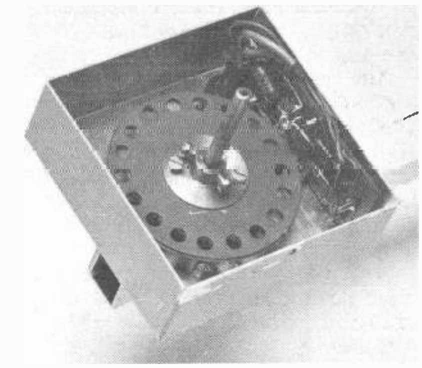


Fig. 11. Circuit board layout for the wind speed sensor unit. The photograph below shows the top view of the prototype board.



Close up view of the chopper disc.





Interior view of completed wind speed detector unit.

WIND VANE

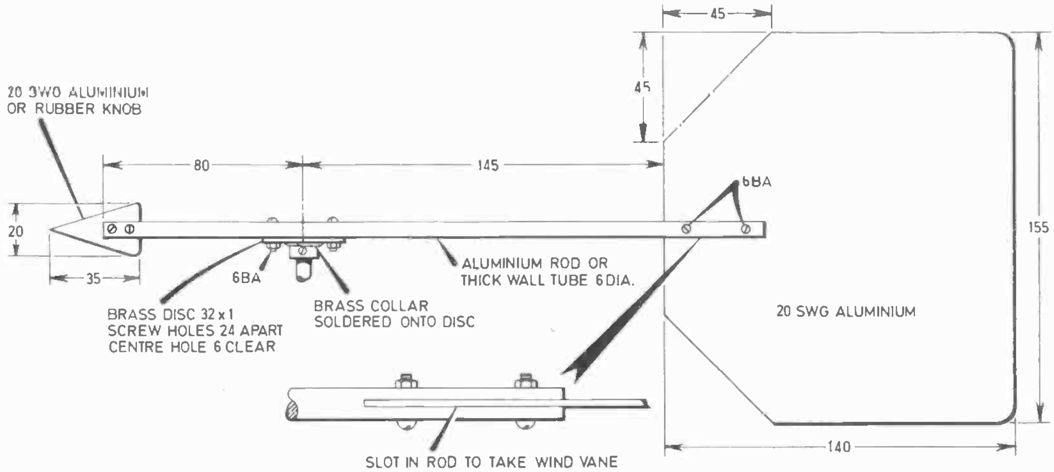
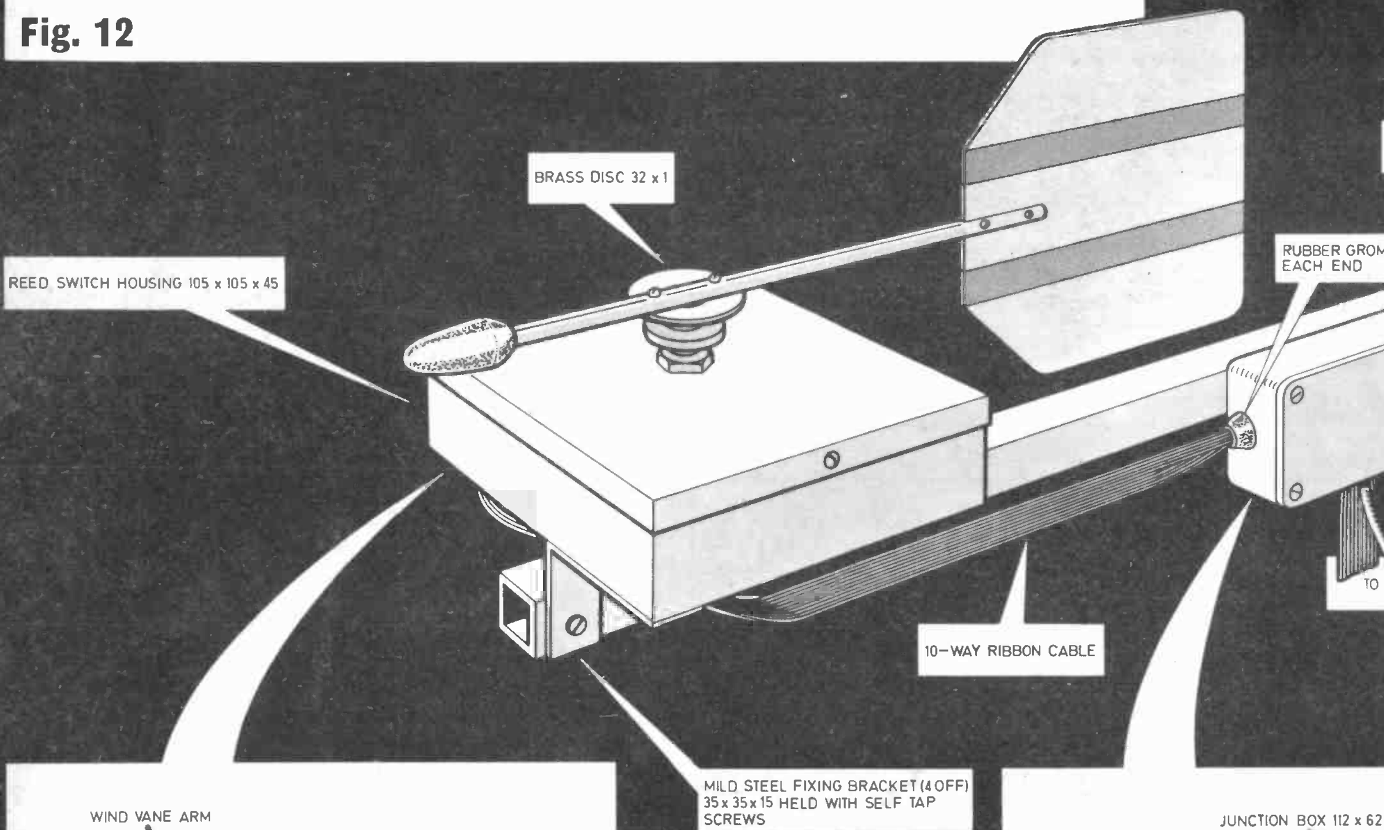


Fig. 12



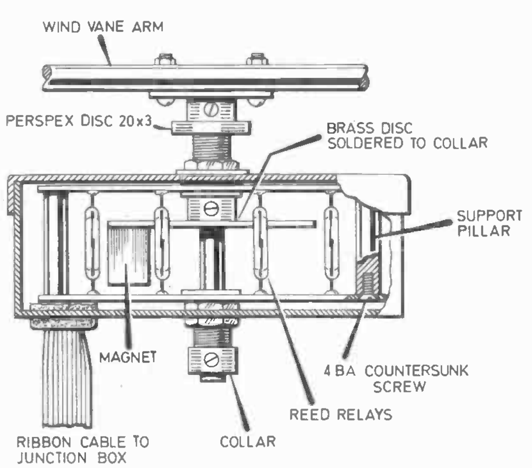
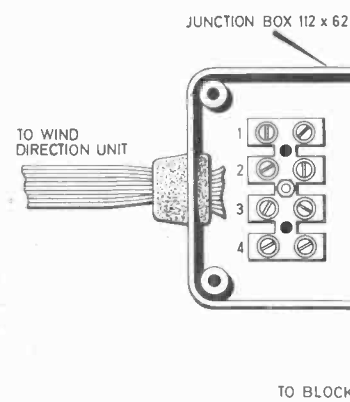
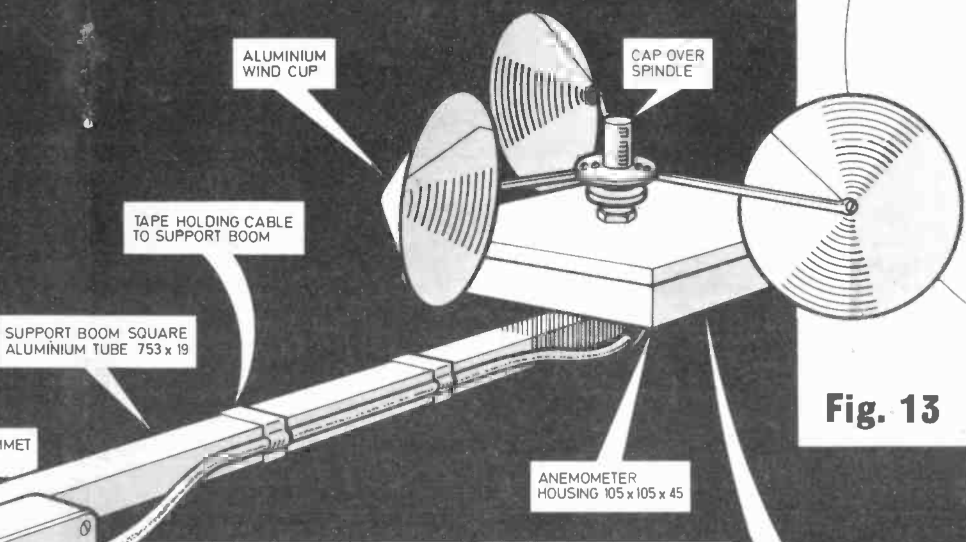


Fig. 15 **REED SWITCH HOUSING**



TERMINAL BLOCK HOUSING

VEATHER CENTRE



WIND CUP

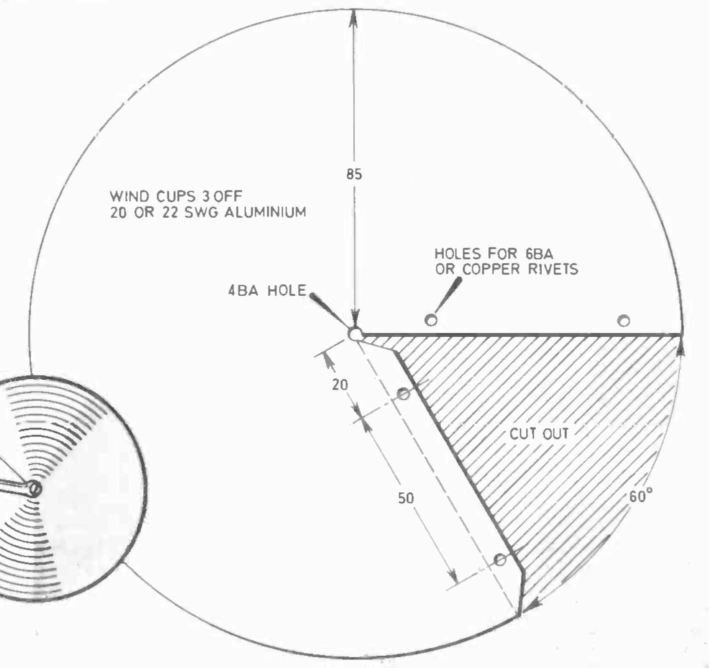


Fig. 13

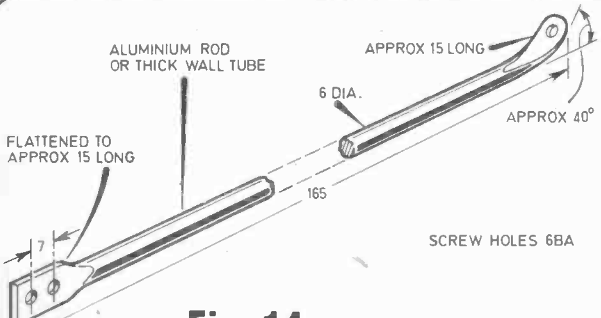


Fig. 14

WIND CUP ARM

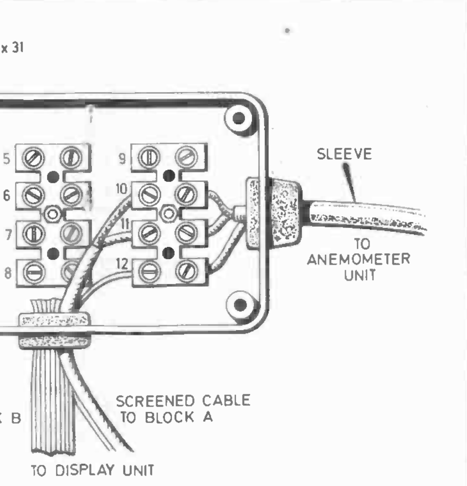


Fig. 16

ALL DIMENSIONS IN mm

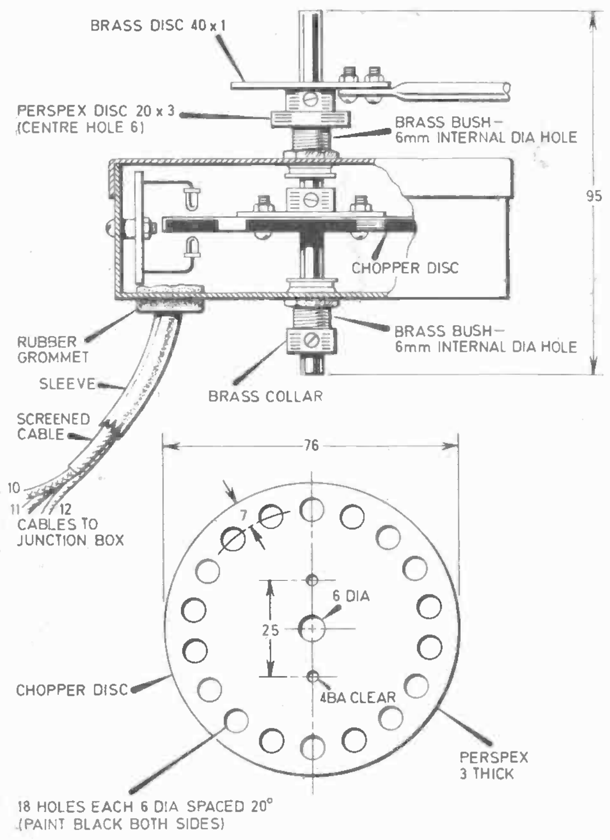


Fig. 17

ANEMOMETER HOUSING

appropriate switch closed, as the vane is moved slowly round by hand from N through to N.

If an oscilloscope is available, a preliminary check could also be made on the anemometer unit. Connect up a 12V battery with positive going to connection 12 on the terminal block, negative to connection 10. The output from connection 11 can then be fed to the oscilloscope.

Spinning the cups should produce a nearly uniform square wave as shown in Fig. 3 from Part One, last month.

TEMPERATURE DIODES

The final items in this project are the temperature sensing diodes D1 and D7 which are mounted in small plastic boxes, such as those used for typewriter ribbons, for protection.

Before this is done, however, the equipment needs calibrating for each diode.

The specified meter has a scale of 0 to 100 in major units of 20, subdivided into divisions of 10 and 2 and therefore a total of 50 divisions. Each of these represent two degrees of temperature or 2 m.p.h. of wind speed.

TEMPERATURE CALIBRATION

No two diodes, even of the same type, have exactly the same current/resistance characteristics, so the equipment must be calibrated separately for each sensing diode. For this purpose two wires are temporarily soldered to the ends of the diodes.

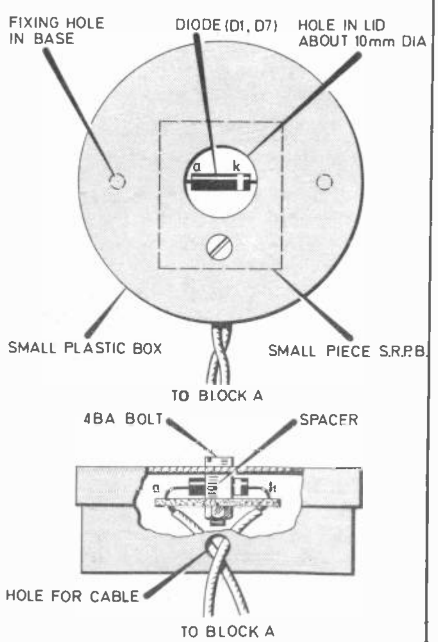
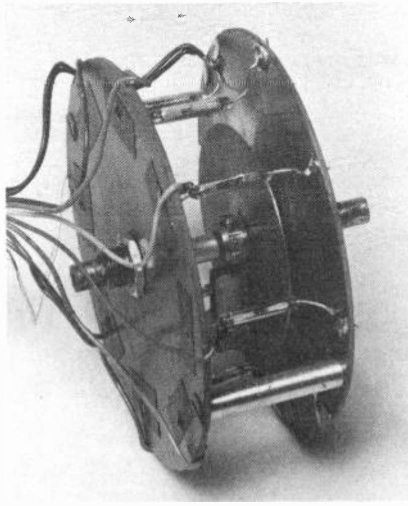
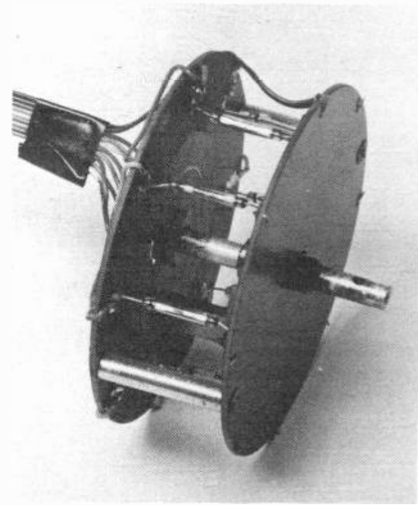


Fig. 18. A suggested housing and mounting for the temperature sensing diodes.



View of the reed switch assembly showing lower circuit board and common connection of the switches.



View of the reed switch assembly showing the upper circuit board and individual switch connections leading to the ribbon cable.

OUTSIDE TEMPERATURE

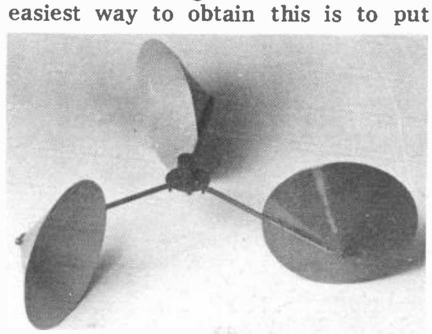
Take one diode and connect it up to the outside temperature terminals on the back of the main display unit. Make sure that the cathode of the diode is connected to the common or earthed input terminal.

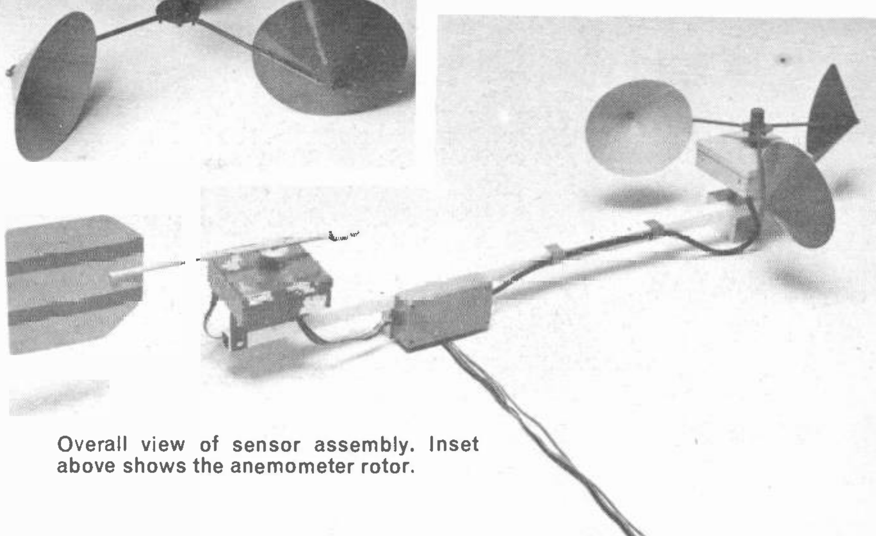
Set the wind speed select switch S3 to "wind speed cal" and the temperature select switch S1 to "0 degrees cal". The l.e.d. D8 should be flashing slowly. Adjust VR3 until the meter reads 0 degrees which is 40 on the normal meter scale.

For the next stage a small dish or glass of freezing mixture is needed. This should ideally consist of ice and water at zero degrees Celsius and the easiest way to obtain this is to put the water into the dish or glass and place it in a freezer until ice is just beginning to form. Set the temperature select switch S1 to "outside temperature" and the wind speed select switch S3 to "temperature" and place the diode in contact with the mixture. Set VR5 about half way and adjust VR4 until the meter reads approximately 0 degrees.

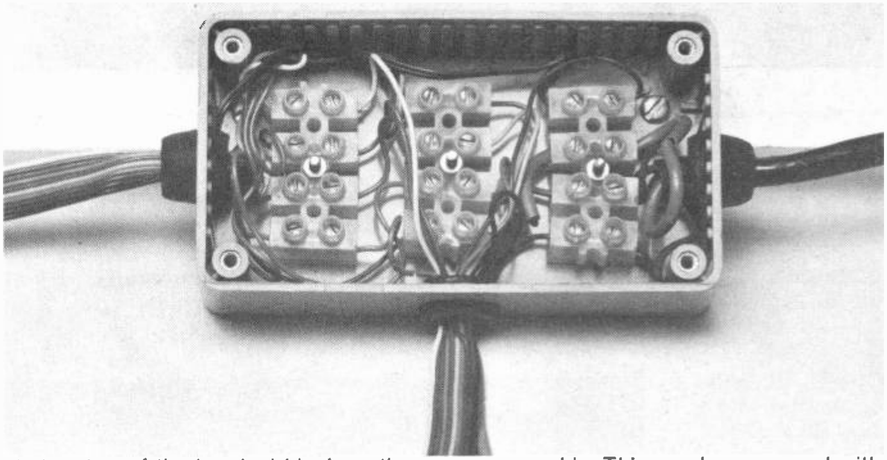
Remove the diode from the ice/water mixture and wait for a few minutes for the meter to increase its reading and then remain stationary. This will be at room temperature. Next adjust VR5 until the meter is reading the correct temperature. This can be verified with a normal mercury in glass thermometer.

Now return the diode to the ice/water mixture and readjust VR4 so that the meter reads 0 degrees and keep on moving the diode from ice to room temperature in turn and adjusting the relevant presets until





Overall view of sensor assembly. Inset above shows the anemometer rotor.



Interior view of the terminal block on the sensor assembly. This can be compared with Fig. 16.

correct reading appears every time.

The circuitry for the outside temperature of the unit is now calibrated for this particular diode. This diode must be kept only for outside temperature measurement.

INSIDE TEMPERATURE

The procedure for setting up the inside temperature circuit is exactly the same but using the diode sensor chosen for this connected up to the appropriate input terminals. In this case the presets VR1 (zero degrees) and VR2 (room temperature) are used. This diode must be kept only for inside temperature measurement.

DIODE MOUNTING

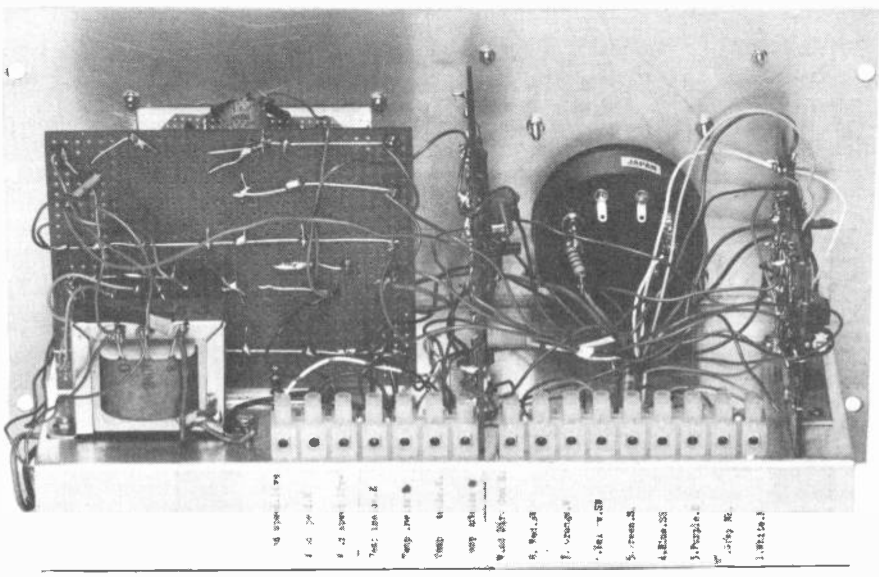
Each diode can now be mounted in a small plastic box and provided with a pair of connecting leads long enough to reach the final positions from the readout display unit.

Likewise, the wind speed and direction unit can now be permanently mounted in position, although it would be a good idea to connect it up to the display unit and quickly check the wind speed and direction functions before finally installing the wind speed/direction sensor unit in its permanent location.

WIND SPEED

Calibration is completed by setting up the display unit for correct wind speed. Set the wind speed select switch S3 to "wind speed cal". The l.e.d. D8 should be flashing slowly. Adjust VR6 until the meter reads 19, that is about half a division below 20. Calibration for wind speed is now complete for 0 to 100 m.p.h. but can always be checked again by repeating the above procedure.

Rear view of display unit showing sensor connection points and terminal blocks.



At this point the meter can be labelled. First, remove the meter cover and very carefully release the scale itself by undoing the securing screws. Then slide the scale outward underneath the pointer. Calibration figures for temperature and wind speed can be put on with Letraset or drawing ink as shown in the photographs. Equally carefully, replace the scale and meter cover.

The Weather Centre is now ready for use.

SENSOR LOCATION

The sensor for outside temperature should be mounted about 1·5m above ground on a North-facing wall or location shaded from direct sunlight. Make sure that water cannot enter the enclosure by sealing the lid all the way round with tape or epoxy resin. The sensor for inside temperature can of course be used anywhere in the house, the most likely place being the main living room. Alternatively, it can be used in a greenhouse.

The wind speed/direction sensors should be mounted well clear of any obstructions such as chimney stacks that might cause a disturbance in the air flow. The boom should also be lined up so that the reed relay S4 corresponding to the N l.e.d. D15 is in fact pointing North. Wind speed is measured in miles per hour or knots, either of which can be converted to the Beaufort scale. A printed scale is provided (see Fig. 10) for the constructor to fasten onto the front of the display unit for reference.

However, it must be remembered that even when the wind is blowing steadily, there are still fluctuations in wind speed known as gusts and lulls. For example, when the general wind speed is averaging 20 m.p.h. the speed over a period of a few minutes may fluctuate between 10 and 30 m.p.h.

Wind direction never remains absolutely steady either and even with normal wind the vane may move rapidly between two or three main compass points. For example, with a generally West wind the l.e.d. indicators may show SW and NW frequently together with W. If the dominant indication is West, then this will be the main direction.

FURTHER INFORMATION

Bona fide applicants, such as school teachers, students engaged in weather studies, colleges, etc can usually obtain all kinds of information on weather and weather forecasting, quite free from the Independent TV companies' weather departments and you might also like to try your local Meteorological Office weather station, whose address is usually in the telephone directory. ⌑

Everyday News

CHALLENGE OF THE CHIP

The chips are down at the Science Museum and they're there for all to see! Over 200 microprocessors are on show, some working, in an exhibition on the first floor of the Science Museum, London

Aimed at showing the present and future possibilities of the chip in everyday life, this is an exhibition that tells the story from the beginning through to displays of applications of the very near future. It deals with the invention, development, and applications of the transistor, integrated circuit and the methods by which they are made on a minute scale.

Electronic games and toys take up a large section of the exhibition. This is because most people come into contact with microchip technology through these and therefore they come to terms with them more easily than just looking at a piece of technical equipment.

A large number of manufacturers and suppliers have contributed objects and equipment for display. The aim is to attract as many people as possible to this free exhibition. To this end special evening openings are being held to enable staff of industrial and commercial organisations to attend at their leisure.

Super Market

One exhibit, that of a supermarket checkout point, is manned and the continuous demonstration shows just one application of the chip together with laser technology.

Each item "purchased" is passed over a window instead of the assistant lifting the item up to read the price. A laser beam scans the window until it reads a barcode (thick and thin black lines printed onto the packing of the item purchased), the information is fed to a microcomputer in the cash register automatically.

The printed bill gives details of the item: the price, an abbreviated "title" for each purchase i.e. B.FAST CEREA for Corn Flakes (a breakfast cereal). The bill is totalled after the assistant touches the total button or touchplate. They then enter the amount of money tendered, the printout gives the amount of change due, the till drawer opens, when it closes the date and time of purchase prints out and a receipt number and message appear "THANK YOU, CALL AGAIN".

Another very interesting exhibit, contributed by Marconi Avionics, is a large model of an advanced fighter plane of the future, demonstrating the role of the microprocessor in "tomorrow's" military and civilian aircraft.

This is an exhibition that is a must for everyone. The whole family will find something of interest and fun in its presentation. Due to run until "at least the end of the year" it will be interesting to see how many items stand the pace of continuous use.

Audio Agreement

A step forward to industry standardisation in digital audio discs has been made by a new agreement between Sony and Philips who are already in agreement on compatible video discs.

The audio discs will use 16-bit encoding on a 12cm disc and will be single-sided with a playing time of one hour. The discs play through an optical laser system with no wear on the disc.

TX9 Exported

The new and highly successful Thorn TX9 TV chassis has attracted world-wide attention. An agreement recently signed allows the TX9 design to be assembled from kits of parts in Hong Kong and China. Similar agreements have also been made with electronics companies in Italy and Scandinavia.

VDU's Cleared

Anxiety about health hazards from visual display units has been largely dispelled in a report from the VDU Eye Test Advisory Group.

The report claims that there is no significant radiation hazard and that complaints of strain arise from method of use of the equipment and not the equipment itself. The report, however, urges the need for regular checks of the eyesight of continuous users.

Computer manufacturer LogAbax has estimated that computers are being installed in the UK at a rate of 400 a week, mostly to small or medium business users.

NEWSPAPER by Satellite

The *New York Times* is sending facsimile pages by high speed satellite data link to Chicago for local printing. Two pages are transmitted every 2½ minutes through unattended earth terminals at each end using 10 metre diameter dishes.

. . . from the World of Electronics

—ANALYSIS

TWO WORLDS

The electronic hobbyist soon acquires a good knowledge of what's happening and what's new in consumer electronics. He or she gets full exposure to component and kit availability through electronics constructor magazines such as EVERYDAY ELECTRONICS. The lastest in ready-mades can be seen in every shopping centre. Whether we buy or build our equipment it ends up in our homes and, in the jargon of the economist, we are all members of the consumer electronics market.

Less well known to the hobbyist is the other world, that of electronic capital equipment also sometimes called "professional" electronics. This world is largely hidden from the public although we benefit daily from it.

The world of electronic capital equipment embraces the radio and TV transmitters and studio equipment, the radars and other navigational equipment that speed us on our holiday flights, the computers that remind us of our bank overdraft, the police radio network which helps preserve law and order, the industrial automation keeping industry going, and defence electronics which helps maintain peace.

Electronic capital equipment design and manufacture is a success story that is overlooked by the media who much prefer to report the failures of steel or shipbuilding, or industrial unrest. This industry is producing £1,500 million worth of equipment and systems a year and selling it profitably. About one third of the total is exported and after deducting imports in the same categories there is a surplus of £140 million in overseas trade balance.

The workforce of some 100,000 people is increasing yearly despite the fact that i.c.s have reduced labour content in the finished product. Another big plus factor is the level of enthusiasm in the industry and consequent lack of disputes. After all, everybody knows they are backing a winner and don't want to see it nobbled when order books are at their best ever levels.

There is only one snag. The sky would be the limit but for the fact of a chronic shortage of engineers and technicians. This is where the hobbyist can help while, at the same time, promoting his or her own interests. Anyone who understands the fundamentals of electronics can carve a career in an industry in which there is virtually no limit to growth. The jobs are there waiting to be filled and providing you are keen (which most hobbyists are) and know your basics the firm will help train you.

It's worth thinking about.

Brian G. Peck

USA Buys British

Multi-million pound orders have been received by Redifon Simulator Ltd for flight simulators for the new generation Boeing 757 and 767 jet aircraft for the United States.

Britain's aerospace industry, which has a large electronics content, is having a record year with exports targeted at £1,500 million. Over 50,000 trade visitors from 100 countries will attend the Farnborough Air Show in September.

Teletext in Print

The Department of Industry has just published a leaflet on "Teletext" as part of a campaign to make the public more aware of the TV information service in which the UK leads the world—who said the printed word was on the way out?

Copies of the Teletext leaflet are available free from MAP Information Centre, Freepost, Dept of Industry, Room 114, Dean Bradley House, 52 Horseferry Road, London SW1 2BR.

WORRIED UNION

The Post Office Engineering Union is reported as "being worried" over the implementation by the BPO of the new System X digital telephone network, the first exchanges of which will enter service this year. Reason for Union concern is System X reliability of a measured call failure rate of one in 10,000, needing a staffing of only one technician per 10,000 lines, far fewer than at present.

In Union eyes System X is far too good. Subscribers, however, will welcome the improved reliability.

SOLAR TELEPHONES

British company Lucas Energy Systems has won a £1·2 million contract for solar panels to power a rural telecommunications network in Colombia. Sun power will be converted to 100kW of electrical energy through 2,550 solar panels distributed throughout the network.

This is believed to be the largest single order ever taken in this area of solar panels and was won against fierce competition from the USA, Japan and France.

Japan's JVC and Britain's Thorn EMI are joining forces in the video disc business. The new tie-up will challenge RCA and Philips for dominance in the market place.

All three manufacturers have different proposed systems with none so far recognised as an industry standard.

Electronic Translation

The EEC Commission is reported to be investigating schemes for electronic translation between the six official languages used daily by the 7,000 civil servants in Brussels.

Automatic translation from one language to another would ease the task of, if not dispense with, the present force of highly paid translators.

GOLD STANDARD

One of the measures of health in the electronics industry is gold consumption, used in high quality components and assemblies. The UK industry doubled its gold intake during the past year to a value of £60 million, fourth highest of the electronics producing nations with only the USA, Japan, and Germany ahead in the gold usage league table.

The prospect of a flat "hang-on-the-wall" TV receiver is still a dream of the future according to speakers at a recent IEE colloquium on the topic. Except, that is, for tiny screens. For the foreseeable future the conventional c.r.t. will remain on top.

Underwater Colour

An underwater colour TV camera for deep sea (up to 2,000ft) inspection of structures has been developed by Marconi Avionics. Special signal processing brings out colours which otherwise are obscured by sea water and can reveal information vital to safe maintenance.

The camera is housed in an anodised aluminium housing similar in specification to that used on naval torpedoes. It can be hand-held by a diver or operated by remote control.

RADIO WORLD

By Pat Hawker, G3VA

Electronics and reliability

Over many years, industry has been striving to overcome the feeling of many of the public that complex electronics equipment, although capable of doing many wonderful things, can still prove to be rather unreliable, particularly when it is used in hostile environments.

Semiconductors rather than glass valves have done much to improve matters, although, it could be argued, better packaging and materials research have done even more. It was said, for example, that over 90 per cent of the early radar cathode-ray tubes arrived overseas during wartime in a damaged or broken condition due to bad packaging.

The need to put equipment into packages capable of being launched into space and working unattended for from five to seven years has led to intensive work on discovering and overcoming failure mechanisms, and this has had a valuable spin-off throughout the industry. In the past decade, the number of service calls to the domestic colour TV set has dropped, on average, from over four per year to less than one.

But the 1980 *Observer* single-handed Atlantic yacht race cannot have done this image any good. Much was expected of the French *Argos* automatic position-reporting-via-satellite equipment that had performed well during some earlier events. But this time, using new deck-mounted equipment, more than 30 of the units failed within a matter of days.

According to preliminary reports this seems to have been due more to the redesigned plastics casing than due to the electronics. Instead of flexing, the plastics apparently stiffened and cracked in the presence of salt water, letting the highly conductive sea water reach batteries and electronic circuitry; so it now seems a case of "back to the drawing board".

This again emphasises a very old rule: mechanical engineering remains a vital part of good electronic engineering.

The UK domestic environment is much kinder to electronic equipment than is the case in many parts of the world—and very much kinder than any form of mobile service. One still hears complaints that "tropicalisation" is less effective than it might be when up against the combined onslaught of heat, humidity, dust and insects; semiconductors, on the other hand, have a particular dislike for low temperatures.

Printed circuit boards still give trouble, including those elusive hairline cracks and the peeling off of the copper; carbon 'pots' dislike moisture; rubber, springs, push-button switches etc can deteriorate rapidly in the tropics. The thin wires found in many receivers are vulnerable to hard use, while connectors, plugs and sockets and the like are all too easily damaged when used under field conditions.

Another problem is that while, for example, modern large-scale integrated circuits can form effective multi-channel synthesisers for hand-held equipment, the power they consume is considerable, particularly where dry batteries are stored at unsuitable temperatures.

CB at the crossroads

As someone entirely sympathetic towards the concept of an "Open Channel", it is possible to understand why the frustrated CBers feel that only by keeping up constant pressure on Parliament, the Home Office and the media are they likely to live long enough to receive more than promises. But it has to be said that much of their "propaganda" is undoubtedly over-pitched and by no means easy to justify.

This could rebound on the movement in future as a similar (successful) campaign did in Australia a few years ago. Neville Williams, editor of *Electronics Australia* makes this clear in a trenchant editorial "CB radio is at the crossroads" in a recent issue of that magazine. It seems well worth quoting, if only as a warning:

"In 1977, with much fuss and fanfare, citizens band radio in Australia was legalised. On the one hand, the move was seen as a victory for human rights and free speech; on the other an opportunity for numerous companies to make a fast buck. For a while, CB was very much the "in" thing.

"But within 12 months, the scene had changed. For many, the fast buck dream had turned into a nightmare. And the platitudes about human rights and free speech had been buried under an avalanche of everything from jargon to obscenity. From being a "cause", CB became the target for widespread ridicule.

"Massive desertions from the ranks of licensed CBers followed, including at least two groups which the CB movement could ill afford to lose. One such involved many of the original human rights, free speech campaigners who had seen in CB a potential means of exchanging informed opinion on many subjects; they hadn't counted on the high level of adolescent ambient!

"The other group included people with an evolving interest in the technology of communication. Many such have moved into the ranks of amateur radio and have adopted the accepted manner and mores of the amateur fraternity.

"A large proportion of those who remain are not really CBers at all; they have no licence, no inhibitions about equipment, power, channels, or the way they use those channels. Ultimately, the Government will have to crack down on them and a recent prosecution in Sydney may provide an advance sample: a $A1,000 fine, plus costs, plus confiscation of all equipment."

Letters of Authority

So while the long-drawn-out controversy over CB rumbles on, with ever wilder estimates of the number of "illegals" or pirates using 27MHz CB equipment in the UK (between 150,000 and 200,000 according to some sources though about 15,000 to 25,000 seems a much more likely figure for regular users), less is heard about the "legal" use of 27MHz in the UK for radio-paging and model control.

I gather there are some 5,000 licences or "Letters of Authority" for radio-paging systems, plus as many again for inductive-loop systems. Since each system represents an average of about 20 pocket receivers or "bleepers", total users of both types of system must now amount to over 200,000. There are some 23,000 subscribers to the Post Office radio paging systems which opened in 1973 in the Thames Valley area and in 1976 in the London area, with plans to extend this nationwide.

Many of these systems operate on v.h.f. or u.h.f. and on 27MHz the systems are for "bleeping" only, on other bands systems may include talkback, "talk through" (ability to speak to another pocket set user via the control unit) etc, although the regulations are currently being changed so that systems providing speech facilities will be known in future as "local communications networks" as an intermediary category between "paging" and "private mobile radio".

Government-funded organisations are not "licensed" but operate under a "Letter of Authority" issued by the Home Office.

Licences for 27MHz radio control of models have long been available in the UK although for some reason or other the authorities have not been prepared to issue licences covering the garage-door opening systems long popular in the United States.

Radio Control

A consumer boom in radio control of models is expected in the United States following the introduction of new special-purpose integrated-circuit devices by National Semiconductor Corporation. These, it is claimed, will make it possible to build complete, multi-channel, proportional-control systems with an operating range of about 100 metres for a small fraction of the cost of current designs.

Tail-pieces

An American study suggests that watching television now occupies more waking hours than any other activity except work (43 hours per week for the typical household) based on a survey of 309 urban and suburban homes.

The recent revival by a Russian newspaper of the charge that the BBC external services are used to broadcast messages to secret agents makes one hope that, if this is so, which seems extremely doubtful, then it is conducted more effectively than the famous "personal messages" to the wartime French Resistance, when the vital "D-Day is coming" messages were known in advance to the Germans and could have led to a disaster had not the Germans mishandled the information they obtained from the messages!

Complete Audio/Tuner Kits

Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

Mark III A series	'Reference series' tuner modules	........£171.35 inc.
Mark III B series	'Hyperfi' modules, with switched IF BW, pilot cancel decoder	........£198.95 inc.

A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W-100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works.
Only one version of this item: Complete kit ....£178.25 inc. Carr. £5.

Preamplifier

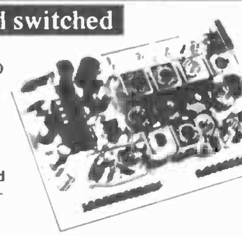
More features and facilities, thanks to DC switching and control design

Previewing the most comprehensive audio preamplifier yet...... DC switching of 7 inputs, plus two tape in/outs. 2 low pass, 2 high pass active filters, genuine volume related loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. Suitable for bus/remote control, tape dubbing, switched monitor etc. 80dB S/N+, THD -75dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Radio/Audio/Communications Modules

LW-MW-SW-SW DC tuned and switched

91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands
MW/LW: £15.58 +1SW £16.73



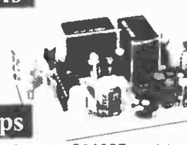
VHF Tunerheads

Europes largest stock range for broadcast and communications. Probably also the world's — details in the catalogues and PL. Specials are also supplied in the region 30-220MHz.

Pilot Cancel PLL Stereo decoders

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output

944378-2
£26.45

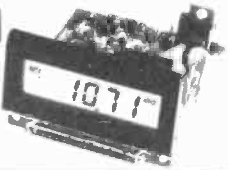


Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system)
Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

Various digital frequency displays

The World's largest range of receiver DFMs is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility. 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75

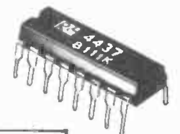


Semiconductors

Radio/Communications ICs

FOR COMPLETE LISTINGS — SEE OUR NEW PRICELIST

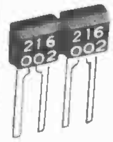
CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16



SL1610	1.84	SL1626	2.80
SL1611	1.84	SL1630	1.86
SL1612	1.84	SL1640	2.17
SL1613	2.17	SL1641	2.17
SL1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

VARICAP DIODES........
A section from our PL:

BA102	0.35	16:1 ratio AM tuning	
BB204	0.41	KV1215 9v triple	2.93
BB105	0.41	KV1211 9v dual	2.01
BB109	0.31	KV1225 25v triple	3.16
MVAM2	1.93	BB212 9v dual	2.25



POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

2SK133	120v N-ch 100W MOSFET	£6.33	2SJ48 Pch complement	£6.33
2SK135	160v N-ch 100W MOSFET	£7.29	2SJ50 Pch complement	£7.39
PA101B	Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)			

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC. 30mW out (amplifyable) -£2.30 inc
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555,NE556, etc

Coming Soon...........

Contain yourselves, RF fans ! Not yet ready for a full launch until autumn, but previewed here:-

SSB transceiver system : 10kHz to 1000MHz !!

A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP. 0.2uV basic sensitivity in HF, Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

Components

Crystal Filters

Most popular types are available ex-stock, and in quantity.

10.7MHz	25kHz Channel spacing 8pole	£16.67
	12½kHz ..	£17.82
	2.4kHz SSB	£19.78
	Monolithic dual roofing filter	£2.30
34.5MHz	1.3dB loss, 80dB stopband HF first filter in synth. RX	£36.80
RC XTALS	FM pairs (no spilts)	£3.74
	AM pairs ..	£3.57
USB/LSB	Xtals for 10.7SSB filter	£2.88 ea

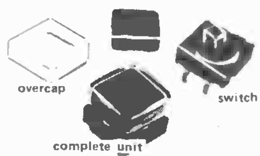
Piezo Sounders

The most efficient warning sounders yet

The latest thing in electro-acoustic efficiency. 1mA of drive from CMOS will give an SPL of 83dB - 10v RMS drive from CMOS uses 3mA for 100dB SPL at 4.8kHz (88dB at 1.65kHz)
The data sheets shows various drive circuits, and give full specifications with regard to broadband responses and power consumption etc. 1 off 44p inc. 100 off 28.75p (25p ex vat)

Keyboard switches and caps

From the world's most widely used switch manufacturers - ALPS - come the biggest and best range of keyswitches, and data entry keyboard switches. The SCM81101 is shown here, with the KT5 2-part cap (with clear top, to enable easy fitting of your chosen legend. Other types are available with built in LED, 90º mounting etc.
SCM81101 : 17p, KT5 : 16p - or 29p/pair



LCD CLOCKS
LCD DVM

Clocks use 1.5v at 15uA only DVM 9v/1mA

CM161: 7mm LCD 12/24hr, alarms etc £11.44 each
CM172: 13mm, 12hr, alarms,timer etc £14.32 each
CM174: 13mm, 12hr, min/sec stopwatch £14.32 ea
DVM 176: ICM7106 based LCD 3½digit £22.36 each

WHAT's NEW at AMBIT

NEW PRICELIST/SHORTFORM:- 28 pages, FOC with A5 SAE pse

Bigger print than our recent one page list - and vastly extended

If you still need convincing to invest £1.60 in the cats, be mean and get this first.

POWER MOSFET APPLICATIONS HANDBOOK by HITACHI :

£1.50 each - or free with pairs of HMOS and the PA101B.

Everything you should know about HMOSFET devices theory and applications.

Please send an SAE with all enquiries. Phone orders by ACCESS - but minimum £5 Callers welcome

CATALOGUES, 60p ea - all three for £1.60
PRICES SHOWN HERE INCLUDE VAT

ambit
INTERNATIONAL

CWO PLEASE - Commercial MA terms on application
Goods are offered subject to availability, prices subject to change - so please phone and check if in doubt.

Parts 1-3 AMBIT catalogues 60p ea, or £1.60 the lot.

200 North Service Road, Brentwood, Essex

TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG

LIGHTS FAILURE MONITOR

By C. R. BIRRELL

ONE OF the more insidious equipment breakdowns that plague the motorist is that of bulb failure. Often he will not notice until he either makes a special check (which should after all be carried out weekly) or he is stopped by the police, and we need hardly quote the old adage that ignorance of the law is no defence.

The device described here gives continuous monitoring of all external lighting equipment apart from the direction indicators and will give an instant warning should one of the bulbs go open circuit in use.

When failure of a monitored light bulb occurs, a corresponding l.e.d. illuminates at the same instant on a display unit installed inside the car.

CIRCUIT

Although the circuit may look a little daunting at first, closer inspection reveals that it consists of ten individual identical sections plus a test facility.

Fig. 2 shows the complete circuit and it should be noted that each of the boxes *A* to *J* contain the same circuit network which is shown in Fig. 1.

At this point we should point out that the components are numbered in a slightly novel way in that all components associated with each box have the letter of that box after their reference number.

For example the transistor in box *C* is referred to as TR1*C* or the l.e.d. in box *H* is referred to as D2*H*, and so on.

Let us take circuit *A* for the moment. This is monitoring the offside front side-light. The monitoring circuit is so arranged that there is a diode D5*A* in circuit between the bulb and its switch.

Consider Fig. 1. Suppose the light bulb is operational. When the switch is closed, a current will flow through the silicon diode D5*A* and the light bulb.

A voltage of 0·7 volts is dropped across the diode. This voltage is large enough to provide the germanium transistor TR1 with sufficient base bias to switch it on.

In this mode TR1 acts as a short circuit across the l.e.d. D2 thus preventing it from lighting up.

OPEN CIRCUIT

Let us take another case, this time with the bulb open circuit. When the switch is closed, current will not be able to flow through the diode. Hence the voltage across the diode will fall to zero and the transistor will switch off.

Of course there will no longer be a short circuit across the l.e.d. so it will light up indicating that the bulb has failed.

A further point should be made that when the light switches are off, then no current will flow into the sensing network at all so the unit is in effect switched off.

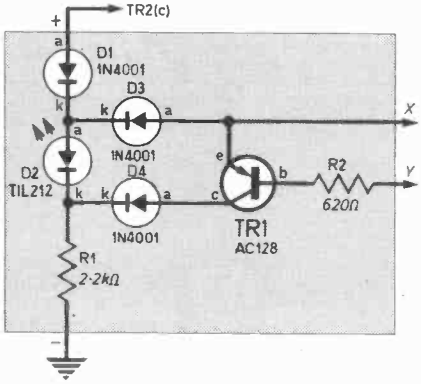


Fig. 1. Circuit diagram of one of the sensor modules of the Lights Failure Monitor.

COMPONENTS approximate cost £9·00

TEST FACILITY

No monitoring unit is completely free from failure in itself so a test facility is provided to make sure that all the l.e.d.s are functional.

Essentially we have a line that feeds every l.e.d. via diode D1. When we wish to test the system, the base of TR2 is grounded via R3. This switches on TR2 which allows current to flow through every l.e.d. in the system and light them all up.

It is then very easy to spot a faulty indicator. Diodes D1 are necessary to prevent current flowing back down the test line when it is not being used.

NEGATIVE EARTH

As can be seen from the circuit diagrams in Fig. 1 and Fig. 2, this unit has been designed for a negative earth system.

Fortunately nearly all new cars are built this way. However modifying this circuit for the older positive earth system poses several problems mainly because of the fact that the current flowing through the bulbs is going in the opposite direction.

In fact modification would involve changing the design of each boxed module, not to mention redesigning Fig. 2 so the author has decided to restrict himself to a negative only version.

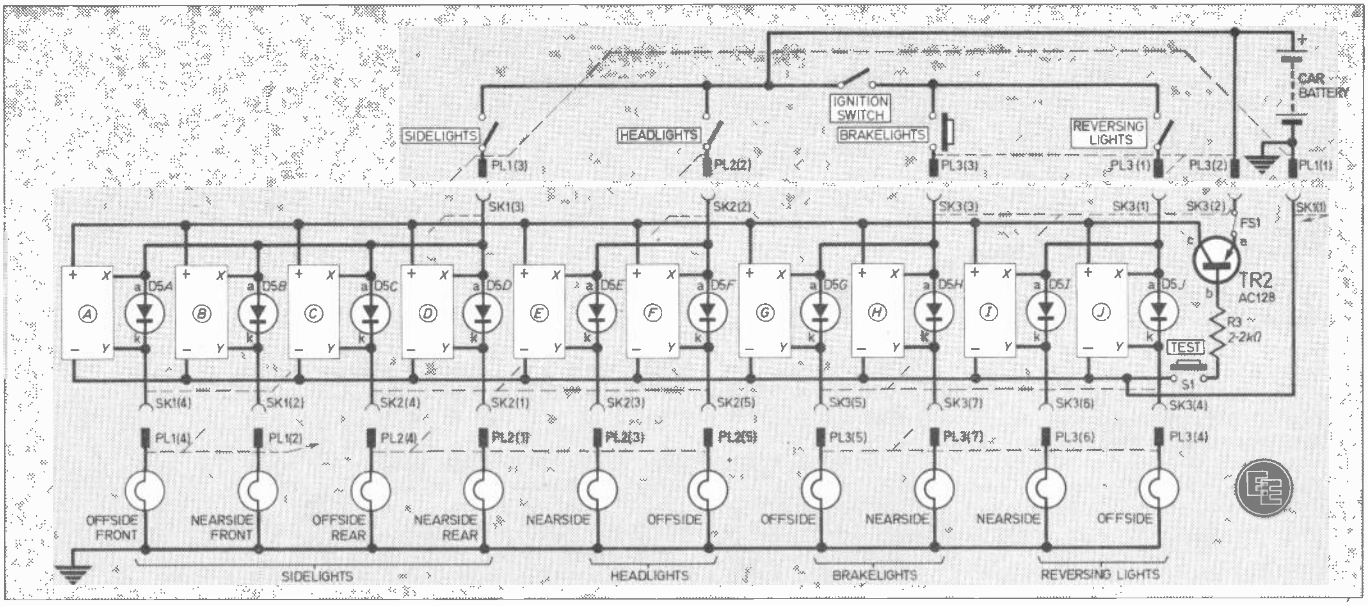


Fig. 2. Complete circuit diagram of the Lights Failure Monitor. Note that each lettered box contains the circuit elements from Fig. 1.

CONSTRUCTION starts here

CIRCUIT BOARD

The main part of the Monitor is built on a piece of 0·1 inch stripboard, 37 strips by 14 holes and the component layout is shown in Fig. 3.

Straight away it can be seen that the spacing between components is very close so some care will be needed in construction.

The board should first be prepared by making all the breaks in the copper strips. This can be done using a spot face cutter or small twist drill.

When this is completed solder the resistors and diodes in place. It is necessary to do this first because the wire links must fit around these components and in fact these can be put in next.

FINISHING OFF

The board is finished off by soldering in the transistors, fuse clips and lead-off wires.

Readers will notice that the l.e.d.s are wired straight onto the board. Make sure that you leave long enough leads so that they will fit into their holders in the case.

In the prototype this meant bending the leads through ninety degrees so that they would slot into their holders in the side of the case.

CASE

The circuit board is mounted in a plastics box 112 x 62 x 30mm. This should first be drilled and cut to accept the three sockets, test switch and the ten l.e.d.s.

This involves marking up the side of the box with the correct drilling dimensions and making the holes, preferably with a hand drill. Larger holes can be made by making a small hole and opening it out with a file.

The sockets and switch are then fastened in position and the clips for the l.e.d.s pushed through their respective holes.

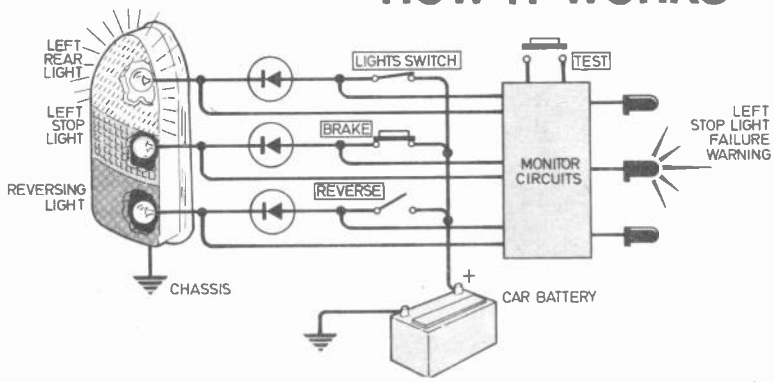
INSTALLATION

Before attempting to install the Monitor, study the diagram in Fig. 4 very carefully.

The main task is to insert the diodes D5*A* to D5*J* in series with the power cables from the light switch to the bulbs. This involves finding the correct wire that feeds each bulb to be monitored and reference to your car manual may be necessary in order to work out the colour code of the individual wires within the vehicle's wiring harness.

The most convenient way to install the diodes is to insert them between

HOW IT WORKS



A diode is connected in series with each light bulb to be monitored and the voltage drop across each diode is also monitored.

If the light bulb is working, a current will flow through the diode which will keep the l.e.d. in the display unit turned off.

If the light bulb is open circuit then no current will flow and the l.e.d. will turn on indicating where the fault lies.

LIGHTS FAILURE MONITOR

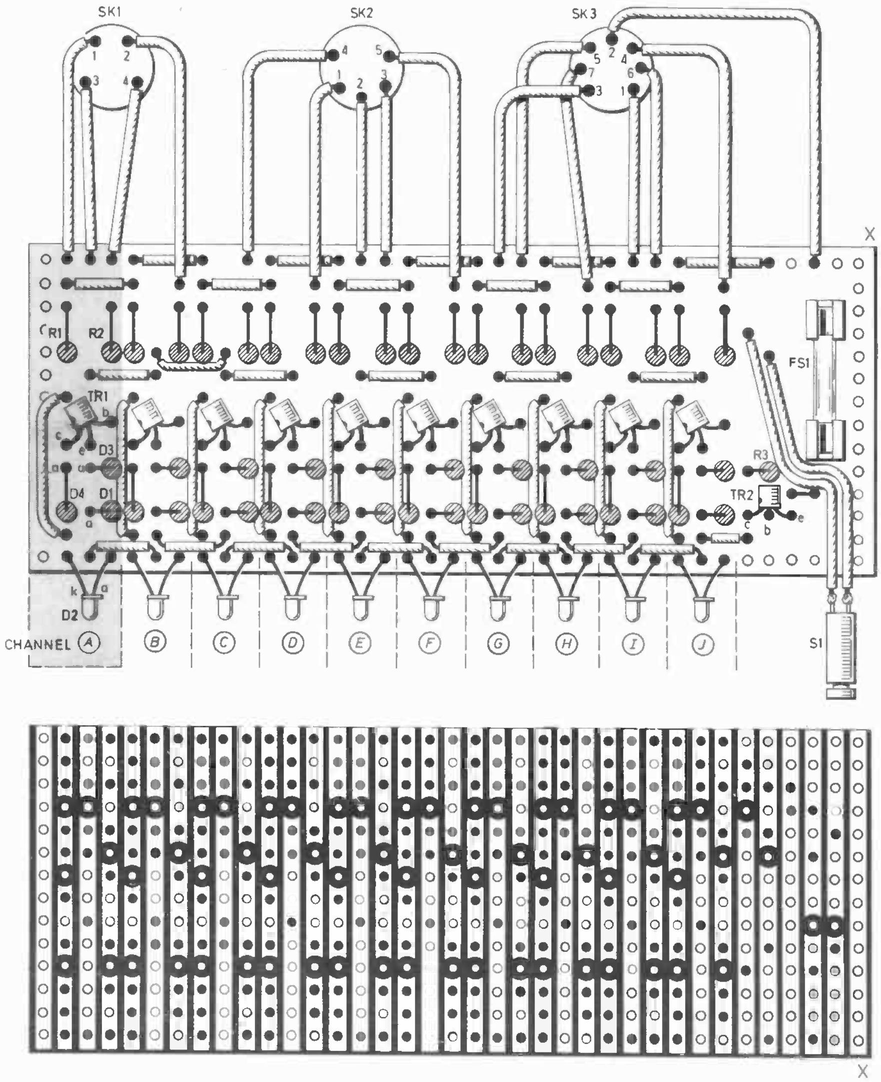
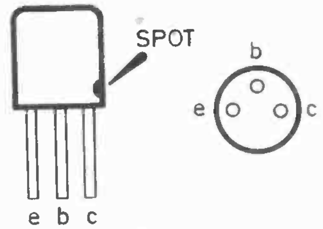
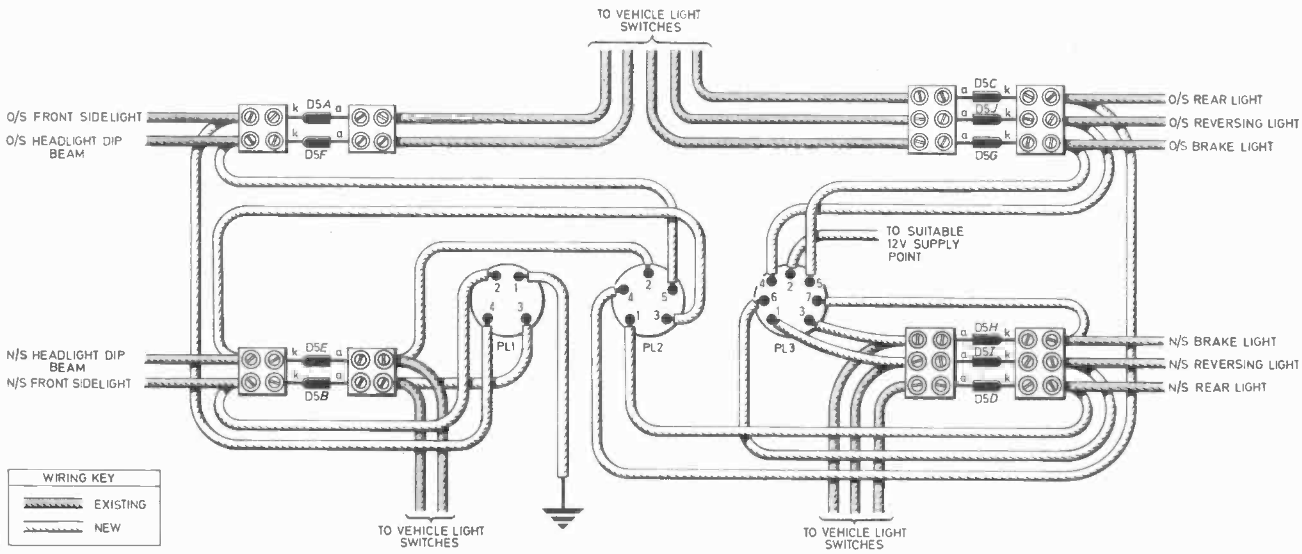


Fig. 3. Circuit board layout for the display unit. The cathodes on the l.e.d.s may be identified by a flat on the casing next to the cathode lead.
It can also be seen that only one channel has been fully labelled. Each channel is identical and their layouts are exactly the same.



AC128 LEAD IDENTIFICATION

Fig. 4. Wiring diagram for installing the unit in the vehicle. The new and existing wiring can be seen clearly. Note that the contact numbering on the three plugs corresponds with the pin numbering on the sockets in Fig. 3. Care must also be taken to ensure that the correct diodes are used for D5*E* and D5*F*.



COMPONENTS

Resistors
R1*A-J* 2·2kΩ (10 off)
R2*A-J* 620Ω (10 off)
R3 2·2kΩ
All ¼W carbon ± 5%

Semiconductors
TR1*A-J* AC128 *pnp* germanium (10 off)
TR2 AC128 *pnp* germanium
D1*A-J* 1N4001 small signal silicon diode (10 off)
D2*A-J* TIL212 yellow l.e.d. including clips (10 off)
D3*A-J* 1N4001 small signal silicon diode (10 off)
D4*A-J* 1N4001 small signal silicon diode (10 off)
D5*A-D* 1N5400 3A silicon diode (4 off)
D5*E-F* BYZ13 6A silicon diode (2 off)
D5*G-J* 1N5400 3A silicon diode (4 off)

Miscellaneous
S1 push-to-make momentary action switch
PL1 4-pin DIN plug
PL2 5-pin 240 degree DIN plug
PL3 7-pin DIN plug
SK1 4-way DIN socket
SK2 5-way 240 degree DIN socket
SK3 7-way DIN socket
FS1 500mA 20mm cartridge fuse
Plastics case, 112 × 62 × 30mm; 0·1 inch stripboard 37 strips × 14 holes; two-way screw terminal block (2 off); three-way screw terminal block (2 off); connecting wire.

See **Shop Talk** page 553

two terminal blocks and use the terminals at the opposite end of the blocks to connect up the severed ends of the wire. Fig. 4 will make this clear.

As each different vehicle has a different wiring harness, it is impossible to give precise details as to where you should cut the lighting cables and insert the diodes. However you should try to do this as close to the proposed site of the display unit as possible, and far away from any possible sources of damp.

Once all the diodes have been installed the wires that lead to the display unit can be attached as in Fig. 4. These should be terminated with the appropriate DIN plugs. An earth and positive supply should also be installed.

SYSTEM TESTING

At this stage the system can be tested. Plug the three DIN plugs into their appropriate sockets on the back of the display unit. When the test button is pressed all the l.e.d.s should light up.

Each individual circuit should be checked next. To do this, loosen or remove each monitored bulb in turn. When the relevant switch is activated in the car, the corresponding l.e.d. should light up indicating that the circuit is faulty (in fact we have simulated an open circuit bulb).

As soon as you are satisfied that everything is working properly, the terminal blocks should be insulated, for example by binding with p.v.c. tape, and then fixed securely in the car.

The display unit can be finished off by labelling the indicator l.e.d.s using Letraset or other self adhesive transfers and then the display unit can be firmly attached to the dashboard or other suitable location inside the vehicle. ⌘

---

in My Class

by
T.R. de Vaux-Balbirnie

ANDREW was gazing into the large compartmented drawers which we had adapted to carry our stock of resistors. The thing which struck him was the apparent "silly values" to be found—390, 470, 560 ohms and so on. He asked why the values did not run—350, 400, 450, 500 and simplify the whole business. He argued that calculations would be much easier that way and I agreed.

I told him that these were called "preferred values" and that I would talk to the whole class about them.

I told them that we were talking about ordinary carbon resistors with 10 per cent tolerance—they are allowed to be up to 10 per cent higher or lower than their nominal value. These are cheap components and good enough for most purposes. A 100 ohm resistor could, for example, have an actual value of anything between 90 and 110 ohms.

I showed, with the aid of a diagram, that when the tolerance is taken into account, the preferred values just about cover all values. Naturally, the family of 5 per cent resistors will have its own set of preferred values.

There would be little point, I told them, in making a 200 ohm resistor if this value was covered (just about) by the upper limit of a 180 ohm (198 ohm) or the lower limit of a 220 ohm (198 ohm) resistor.

I went on to tell the class that when the actual value of a new carbon resistor is measured it is often surprisingly close to the nominal value—perhaps within 2 per cent—but it will not always stay that way. In service, its value "drifts" and if it is subject to mis-use it may easily go outside its 10 per cent limit. Hot running was one particular cause to be avoided.

WORKSHOP MATTERS

By Harry T. Kitchen

R.F. Sources

A few months ago (May) we looked at audio frequency signal sources, and this month I want to extend the frequency range to cover radio frequencies.

Such sources are invaluable whilst trouble-shooting or designing equipment, and again we have a very wide specification/price spectrum. The latter figure can range from a few tens of pounds for the very basic sorts of oscillator, to × £100 and even more for the precision signal generator. Your ambition must therefore be tempered by your pocket!

Oscillators

The term "oscillator" is used to describe a signal source where neither frequency or output voltage is closely controlled, (though advertising literature would often have you think otherwise). Such instruments comprise, essentially, (in the older type) two-separate valve oscillators, one for the radio frequency, the other for an audio frequency with which the former is modulated.

In the modern version oscillator, we usually have two transistors which fulfill precisely the same functions.

Modulation, incidentally, is the process of causing the *amplitude* of the radio frequency to vary at the same frequency as the audio frequency. Demodulation, at the receiver, consists of removing the radio frequency, leaving us with the audio frequency.

The process of modulation in such a simple oscillator consists of varying the voltage supplied to the r.f. oscillator at the required a.f. frequency. Thus, when the voltage is at its maximum, the r.f. oscillator oscillates more vigorously then when the supply is at its lowest level.

There is very little control over the "depth" of modulation, and the output voltage is extracted from the oscillator stage, possibly via a secondary winding on the oscillator coil.

The output control is a glorified volume control used for potting down the output voltage. As it is closely coupled to the oscillator varying loads will affect the frequency as well as the actual output voltage. Such an oscillator cannot be seriously considered for precision work, but within its limitations it is a useful tool.

Signal Generators

We come now to the precision brigade, instruments that are entitled to the description signal generators, and our pockets must not only be very deep but also very well filled.

Signal generators should be capable of providing an accurate and stable frequency; accurate and stable output voltage; a means of setting the output voltage to a pre-determined point on an output meter so that the precise output voltage from the attenuators can be determined, should be capable of being set, and reset to any pre-determined frequency and voltage; should have variable modulation depth; zero leakage; zero f.m. on an a.m. signal. A formidable list, justifying the high cost. Let us look at some of these items in greater detail.

The stability of frequency and output voltage will be clear, as will the requirements of setting, and resetting, accuracy. What of variable modulation depth, zero leakage, and zero f.m. on a.m.?

Modulation Depth

Earlier we saw that the r.f. signal is modulated by the a.f. signal and thus varied in amplitude at the frequency of the a.f. signal. Theoretically it is possible to achieve 100 per cent. modulation where the r.f. signal varies from zero, when the a.f. signal is zero, to a maximum when the a.f. signal is at its peak.

In practice this is difficult to achieve since the modulating device, valve or transistor, cannot be completely saturated to achieve zero output, nor completely cut-off to achieve maximum output.

The normal, everyday, modulation depth is 30 per cent, and the modulating frequency is typically 400Hz or 1kHz, with provision for an external modulation frequency of variable depth. A variable modulation depth is essential for checking for detector distortion in receivers, and for this reason purity of the modulation signal is important.

Zero Leakage

Zero leakage is impossible to achieve, but certainly the leakage of the oscillator frequency should be extremely low. If we are, as is sometimes necessary, measuring receiver sensitivity at the microvolt level, then even a very low leakage via the mains lead, which after all can act as a transmitting aerial, can invalidate our measurements.

The signal generator must be a box within a box; the oscillator contained in a leak-proof box, within the main cabinet. Mains input must be meticulously filtered to prevent the egress of the oscillator frequency.

For precise attenuation the various stages must be isolated from one another so that there is no possibility of the oscillator frequency getting out other than by the designed method.

Zero F.M. on A.M.

So far it has been accepted, albeit tacitly, that we are discussing a.m. oscillators and generators only. The presence of an f.m. signal on what should be a purely a.m. signal can be embarassing when measuring receiver selectivity.

Let us suppose that we are working at 1MHz, and that the generator has a (unwanted) deviation of 25kHz, so that our nominal 1MHz signal is actually sweeping from 975kHz to 1·025MHz. This means that our receiver can be up to 5 per cent inaccurate without us knowing about it, possibly an error of some magnitude, equally possible an error of considerable magnitude.

Fundamental Tuning

Some of the cheaper sorts of oscillator are equipped with an additional scale enabling tuning to be effected on harmonics, whereas proper tuning is effected on fundamental frequencies only.

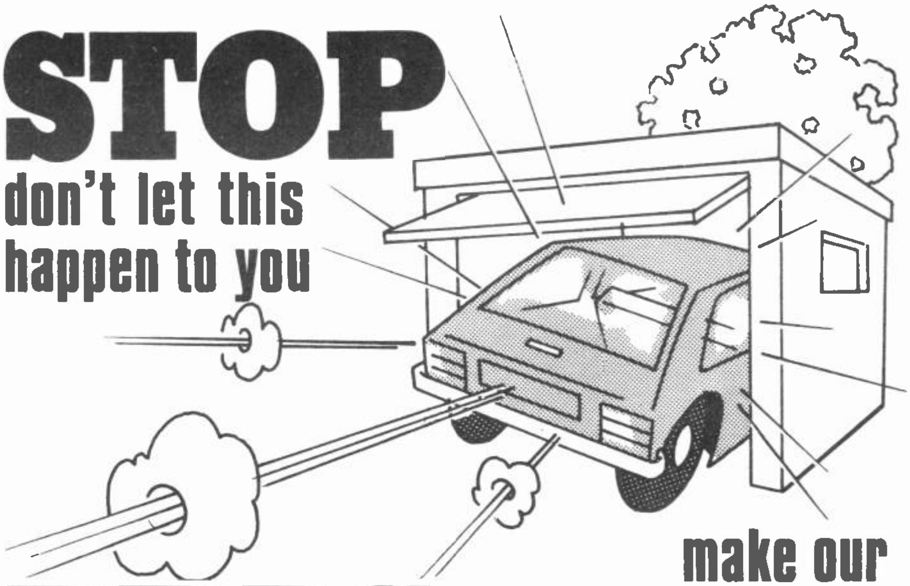
Fundamental tuning, if used as intended, restricts the user to the highest frequency provided. That means if the maximum frequency is 100MHz, then that is as high as you can go—officially. Unofficially you can go higher; using the second harmonic you can go up to 200MHz, the third harmonic enables you to go up to 300MHz, and so on.

This, in my opinion, is an undesirable practice, as it is all too easy to pick up the wrong harmonic, particularly if the frequency calibration is at all inaccurate. The only safe and accurate way is to use a fundamental frequency, though in an emergency it is possible to use the second harmonic and tune to twice the required frequency, that is 88MHz if 176MHz is required.

On harmonics the output signal is reduced, and this can also affect accuracy particularly if an insensitive receiver is involved.

Contributory factors to accurate measurement are the use of cables of the correct impedance to terminate the output from sig-gen's (as signal generators are invariably termed by those "who know") and the use of a dummy aerial. The reasons involve e.m.f. and p.d., and we will look at these in some detail in the next article.

STOP
don't let this happen to you



make our
PRECISION PARKING PAD

By T. R. de Vaux-BALBIRNIE

THE PAD referred to in the title is a block of plastic foam which activates a warning light when compressed by pressure from a car bumper. With this pad suitably placed on the garage end wall and a separate unit housing the warning light, the device will ensure that the car will be parked close to the end wall without the possibility of damage and without assistance. Parking like this is sometimes necessary when the garage is only just big enough for the car or when two vehicles have to be squeezed in.

One feature of the circuit is that it requires no setting for day-to-day use. Nothing need be remembered on approaching the pad—the lamp will always be ready to signal attention. When the time for battery replacement approaches it will be seen that the warning light becomes dim long before the circuit fails to operate altogether.

The most difficult part of the project is not the electronics, which are very simple, but the construction of the pad unit itself. Experimental pads which reduced their electrical resistance when they were squashed were tried but they proved unreliable. A far better solution was found using a reed switch operated by a magnet. As the foam is compressed the magnet approaches the reed switch to the point where it switches on.

CIRCUIT DESCRIPTION

The circuit diagram of the Precision Parking Pad is shown in Fig. 1. When the magnet approaches the reed switch, S2 closes (switches on) and connects the battery to C1. This voltage step is transmitted to the gate of CSR1 triggering it into conduction and C1 continues to charge up through the gate circuit. Once the thyristor has been fired in this way it will continue to conduct even when C1 is fully charged and the gate voltage and current drops to zero.

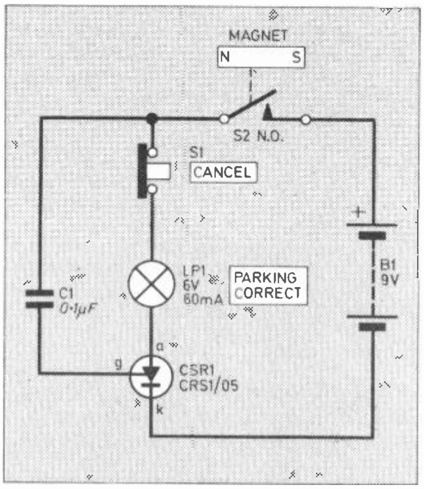


Fig. 1. The complete circuit diagram for the Precision Parking Pad.

When CSR1 conducts the warning light LP1 is illuminated. The operator may cancel the light by breaking the current to the lamp with S1, a miniature push-to-break switch. As C1 is left fully charged it can give no further gate current so the lamp will remain off when S1 is released.

When the car is driven away from the pad, the magnet moves away from S2 and the reed switch opens so cutting off the battery supply to the circuit. C1 will now discharge by leakage within a few seconds and will be ready to operate again as described above. When the reed switch is closed and the warning light cancelled, the only current flowing is leakage through C1 and CSR1. This leakage is so small as to be negligible. The life of the battery should be solely determined by the length of time the warning light is left glowing.

CONSTRUCTION starts here

PAD AND SWITCH

The foam pad itself was a 100mm cube offcut. Perhaps an old cushion could provide a suitable piece of foam or even a cheap car sponge. The magnet was bought from a local hardware shop. Although several types were offered, the kind shown in the illustration proved most effective. Good results will only be obtained with a powerful magnet made from modern materials.

The reed switch is of the normal open type—i.e. it switches on when the magnet is moved near. Two types of reed switch were tried.

The first was about 25mm long and the other about 38mm. Both worked very well but the longer switch proved slightly more sensitive and was finally chosen for the prototype. For testing purposes, a simple battery and bulb test-circuit should be made up with the reed switch placed in

PRECISION PARKING PAD

The completed prototype warning light unit fitted to the garage wall. For convenience, a position close to the drivers side window is suggested. The battery is to be situated between this unit and the pad for easy replacement.

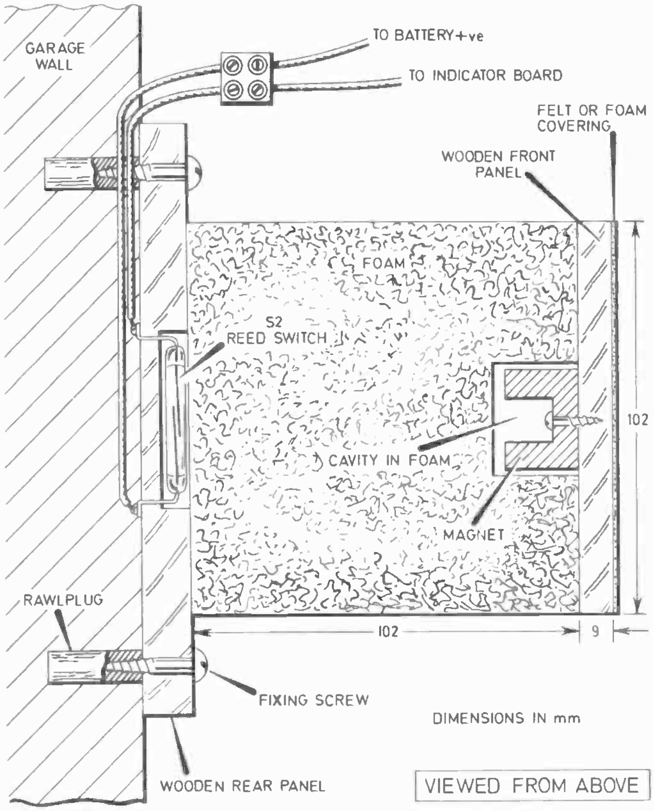


Fig. 3. Cut-away view of the pad assembly showing magnet and reed switch fixing. Note that the horizontal dimension of the foam cube will vary according to the magnet and reed switch used, and will depend on the findings with the test circuit (Fig. 2.).

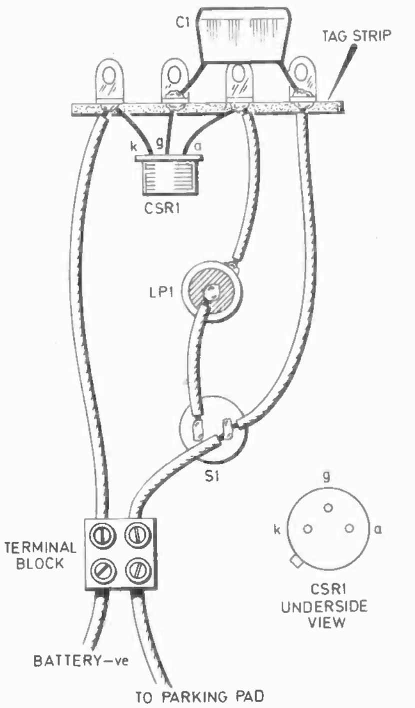
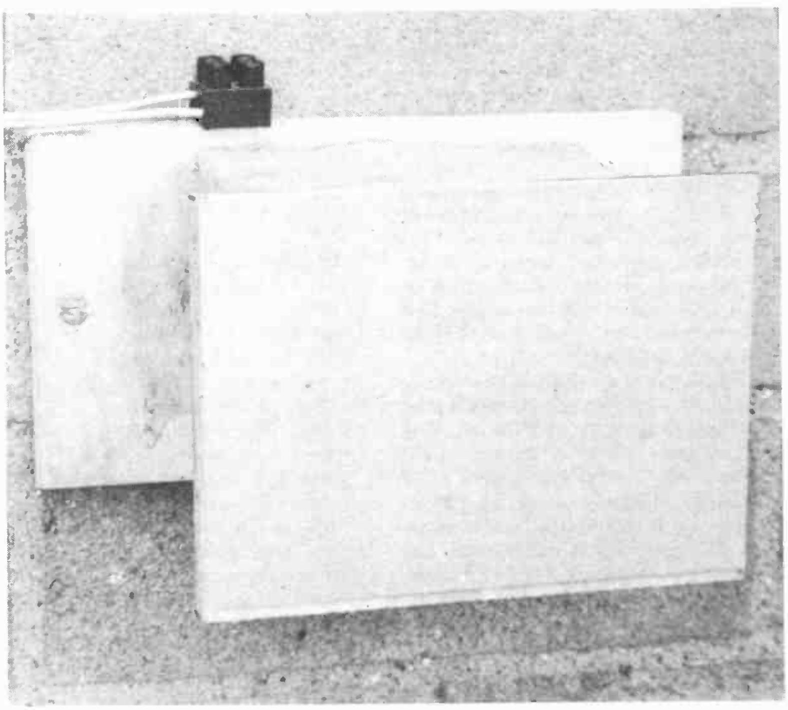


Fig. 4. Circuit construction details. The tag-strip, LP1 and S1 are mounted on the rear face of the blank socket box cover. Care should be exercised when drilling this cover as it is very brittle and likely to chip and crack.



The completed pad assembly securely screwed to the garage end wall at bumper height.

series as shown in Fig. 2. The bulb should light when the magnet is moved to within about 70mm from the reed switch. Careful note of the best relative positions for these two components should be made so that they may be adhered to in the final construction.

The rear panel of the pad assembly was made from 12mm-thick plywood and has a cavity chiselled into it to accommodate the reed switch, see Fig. 3. This protection is necessary as reed switches are very fragile components and could easily be damaged if the pad was carelessly used.

Checks should be made to ensure that even with the foam fully compressed, the magnet cannot touch the reed switch.

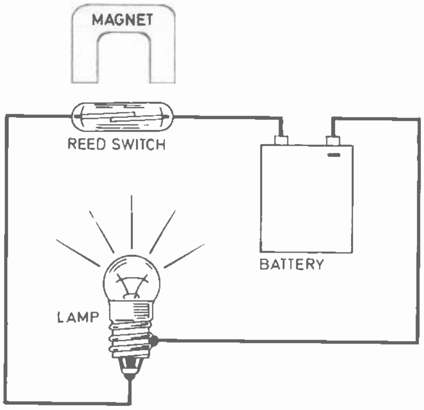


Fig. 2. A test circuit for determining the operating distance of the magnet from the reed switch.

In the prototype, the reed switch was secured by gently bending the end connectors at right angles and passing them through two holes drilled for the purpose. They protruded a short distance through the panel and were then bent over. Soldered connections were then made to them.

The wires leading from the reed switch must be run in grooves cut into the rear of the panel so that they will be protected from abrasion when the unit is finally attached to the wall. The wires lead to a piece of miniature terminal block mounted in a convenient position.

The front panel of the pad assembly was made of 10mm-thick plywood and has the magnet attached to it. The magnet chosen had a handy hole drilled in it so a wood screw was used to attach it. A cavity must be cut in the foam to accommodate the magnet. In the prototype, this was cut using a razor blade. It does not need to be particularly neat as it will be covered up.

The foam is sandwiched between the top and bottom panels using a suitable adhesive. This adhesive must be chosen with care as some have a devastating effect on foam. It is essential to try it out on a scrap piece first.

COMPONENTS

C1	0·1μF plastic or ceramic
CSR1	CRS1/05 or similar 1A 50V thyristor
S1	miniature push-to-break, release-to-make button switch
S2	reed switch with normally open contact
LP1	6V 60mA m.e.s. bulb
B1	9V type PP9 or other, see text

Tagstrip, 4-way; magnet (811); 13A plastic surface mounting mains socket box with plain plastic cover; battery clips to suit; materials for pad assembly; bell-wire; 2-way terminal block (2 off).

Approx. cost Guidance only (see page 553) **£2·50 excluding battery**

When the pad assembly is complete it may be checked by squashing the foam by hand and listening carefully. It is likely that a click will be heard somewhere along the travel as the reed switch operates. When relaxed it should click open again. If the clicks cannot be heard then an electrical test should be made using the battery and bulb test-circuit again (Fig. 2).

COMPONENT ASSEMBLY

When the pad assembly has been checked, the circuit proper may be built. This was constructed on a piece of 4-way tag strip as shown in Fig. 4.

To house the prototype warning light assembly, a standard 13 amp surface mounting plastic box was obtained of the type used for mains sockets. At the same time a plain plastic cover was bought. These items are readily available from electrical dealers. The circuit was mounted on the cover using two small nuts and bolts to hold the tagstrip in place. Holes were drilled for the indicator light and the push-to-break switch. Great care must be taken.

For the indicator light, the prototype used a 6 volt bulb with the connections soldered direct to it. This is the cheapest way and gives maximum brightness. If a neater appearance is required then a proper panel indicator light may be used. Fix the panel-mounted components in place and wire up as shown in Fig. 4.

BATTERY AND SETTING UP

In the prototype, a PP3 battery was mounted inside the box. These little batteries, however, tend to have a rather short life so it is advised that a larger battery be placed outside the case. It should be noted that it is quite in order to use a 9 volt battery to operate a 6 volt bulb in circuits such as this. There is a voltage drop of about 1 volt across the thyristor and there is an additional voltage drop across the internal resistance of the battery.

When the whole project has been constructed a suitable place for the pad assembly must be chosen. Tests should be made to find the best position so that the foam will be squeezed fairly and squarely by the car bumper. When the best position has been found, the unit should be mounted on the wall with two wood screws plugged in the usual way.

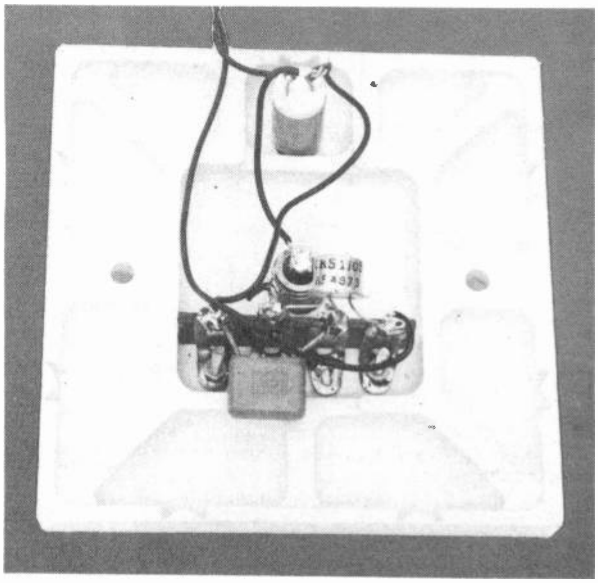
The indicator unit is wired to the pad assembly and battery by means of light-duty twin wire such as bell wire via the terminal blocks. It is best to mount this unit on the wall in such a way that the light can readily be seen from the driving position. If it is placed at window level then the unit may be cancelled before getting out of the car so conserving battery power.

When using the parking pad, the car is driven up very slowly to the pad and stopped as soon as the indicator lamp lights. The cancel button is then pressed.

One final refinement is a felt covering for the wooden front panel. This prevents any chance of scratching the bumper.

In terms of broken light clusters and bent bumpers, this unit should recover its cost in no time! ☐

Completed circuitry on the rear face of the socket cover.



SQUARE one FOR BEGINNERS

STOCKING UP—SEMICONDUCTORS

Two previous articles have been devoted to resistors and capacitors. This month we discuss certain semiconductor devices that should be acquired by the beginner to start a stock of useful components.

DIODES

Diodes are one-way devices—they will pass current only if connected in circuit right way round, that means anode connected to the positive side of the circuit and cathode to the negative side.

Diodes are broadly divisible into four classes: (1) small-signal diodes, as used for detection in radio receivers, and also in logic circuits; (2) power diodes, used for rectifying alternating current; (3) Zener voltage reference diodes; (4) photodiodes and light-emitting diodes (l.e.d.s).

A small quantity of class (1) should be held in stock since they are frequently needed. They are small components and inexpensive. Suggested types and quantities to be held as stock are given in Tables 1—3.

The larger "power" type diodes (or rectifiers) are more expensive and in comparison bulky in size. They are available also as bridge rectifiers—four rectifiers integrated within a package. Power diodes are made in a variety of voltage and current ratings, and are best purchased as required, for some specific purpose.

If a diode is connected in reverse, that is anode to negative side of circuit, the diode will not conduct. Should, however, the applied voltage be sufficiently high, the diode will "breakdown" and conduct. If the voltage subsequently falls below the breakdown value, the device will become a barrier to current flow once again.

This property is exploited in devices known as Zener voltage reference diodes. These are used for maintaining the voltage level or to provide a reference voltage at some point in a circuit.

Zener diodes are made with various "breakdown" voltages; from 2·7 volts upwards. A few Zeners should be held in stock. Those suggested in Table 4 should cover many normal needs.

Light-emitting diodes are becoming increasingly commonplace, replacing filament lamps for signal and indicating purposes in many electronic projects, and it is worthwhile holding a small stock of selected types—see Table 5. The most practical colour is red, but these devices are available in green and yellow also.

Photodiodes are but rarely used and can be disregarded for the present.

TRANSISTORS

Despite the large number of different transistor types, the constructor can cover many of his needs from a very small selection of small-signal, audio frequency transistors.

BC108 is an essential general purpose transistor for the constructor. Closely related types are the BC107 and the BC109, the latter being a low-noise version of the BC108. These three types are available in TO-18 cans.

Another popular general purpose transistor is the ZTX300. This is made in a plastic package, the leads being arranged in what is known as "E line" configuration.

These transistors and a few others are listed in Table 6, which includes in the final ("Qty") column recommended quantities that the new constructor should obtain and hold as initial working stock.

Other types of transistors, including special types such as field effect transistors (f.e.t.s) and unijunction transistors, will be required from time to time, but these are best purchased as the need arises.

INTEGRATED CIRCUITS

Integrated circuits (i.c.s) are now so commonly used that it makes sense for the beginner to purchase a few of the more popular types. We suggest just two types to commence with: the 741 operational amplifier and the 555 timer. See Table 7.

Both of these i.c.s are available in 8-pin dual-in-line packages.

TABLE 1
GERMANIUM SIGNAL DIODES

Type	Max p.i.v.	Current	Qty
OA91	100V	20mA	*4*

TABLE 2
MINIATURE 1A PLASTIC ENCAPSULATED DIODES

Type	Max p.i.v.	Qty
1N4001	50V	*4*
1N4004	400V	*4*

TABLE 3: HIGH SPEED SILICON SWITCHING DIODES

Type	Max Voltage	Max Current	Qty
1N4148	75V	75mA	*4*

TABLE 4
ZENER VOLTAGE REFERENCE DIODES

Type	Voltage	Qty
BZY88	5·1V	*2*
BZY88	5·6V	*2*
BZY88	10V	*2*

TABLE 5
LIGHT EMITTING DIODES

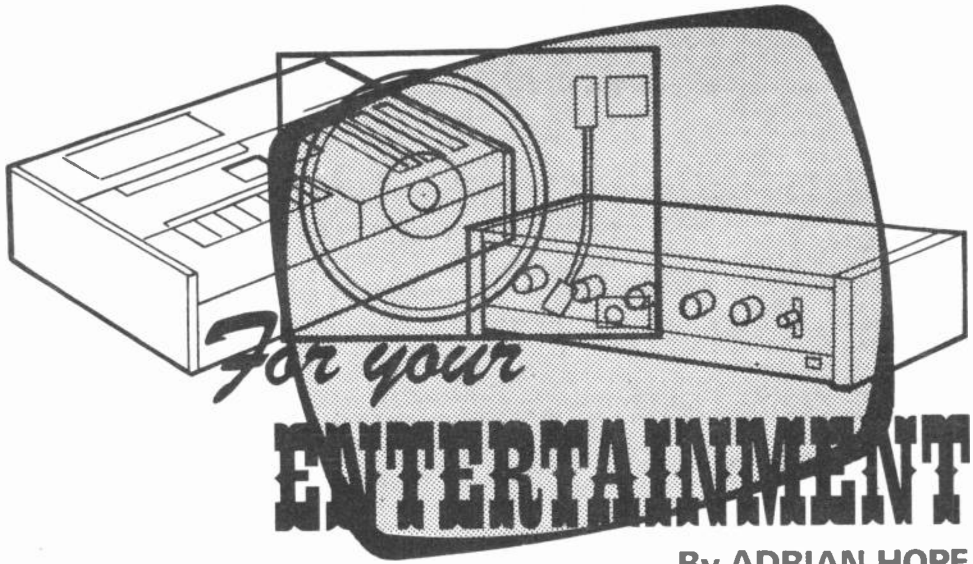
Type	Colour	Dia.	Qty
TIL220	Red	5mm	*4*

TABLE 6: TRANSISTORS

Type	Material	Outline	Application	Qty
BC107	*npn* S	TO-18	Audio driver stages	*5*
BC108	*npn* S	TO-18	General purpose	*5*
BC109	*npn* S	TO-18	Low noise audio	*2*
BFY51	*npn* S	TO-39/TO-5	General purpose	*2*
ZTX300	*npn* S	E-line	General purpose	*2*
2N3704	*npn* S	TO-92	Audio amplifier	*2*
2N3702	*pnp* S	TO-92	Audio amplifier	*2*

TABLE 7
INTEGRATED CIRCUITS

Type	Function	Qty
741	Operational Amplifier	*3*
555	Timer	*3*



For your ENTERTAINMENT

By ADRIAN HOPE

Before Their Time

I'll bet that few people working today in electronics will even recognise the name John Sargrove. I certainly didn't until the Institution of Electronic and Radio Engineers organised an evening meeting to remind a few interested people of Sargrove's work.

In a nutshell he was another of those unfortunate inventors, like Alec Reeves, Charles Babbage and Alan Blumlein, who were way ahead of their time. It was Reeves who invented PCM in the 1930's, long before transistors were available to make the system work.

Working a few years earlier than Reeves, Blumlein invented stereo and film recording long before the industry was ready for it. And it was in the early 19th Century that Babbage first laid plans for a computer which was the mechanical equivalent of today's electronic calculator.

Although it is not widely recognised, John Sargrove, who died in 1974, worked soon after World War II on a system of total automation for radio and TV receiver production. Although the scheme, christened ECME (Electronic Circuit Making Equipment) won Sargrove the first ever Clerk Maxwell premium in 1946, the idea was too far ahead of its time to become a commercial success.

Automated Radio

His dream was to build a factory which would build radios almost untouched by human hand. Those who remember him recall that "he wanted every Indian to have a radio".

Of course, in the 40's all radios had to rely on valves and all automation equipment for building them had to rely on mechanical relays. Transistors and solid state switching were still a pie in the sky.

Nothing to be daunted, Sargrove designed a radio that was based on large integrated circuits with sockets for valves. But the circuits weren't i.c.s as we know them. Each was a large board with 15 solder joints, 15 capacitors, two variable condensers (capacitors) and several valve sockets. But everything was laid out by robot hands. The resistors were deposited as layers and only the glass valves were plugged in by hand. The Sargrove production line was actually used by Cossor in 1947 to produce radios. Unfortunately the scheme was short lived.

He originally saw ECME as "the answer to the vexed problem of post war labour problems". But very soon fears of job shortages replaced concern over labour shortage. The Daily Mirror ran a centre spread on the risks to employment presented by automation. Sargrove himself argued that automation didn't create unemployment. What it created was the need to redeploy a labour force from tedious repetitive jobs into more rewarding and constructive work.

Energetically he went out round the country and lectured on his ideas. His faith in the viability of automated factory production of electronic equipment sprang from experience of the valve and light bulb industry. If these precision products can be made in millions by total automation why not circuit boards and whole radios?

A Cautionary Tale

Beware the creeping calculator disease. Can *you* still do any mental arithmetic Here's a true cautionary tale.

Recently a sixth former left school with an impressive string of 'A' levels and an assured place at university to study engineering. To fill in the few months between school and college he took a temporary job as a milkman. Or more accurately, he tried to take a job as a milkman.

The dairy in question has a policy of giving every new milkman a half hour arithmetic test.

"I'm afraid I haven't brought my calculator" explained the would-be engineer. "No matter" said the dairy foreman "We wouldn't let you use it in the test anyway".

The student never did work as a milkman. Stripped of his calculator, he was arithmetically helpless and failed the test miserably.

Innumerate Society

Are we becoming an "innumerate" society? I raised the subject with the head of the maths department of a large London comprehensive school along with some of the school governors.

"We are educating children for a technological age" was the reply. It seems that as far as schools are concerned, calculators became acceptable as an everyday tool and an exam aid, when their cost fell below £10. The maths master argued that skills like long division and long multiplication are no longer of much importance.

What does matter, he believes, is the ability to "estimate" an answer to check that a calculator answer isn't totally haywire, for instance through mis-keying a decimal point. But isn't this based on the wholly false premise that everyone now carries a calculator around with them at all times? What about holiday trips to the beach or to restaurants where you may need to split a bill accurately several ways. And what happens if your calculator batteries run down when you want to check the price of 13 litres of petrol at an odd number of francs per litre?

The teacher's argument is that where accuracy matters, for instance in business, there will now always be a calculator to hand. There will also be an electronic cash register in most shops so all you need is a rough estimation to check the decimal point.

Exactly the same arguments against "progress" were raised, argued the teacher, when schoolchildren were no longer required to work out square roots the hard way. But, as that student who tried-but-failed-to become a milkman found out to his cost, long multiplication and division are far closer to real life than square roots. It's part of the everyday routine of a milkman to work out the cost of several dozen bottles of milk at an awkward cost per pint.

The parent governors had a ready but unconvincing answer to the cautionary milkman tale. "Educate the dairy into allowing the use of calculators". Furthermore I never thought I'd hear a mathematics teacher say "call it £100" when explaining how he would divide a restaurant bill of £98·55 between a large party of diners caught without their calculators. But he did.

Wristwatch Calculators

In the future calculators will become even more accessible than they are now. There is one coming soon from Japan that you wear on the wrist like a wrist watch; and of course it doubles as a watch, alarm and stop watch as well. But should we always take the easy way out?

Language translators with synthesised speech are already available and will become cheaper and cheaper. Should we bother to learn languages in the future? There is already a prototype portable electronic "typewriter" that stores long messages in a solid state memory. Is it worth learning to write?

Have you noticed how on television, especially in programmes imported from the USA, every important written message or caption is read out aloud? Need we now bother to learn to read? It's easy to lose sight of the sociological questions which are being posed by electronic answers.

It's unclear why exactly ECME failed. But in part it was due to the problems of automating such a complicated multi-stage process with mechanical relays. There was always some moving part somewhere ready to go wrong. What's more politcal pressure to kill off the idea mounted.

The idea surfaced again in the 50's when an attempt was made to produce an automated TV production plant. But that too failed for the same reasons.

Sargrove then concentrated his energies on automation processes that, although ingenious, were slightly less ambitious and considerably less touchy. For instance he built machinery to match the colour of rosary beads, sort good from bad coffee beans and check the weight of balls of bakers' dough prior to baking into bread.

These are all more difficult than they may sound but didn't bother the politicians. He also produced the tiniest condenser mic of the time, no larger than a farthing.

Wisdom of Automation

The real irony of the Sargrove saga is that foreign factories, especially those in Japan and Italy, have long since seen the wisdom of automation. Although it is an expensive investment to automate, once the lines are running the mass-produced output is cheap and reliability is high. Workers displaced from routine jobs can often be redeployed in to more stimulating posts.

Printing works and car factories in Italy and almost every industrial factory in Japan now borrow from Sargrove's pioneering ideas of over 30 years ago. Many are heavily automated and very successful.

In the UK we are still debating the wisdom, cost and morality of automation, rather like the captain of a sinking ship worrying about the menu for that night's dinner.

University Industrial Units

During the last decade over 30 British Universities have opened "industrial units" offering companies the benefit of their scientific experience on a consultancy basis. These are intended to be self-supporting departments, set up by the parent University and staffed by university scientists, but operating on a commercial basis.

For example UMIST in Manchester has a Corrosion Unit which worried companies will-approach when their pipe lines or swimming pools spring a leak or their foundations show unaccountable signs of rusting or rotting. At the Department of Cybernetics of Reading University, a Research Unit in Instrument Physics was established in 1969 and has been self-supporting since 1972.

Just some of this excellent pioneering development work undertaken by Universities was highlighted by a recent visit to Reading University.

Ambisonics

One project which will probably already be familiar to some readers is the Ambisonics surround sound system. This is best described as "second generation quadraphonics" and already the BBC, IBA and many European radio stations are appraising the system. A cross-licensing deal has been struck with the Japanese company Nippon-Columbia and the project is being financed by the NRDC.

Essentially Ambisonics differs from the old, and now obsolete, quadraphonic systems because there is no attempt at conveying four separate channels of sound for feeding to four loudspeakers. The original sound information is mixed or coded into two, three or four channels in dependence on the number of recording or transmission channels available e.g. two on a stereo record, four on a four track tape and so on.

This information is decoded in accordance with the type of reproduction system available. Surround sound in the azimuth or horizontal plane is conveyed by two or three channels, or even by two-and-a-half channels (a "half channel" has limited frequency bandwidth and limited amplitude level). Surround sound with height, or "periphony", is conveyed by four channels.

A demonstration of periphony at the Audio Engineering Society Convention in London, earlier this year used a four channel system and eight loudspeakers, above, around and below the listener. It certainly gave an appetite-whetting foretaste of the future of domestic audio.

Unfortunately no major record company has yet adopted the Ambisonic system. They are doubtless all too scared by the memory of the quadraphonic fiasco of non-standardisation.

Driverless vehicles

One of the first Reading commissions was to produce a driverless tractor, intended for the Third World countries. It proved a pointless exercise because in the Third World there is no shortage of labour, but a considerable shortage of cash to spend on high technology!

This situation wasn't realised until Reading scientists had built a driverless tractor which ploughed a field, without human aid, by sensing signals transmitted from wire aerials laid down each side of the field. The Road Research Laboratory heard of this system and in 1973 commissioned work on a driverless bus using a similar system based on wires buried underneath the road.

Experimental cars, vans and even a coach were duly produced. But at the last minute plans to run test projects in British cities were abandoned as a result of local spending cuts.

Nothing daunted, Reading suddenly realised that they had unwittingly produced an automatic control system for a vehicle which could readily be converted into a manual control operable from a single joystick, like a model aircraft control. Such a system would obviously be a boon for handicapped drivers and they soon succeeded in putting a 50 seater coach under the control of a single joystick that could be moved by one finger.

Now the Thalidomide Trust is financing the development of add-on joystick control units for use in cars for the disabled. Around 20 vehicles are currently being modified at the cost of around £2,000 each and should be on the road by 1981.

Speech Therapy

Doctors and speech therapists are faced with an especially difficult problem when trying to teach speech to patients born without a roof to their mouth. This is because human speech relies on an exceedingly complex pattern of contact between the tongue and roof of the mouth.

Reading has now built an imitation roof palate which contains a matrix of tiny electrical contacts. These are connected by super-fine wires to a microprocessor which is coupled to a cathode ray tube screen. This screen displays the pattern of tongue movement over the imitation palate and so helps the patient to follow the example of a tutor.

Speech therapists in British hospitals should soon be using some of these electronic aids.

Moisture Meter

In quite a different technology it is remarkably difficult to measure the amount of water in a solid, such as a house wall. But it can be very necessary to do so. The Reading answer, developed for the Building Research Establishment, is a circuit which registers the capacitive effect of the water rather than the conductive effect as normally sensed by a probe.

A hole is cut in the wall and then plugged with a central metal rod and silver sleeve. This plug creates a capacitor of which the dielectric constant depends on the amount of water in the wall.

A very high frequency current, of around 60MHz, is fed into the plug and its capacitance value read out alongside a scale of moisture content. In practice water has such a high dielectric constant that there is an 80-fold difference between a dry and wet wall.

Unfortunately there is a snag. Because any impurity such as salt in the water makes it conductive, the measurement readout will normally be a very confusing mixture of conductance and capacitance.

The answer is simple once you've thought of it. Conductance and capacitance are 90 degrees out of phase, so the readout is made phase sensitive to offer one value for conductance and another, displaced by 90 degrees, for capacitance. The conductance readout gives a measure of the salt content of the wall and the capacitance readout gives a measure of the amount of water present.

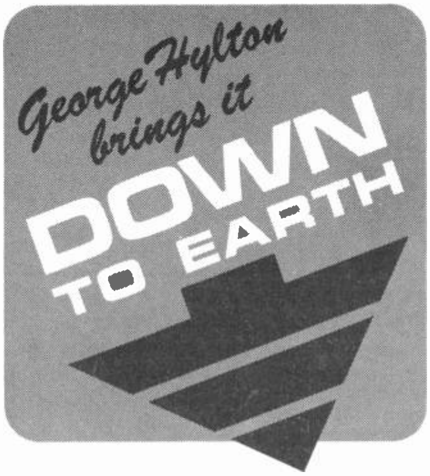
A similar electronic system is used to measure the "lushness" of pasture. Normally pasture has to be collected, burned and analysed to establish its water content or lushness.

Reading use a capacitance meter and a grid of condenser plates interleaved with the pasture. An accurate moisture content readout of the pasture between the plates can thus be obtained.

The system is so sensitive that it is sent haywire by the presence of a human body within 10 metres range. So the readouts have to be transmitted as a 3MHz signal.

The signal is mixed in a receiver with a signal from a tunable local oscillator. The result is a variable beat tone from the receiver, like that which issues from a metal detector.

The beat tone is zeroed by adjustment of the local oscillator by the operator. This gives a direct readout of the signal frequency coming from the condenser plates in the pasture. This in turn gives a direct tell-tale of the amount of water in the pasture which is serving as a dielectric between the plates.



A READER has asked; "In articles about the reception of frequency-modulated radio transmissions I frequently come across the term, quadrature detector. Please explain what this means."

An f.m. signal, when it leaves the transmitter, has a constant amplitude. That is, the peak and trough sizes of the waves do not change. Only the frequency changes.

At the receiver, noise picked up along with the signal or generated by the components in the receiver itself can cause the amplitude to vary. But any variations are eliminated by a limiter which in effect slices the tops and bottoms off the incoming waves so that they end up all cut down to the same size. By limiting the signal in this way the effects of noise are greatly reduced. This accounts for the much lower "background hiss" of an f.m. receiver compared with an a.m. receiver.

Limiting

Let's consider an f.m. transmitter which is not at the moment carrying any programme material. It sends out a steady frequency at a steady amplitude; nothing changes. At the receiver, after limiting, this signal is transformed into a steady square wave, Fig. 1a.

When the programme is transmitted this square wave will change in frequency, higher or lower, according to the variations in the voltage generated by the microphone in the studio. But for the time being there is no programme. It follows that the square wave of Fig. 1a must produce no output.

When its frequency varies, however, it means that a programme is being transmitted and it must then produce an audio output which for low distortion must be exactly proportional to its frequency.

Sampling

In a quadrature detector the no-programme wave is sampled at regular intervals. But the sampling periods are so timed that the samples consist of equal parts of positive and negative bits of the wave. These average out to zero because the positive bits just cancel the negative bits. You can think of the sampling process as switching. The wave is applied to a high speed switch which when on lets it pass but when off stops it.

If the "ons" and "offs" are timed as shown in Figs. 1a and b, then the positive samples are equal in size to the negative samples. If you think of the positive samples as charging a capacitor then it is clear that the negative samples will discharge it by the same amount. The result is that there is no net charge.

Modulation

If the transmitter is now modulated by a programme the frequency varies. For negative going points in the audio modulation the frequency may go low. For positive points it may go high. The sampling periods must be adjusted so that the output goes positive or negative in sympathy.

Suppose the wave form of Fig. 1c is the limiter output for a strong negative interval of the audio wave. If we sample at the times shown then the whole of each negative half cycle is passed by the sampling switch and none of the positive half cycles. So the output is now as negative as it can be (Fig. 1d). For positive-going modulation the frequency goes high and for maximum positive output samples must accept the whole of each positive half cycle, Figs. 1e and f.

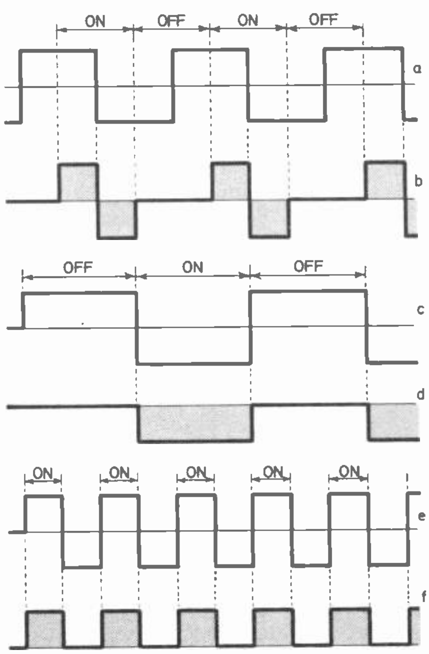


Fig. 1. Waveforms illustrating the operation of the quadrature detector.

When the audio is less intense the samples must include some positive bits and some negative bits but not equally positive and negative. In this way the cancellation will be incomplete and a certain amount of output will be produced. This can be positive or negative depending on whether the positive or negative bits are larger. By adjusting the timing of the samples any amount of net output can be obtained, from "full positive" to "full negative".

This is the principle of the quadrature f.m. detector (also called a quadrature demodulator and a quadrature discriminator). All that remains is to say how it can be made to work.

How It Works

This requires some automatic method of adjusting the sampling times so that the correct outputs are obtained. This is a lot easier than it sounds. The standard method is to use the limited signal itself to time the sampling. The limited signal is applied to two parts of the detector at the same time. One is just to the sampling switch, which lets it pass or not. The other is to the timing mechanism which turns the switch on or off.

It so happens that all the clever work of adjusting the timing to suit the frequency can be done by one quite ordinary *LC* circuit tuned to approximately the frequency of the wave shown in Fig. 1a. This produces just enough phase shift to make the switch turn on and off as at (a).

If the frequency now goes low the phase shift changes and moves the timing towards Fig. 1c. If the frequency increases the sampling times are moved towards (e). The amount by which the times are moved is in proportion to the frequency and so the net output is also in proportion to the frequency which is what is required. As the frequency swings up and down in sympathy with the audio at the studio so the output swings positive or negative in the right way to reproduce the original audio wave.

Quadrature

It is a curious feature of quadrature demodulators that they can be converted from f.m. detectors to a.m. detectors just by changing the phasing of the sampling timer. To be precise, when the detector is used for a.m. it is no longer a quadrature detector.

Quadrature just means that the sampling times are a quarter of a cycle out of phase with the input signal, as they are in (a). For a.m. detection the signal is not limited and the detector samples the positive peaks.

In this case the samples must be in phase with the signal.

TTL POWER SUPPLY UNIT

BY F.G. RAYER

THE TTL integrated circuits in the 7400 series are normally operated at between 4·75V and 5·25V and the TTL Power Supply Unit described here is intended particularly for these. The output is approximately 5V and this is regulated so that there is negligible change in voltage from no load conditions up to a maximum available load current of 1A. Short circuit protection built in.

CIRCUIT DESCRIPTION

The full circuit diagram of the unit is shown in Fig. 1. Transformer T1 steps down the a.c. mains from 240V to 6·3V and isolates the low voltage circuit. Single-pole switch S1 is the on-off switch and the neon indicator LP1 shows when the power is on.

The silicon bridge rectifier D1-D4 has four leads. Two are for the a.c. input from the transformer secondary, the two others are the positive and negative d.c. outputs. Direct current from these leads charges the smoothing or reservoir capacitor C1. About 9V will be present across C1. Instead of a bridge rectifier, four individual 1A silicon diodes could be used.

The LM309K integrated circuit is packaged in a TO-3 can and incorporates the voltage regulation and short circuit protection devices.

With the components shown, maximum current is about 1A and short-circuit current a little over 1·5A. When the voltage at pin 1 of ICI falls below about 7V, regulation is lost. A short circuit in the output circuit would naturally be corrected as soon as noticed but with T1 and the bridge rectifier rated at 2A, these items are not damaged.

CASE

The metal case is made from a single piece of flanged aluminium 100mm x 200mm (e.g. a single Universal Chassis member.) A 90 degree section is cut from each flange 63mm from each end and after all the holes have been drilled, the piece is bent to form an open box as shown in Fig. 3.

After assembly a piece of perforated metal is bent to form a cover, and is fixed with short self-tapping screws run into the flanges.

ASSEMBLY

The component layout is shown in Fig. 2. Before components are mounted all burrs and irregularities should be removed from the case. The front panel components are then fixed in position.

Pins 1 and 2 of IC1 should not touch the metal case and the integrated circuit should rest flat on the side of the case. A tag screwed to the integrated circuit can provide connections to the metal chassis and pin 3. After the transformer is in position it can be wired up. Finally the tagstrips and remainder of components are fixed in position and interwired. Note that the neon indicator should be the type with a series resistor incorporated.

The mains cable enters the case through a grommet and is connected up as shown. Current is drawn from a 3-pin plug fitted with a 2 or 3 amp fuse. Internal wiring can be of insulated flex, or 20 s.w.g. covered.

APPLICATIONS

The supply is very suitable for any TTL project incorporating 74 series i.c.s requiring 5V. Take care to connect the supply with the correct polarity. The output voltage has been found to change by only about 0·05V for loads from zero to 500mA. This power supply unit will run quite large and complex projects as well as simpler devices which may have been operated from a 4·5V battery supply. ⌑

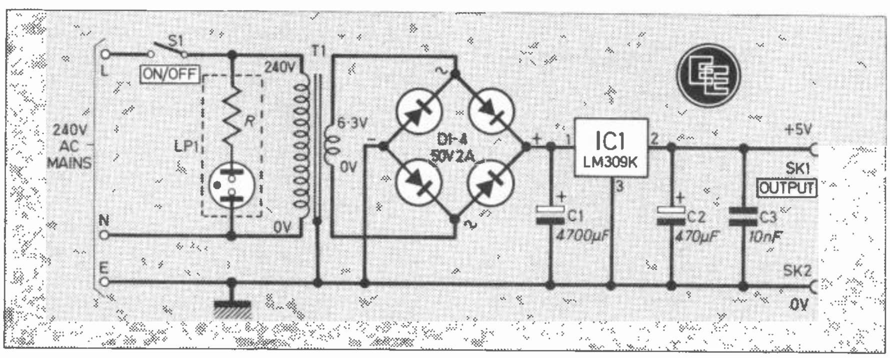


Fig. 1. Circuit diagram of the 5V Power Supply Unit.

COMPONENTS

Capacitors
- C1 4700µF 12V elect.
- C2 470µF 12V elect.
- C3 10nF ceramic or plastic

Semiconductors
- D1-D4 50V 2A bridge rectifier
- IC1 LM309K voltage regulator i.c.

Miscellaneous
- T1 mains primary/6·3V 2A secondary transformer
- S1 s.p.s.t. mains toggle
- SK1, 2 3mm sockets (one red, one black)

Tagstrips: 4-way with one earthed mounting tag (1 off), 2-way with one earthed mounting tag (1 off); solder tags (2 off); three-core mains cable; rubber grommet; p.v.c. covered wire; 100mm × 200mm piece of flanged aluminium (e.g. Universal Chassis member No. CU56A from Home Radio); 226mm × 74mm piece of perforated metal for cover; nuts, bolts, washers for securing transformer, i.c. and tagstrips.

5V POWER SUPPLY UNIT

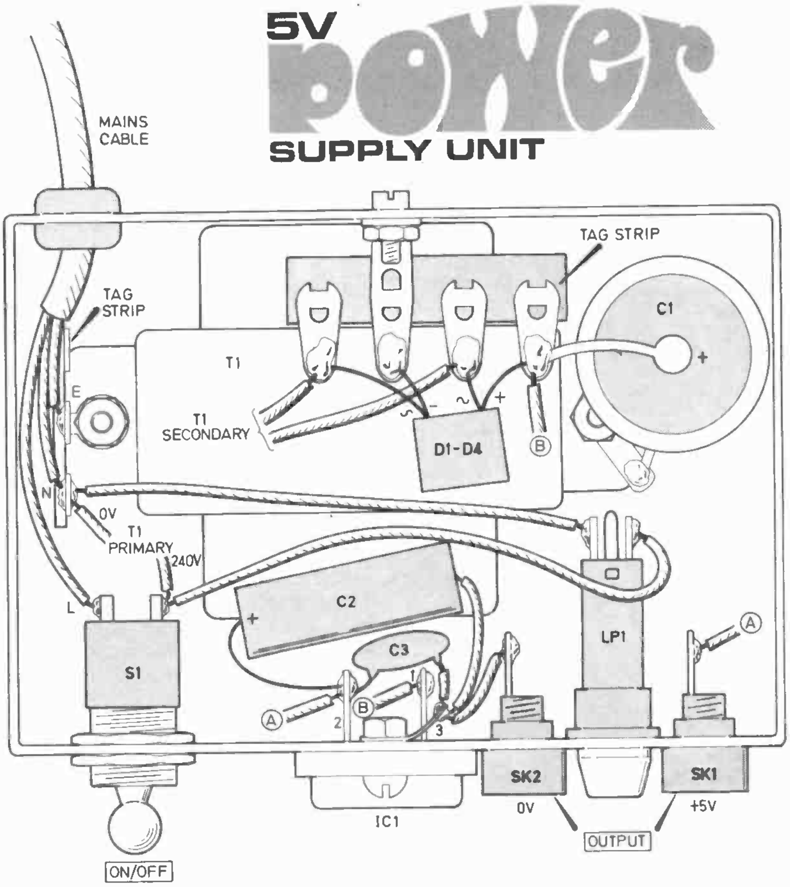
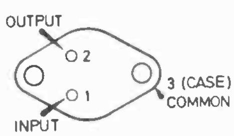
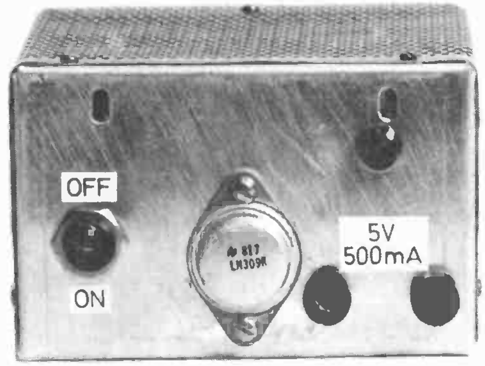


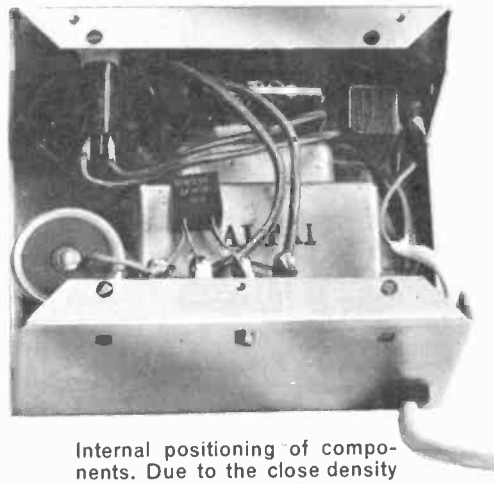
Fig. 2. Component layout and wiring. Make sure that pins 1 and 2 of the voltage regulator (IC1) do NOT touch the metal case.



UNDERSIDE VIEW OF IC1



Components mounted on the front panel.



Internal positioning of components. Due to the close density care must be taken to ensure that components do not short on the transformer, particularly S1, IC1 and LP1.

The completed power supply with a suitable protective U-shaped cover fixed in position with self-tapping screws.

COMPONENTS approximate cost £7

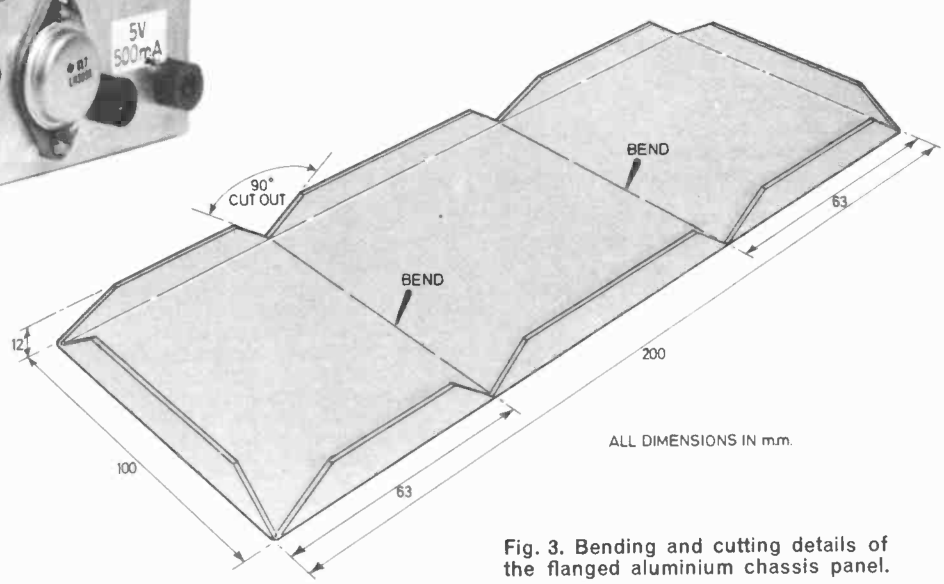


Fig. 3. Bending and cutting details of the flanged aluminium chassis panel.

Britain's first complete computer kit.

The Sinclair ZX80.

£79.95

Price breakdown
ZX80 and manual: £69.52
VAT: £10.43
Post and packing FREE

Please note: many kit makers quote VAT-exclusive prices.

You've seen the reviews...you've heard the excitement...now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything!*

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV...link it to an appropriate power source*...and you're ready to go.

Your ZX80 kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs–all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately–see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available–see coupon).

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability–takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input–to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

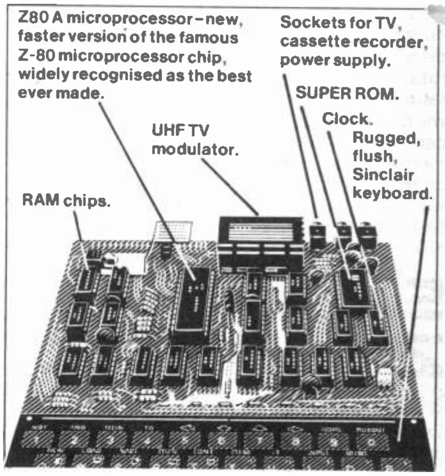
Fewer chips, compact design, volume production–more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer–typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

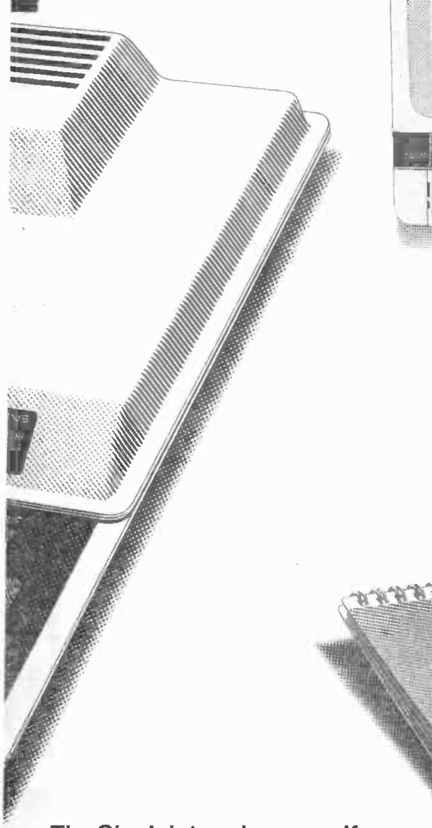
The display shows 32 characters by 24 lines.

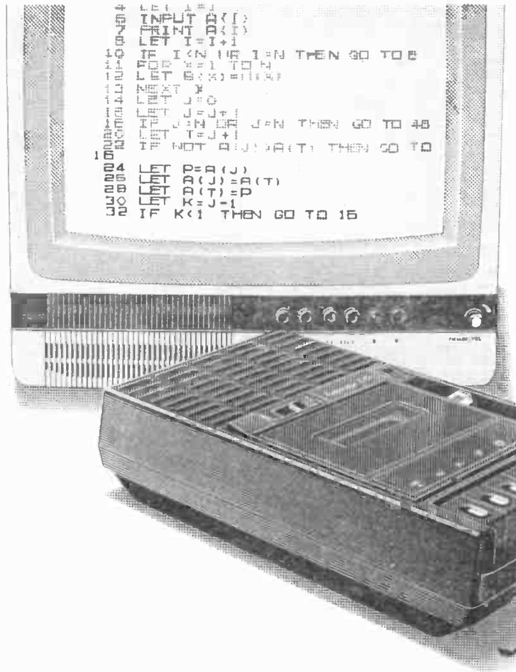
And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



plete





ZX80 software – now available!

See advertisements in Personal Computer World, Electronics Today International, and other journals.

New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.

The Sinclair teach-yourself BASIC manual.

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled and complete with mains adaptor, for only £99.95.

Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.

sinclair ZX80

Science of Cambridge Ltd

6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: 0223 311488.

ORDER FORM

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Remember: all prices shown include VAT, postage and packing. No hidden extras.
Please send me:

Quantity	Item	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	£79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.	£99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	

NB. Your Sinclair ZX80 may qualify as a business expense. **TOTAL** £

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £________
Please print
Name: Mr/Mrs/Miss________
Address________

Marshall's

A. Marshall (London) Ltd., Kingsgate House,
Kingsgate Place, London NW6 4TA
Industrial Sales: 01-328 1009
Mail Order: 01-624 8582
Also retail shops: 325 Edgware Road, London W2.
40 Cricklewood Broadway, London NW2. 85 West Regent St., Glasgow.
108A Stokes Croft, Bristol.

CAPACITORS:
Mullard Ceramic 63v range
1pF to 10,000pF E 24 range
all at £0.06 each
Siemens Ceramic 63v B37448/9
.01: .022: .033: .047mF @ £0.06
.068: .1mF @ £0.08: .22mF @ £0.11
CSF High Voltage Ceramic Discs
Prices £0.07 to £0.18 Range
100pF to 10.000pF
Voltage range up to 6Kv.
See catalogue for details.
Comprehensive range Siemens
Layer Polyester Caps: .001 to 3.3mF
Prices £0.07 to £0.63.
See catalogue for details.
Large range of Mullard/Siemens
Electrolytic Axial/Radial
Capacitance values 1.0mF to 10,000mF
Voltage ranges 25v: 40v: 63v: 100v:
Prices and types as catalogue
Also Mullard C280; Siemens
B32231/4 and B32110. All prices
net + VAT and postage/packaging.

TOOLS BAHCO
Side Cutter with Bezel.
Side Cutter without Bezel.
End Cutter without Bezel.
Vero Metal Shears.
Other items as catalogue.

BOXES & CASES
See catalogue for full range.
Aluminium boxes 13 sizes.
Rexine Covered boxes 7 sizes.
NEW RANGE TMEC CASES
Send S.A.E. for details & types
Price range. £14.04 to £17.00
ABS PLASTIC BOXES
3" x 2¼" x 1⅜"
3¾" x 2¾" x 1⅜" Prices as catalogue
4½" x 3¾" x 1½"
8" x 4¾" x 3"
BAZELLI INSTRUMENT CASES
5 sizes.
Miscellaneous hardware including
Vero Board: Superstrips:
Vero Breadboard.
Vero boxes (see catalogue for full range).

Card Frames: Fliptop boxes: etc etc.

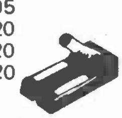
1980 CATALOGUE
U.K.: 65p post paid
Europe 85p post paid
Rest of World £1.25 post paid
Mail order: 01-624 8582

TTL see catalogue for full range

SN7400N	£0.14	SN7491AN	£0.54
SN7401N	£0.14	SN7492N	£0.31
SN7402N	£0.14	SN7493N	£0.32
SN7403N	£0.14	SN7494N	£0.80
SN7404N	£0.14	SN7495N	£0.55
SN7405N	£0.15	SN7496N	£0.34
SN7406N	£0.34	SN7497N	£1.80
SN7407N	£0.26	SN74100N	£1.10
SN7408N	£0.15	SN74107N	£0.21
SN7409N	£0.16	SN74118N	£0.76
SN7410	£0.15	SN74119N	£1.20
SN7411N	£0.15	SN74121N	£0.25
SN7412N	£0.20	SN74122N	£0.48
SN7413N	£0.28	SN74123N	£0.42
SN7414N	£0.47	SN74124N	£0.53
SN7416N	£0.22	SN74125N	£0.40
SN7417N	£0.22	SN74141N	£0.50
SN7420N	£0.15	SN74145N	£0.64
SN7423N	£0.18	SN74148N	£1.05
SN7425N	£0.19	SN74150N	£0.79
SN7426N	£0.19	SN74151N	£0.55
SN7427N	£0.19	SN74153N	£0.55
SN7430N	£0.15	SN74154N	£0.90
SN7432N	£0.17	SN74155N	£0.60
SN7437N	£0.21	SN74157N	£0.59
SN7438N	£0.21	SN74160AN	£0.70
SN7440N	£0.15	SN74161AN	£0.70
SN7441AN	£0.52	SN74162AN	£0.70
SN7442N	£0.40	SN74163AN	£0.70
SN7445N	£0.66	SN74164N	£0.80
SN7446AN	£0.48	SN74165N	£0.80
SN7447AN	£0.48	SN74167N	£1.20
SN7448N	£0.45	SN74174N	£0.80
SN7450N	£0.15	SN74175N	£0.63
SN7451N	£0.15	SN74176N	£0.74
SN7453N	£0.15	SN74177N	£0.73
SN7454N	£0.15	SN74180N	£0.70
SN7460N	£0.15	SN74181N	£1.65
SN7470N	£0.26	SN74182N	£0.83
SN7472N	£0.24	SN74184N	£1.29
SN7473N	£0.25	SN74185AN	£1.10
SN7474N	£0.25	SN74186N	£1.35
SN7475N	£0.31	SN74188AN	£1.84
SN7476N	£0.26	SN74189N	£2.26
SN7480N	£0.39	SN74190N	£0.74
SN7481N	£0.71	SN74191N	£0.79
SN7482N	£0.65	SN74192N	£0.79
SN7483N	£0.60	SN74193N	£0.79
SN7484N	£0.95	SN74196N	£0.74
SN7485N	£0.70	SN74197N	£0.74
SN7486N	£0.25	SN74198N	£1.09
SN7489N	£1.66	SN74199N	£1.09
SN7490AN	£0.33		

KNOBS & SWITCHES
Big selection as catalogue
Also Resistors; Presets; Pots;
Opto; Semiconductors etc.

SOLDERING EQUIPMENT
IRONS-ANTEX
15 watt C15 £3.95
15 watt CCN £4.20
17 watt CX17 £4.20
25 watt X25 £4.20
Stand £1.50



DESOLDERING TOOL
Solder £6.50

SINCLAIR INSTRUMENTS
Digital Multimeter
PDM35 £ 34.50
" " DM235 £ 52.50
" " DM350 £ 72.50
" " DM450 £ 99.00
Digital Frequency Meter
PFM200 £ 49.80
Low Power Oscilloscope
SC110 £139.00

CRIMSON ELEKTRIK HI FI MODULES

CE608	Power Amp	£18.26
CE1004	" "	£21.30
CE1008	" "	£23.91
CE1704	" "	£30.43
CE1708	" "	£30.43
CPS1	Power Unit	£16.96
CPS3	" "	£20.43
CPS6	" "	£26.09
CPR1	Pre Amp	£29.57
CPR1S	Pre Amp	£38.70

All prices + VAT + postage/packaging

KITS FOR E.E. PROJECTS

AUTOFADE	(ZB66)	May 80	£10·25
VARICAP RADIO	(ZB1)	Sept 79	£8·50
TRANSISTOR TESTER	(ZB2)	Sept 79	£5·00
4-STATION RADIO (No Case)	(ZB62)	May 80	£14·00
MORSE PRACTICE OSCILLATOR	(ZB43)	Feb 80	£6·00
WARBLING TIMER	(ZB5)	Aug 79	£5·80
MODULATED TONE GENERATOR	(ZB50)	Dec 79	£3·50
ELECTRONIC TUNING FORK	(ZB7)	Aug 79	£8·90
MICRO MUSIC BOX	(ZB45)	Feb 80	£17·00
STEREO HEADPHONE AMP	(ZB57)	March 80	£15·25
UNIBORAD BURGLAR ALARM	(ZB51)	Dec 79	£5·00
KITCHEN TIMER	(ZB55)	March 80	£12·75
UNIBORAD 9V POWER SUPPLY	(ZB47)	Jan 80	£4·50
LIGHTS WARNING SYSTEM	(ZB63)	May 80	£3·60
BATTERY VOLTAGE MONITOR	(ZB64)	May 80	£4·25
SIMPLE S.W. RECEIVER	(ZB44)	Feb 80	£18·00
INTRUDER ALARM	(ZB23)	May 79	£23·00
AUDIO TONE GENERATOR	(ZB67)	May 80	£3·50
DUAL LINE GAME (No Case)	(ZB65)	May 80	£25·00
GAS SENTINEL	(ZB61)	April 80	£27·00
5 RANGE CURRENT LIMITER	(ZB53)	March 80	£4·50
CHASER LIGHT	(ZB4)	Sept 79	£17·50
SHORT WAVE CONVERTER	(ZB25)	May 79	£13·75
UNIBOARD TOUCH SWITCH	(ZB56)	March 80	£9·00
FUNCTION GENERATOR	(ZB52)	Nov 79	£25·00
OPTO ALARM	(ZB41)	Nov 79	£5·00
AUTO-LEVEL CONTROL	(ZB60)	April 80	£8·00
CABLE & PIPE LOCATOR	(ZB54)	March 80	£3·75
CYCLE DIRECTION FINDER	(ZB59)	April 80	£14·50

All above kits include parts as described in articles i.e. veroboard, i.c. sockets connecting wire and cases where applicable.

TEACH-IN '80

New to electronics? Then start at the beginning. All electronic components for construction of Tutor Deck and Teach-In experiments during the first six parts of the series.
Lists A and B £20·00
List C £2·50

ALL PRICES INCLUDE V.A.T.
BARCLAY/VISA/ACCESS CARDS ACCEPTED.
MINIMUM TELEPHONE ORDER £5·00.

T. POWELL

306, ST. PAUL'S ROAD, LONDON N.I.
TELE: 01-226 1489.

SHOP HOURS: MON.—FRI. 9AM—5.30PM. SATURDAY 9AM—4.30PM

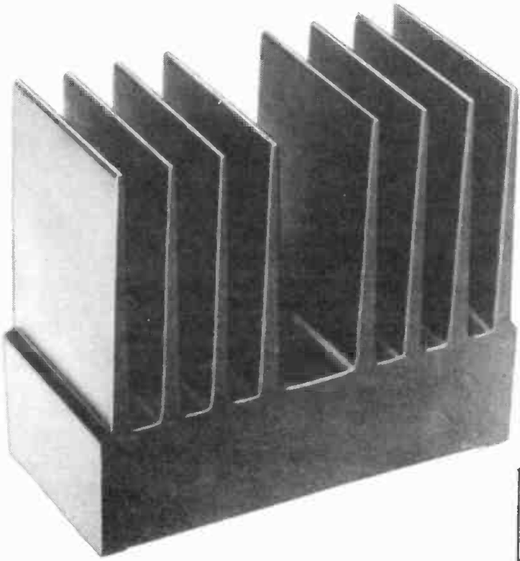
UHF POWER AMPLIFIER MODULE 50 mW Input 2·5 watt out 13 volt 420 To 480 MHz 50 ohm Type BGY 22C @ £12·50.
BLY 34 2 WATT 13 VOLT 175 MHz TRANSISTORS @ 75p.
HF-VHF POWER TRANSISTORS Type 587 BLY, SSB-FM 27 To 80 MHz, 40 watts, 28 volt with data @ £3.
BLY 55 175 MHz 4 watt 13 volt with data @ £2·50.
BLY 97 24 volt 175 MHz 4 watt with data @ £3.
BFR 64 470 MHz 13 volt 3 watt with data @ £4.
UNMARKED GOOD 2N 3866 VHF TRANSISTORS at 3 for 75p.
H.P. HOT CARRIER DIODES 5800-2800 @ 40p each.
R.F. SIGNAL TRANSISTORS 2N 918 @ 25p, 2N 5179, 2N 5180 Both 50p ea.
EDDYSTONE TRANSMITTING VARIABLE 30 + 30pf (60pf) @ £2·20.
VHF-UHF STRIPLINE FET 2N 4417 with data @ £2·20.
VHF R.F. CHOKES wire ended 10 U.H., 30 U.H., 330 U.H., All 7p ea.
BUTTERFLY PRE-SET VARIABLES 25 × 25 of @ 50p, 38 × 38pf @ 60p.
2 GHz STRIPLINE NPN TRANSISTORS @ £1 each.
5 GHz STRIPLINE NPN LOW NOISE TRANSISTORS @ £3 each.
FERRITE BEADS FX 1115 @ 15p doz, Long Type ½" 6 for 10p.
10·7 MHz VERNITRON FILTERS at 50p, 3 for £1.
VHF FETS BF 256C @ 4 for 75p, E304 @ 30p, 4 for £1.
WIRE ENDED VHF AERIAL SWITCHING PIN DIODES with data at 40p each.
STRIPLINE TRANSISTORS NPN BF 362, PNP BF 679. Both at 25p.
X BAND GUNN DIODES with data @ £1·65.
X BAND TUNING VARACTOR DIODES 1 To 2pf or 2 To 4pf, Both £1·65 ea.
MINIATURE CERAMIC TRIMMERS 2·5 To 6pf, 3 To 10pf, 4·7 To 20pf, 6 To 35pf, 10 To 40pf. All 15p each.
VARIABLE CAPACITORS Direct Drive. 5pf @ 75p, 10pf @ 75p, 125 + 125pf @ 60p, 100 + 200pf @ 60p, 250 + 250pf (500pf) @ 85p, 10 + 10 + 10pf @ 75p.
$\frac{3}{16}$" **COIL FORMERS** with core at 6 for 25p.
SUB-MINIATURE CERAMIC TUBULAR TRIMMERS 0·5pf To 3pf @ 15p.
MURATA 455 KHz FILTERS @ 50p each.
MINIATURE 10pf AIRSPACED TRIMMERS @ 20p each.
SOLDER-IN FEED THRU's 6·8pf, 27pf, 300pf, 1000pf All 20p doz.
ERIE RED CAP MINIATURE DISCS ·01uf 100v.w., at 5p each.
ELECTRONIC CAPACITORS 1500 U.F. 63 v.w. Size Approx. 3" × 1" @ 3 for £1.
20 ASSORTED BRANDED 250 mW ZENERS for 60p.
9 VOLT ITRON 9 DIGIT SEVEN SEGMENT DISPLAY Type FG95A @ £1·80.
TRANSFORMERS 240 Volt Input. Type 1. 24 volt Tapped at 14 volt 1 Amp @ £1·30 (P & P 25p), Type 2. 30-0-30 Volt 500 mA @ £1·30 (P & P 25p), Type 9. 12 volt 1 Amp @ £1·60 (P & P 25p).
HOUSE CODED TTL 7400, 7410, 74L00, 7453, 7430, All at 6 for 50p.
TTL I.C's 74H00, @ 15p, 74H10 @ 15p, 74H30 @ 15p, 74H50 @ 15p, 74H51 @ 15p, 74H61 @ 15p, 74H106 @ 25p, 74505 @ 15p, 74510 @ 22p, 74551 @ 22p, 74564 @ 22p, 743158 @ 60p.
6 To 12 VOLT MINIATURE RELAYS 5 amp SPCO Contacts @ 60p.
WIRE ENDED HF TO VHF PIN SWITCHING DIODES untested 25 for £1·50.

Please add 20p for post and packing on U.K. orders under £2. Overseas orders postage charged at cost.

J. BIRKETT

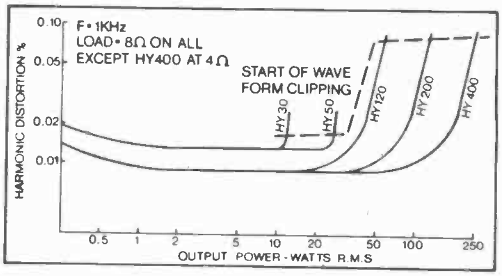
RADIO COMPONENT SUPPLIERS
25 The Strait, Lincoln LN2 1JF Tel. 20767

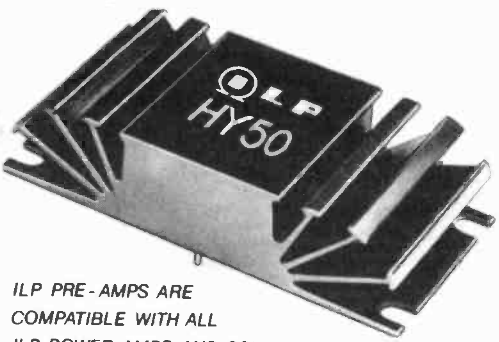
Simply ahead...



POWER AMPLIFIERS

ILP Power Amplifiers are encapsulated within heatsinks designed to meet total heat dissipation needs. They are rugged and made to last a lifetime. Advanced circuitry ensures their suitability for use with the finest loudspeakers, pick-ups, tuners, etc. using digital or analogue sound sources.





Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	100 dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	100 dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100 dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100 dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15

Load impedance - all models 4 Ω - ∞
Input sensitivity - all models 500 mV
Input impedance - all models 100K Ω
Frequency response - all models 10Hz - 45KHz - 3dB

ILP PRE-AMPS ARE COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs

POWER SUPPLY UNITS

ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and are in two basic forms – one with circuit panel mounted on conventionally styled laminated transformer, for smaller PSU's – in the other, for larger PSU's, ILP toroidal transformers are used which are half the size and weight of laminated equivalents, are more efficient and have greatly reduced radiation.

PSU 30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66 **£4.50 + £0.68 VAT**

THE FOLLOWING WILL ALSO DRIVE ILP PRE-AMPS

PSU 36 for 1 or 2 HY30's **£8.10 + £1.22 VAT**
PSU 50 for 1 or 2 HY50's **£8.10 + £1.22 VAT**
PSU 60 with toroidal transformer for 1 HY 120 **£9.75 + £1.46 VAT**
PSU 70 with toroidal transformer for 1 or 2 HY120's **£13.61 + £2.04 VAT**
PSU 90 with toroidal transformer for 1 HY200 **£13.61 + £2.04 VAT**
PSU 180 with toroidal transformer for 1 HY400 or 2 x HY200 **£23.02 + £3.45 VAT**

ILP

AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS.

CLASSIFIED

The prepaid rate for classified advertisements is 24 pence per word (minimum 12 words), box number 60p extra. Semi-display setting £6·16 per single column centimetre (minimum 2·5cm). All cheques, postal orders, etc., to be made payable to Everyday Electronics and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, Everyday Electronics, Room 2337, IPC Magazines Limited, King's Reach Tower, Stamford St., London SE1 9LS. (Telephone 01-261 5942).

Receivers and Components

DISCOVER ELECTRONICS. Build forty easy projects including: Metal Detector; Breathalyser; Radios; Stethoscope; Lie Detector; Touch time-switches; Burglar Alarms, etc. Circuits, plans all for £1·50 including FREE circuit board. Mail only. RIDLEY PHOTO/ELECTRONICS, Box 62, 111 Rockspark Road, Uckfield, Sussex.

P.C.B.s Paxolin 10½" × 4½" 4—£1·30 11½" × 8" 80p. 16" × 11½" £1·40 D.S. 10" × 8½" 85p. Fibreglass 12" × 8" £1·70 8" × 5" 75p. D.S. 10½" × 7" £1·35 8" × 7" £1·15 Panel with 40 assorted 74 series I.C.s £1·60. 20 Wire ended neons £1·00. Small 3 transistor Audio Amps 3—£1·20. 300 Small Components, Trans, Diodes £1·60. 7lbs Assorted Components £3·75 List 15p. refundable post 40p. Insurance add 20p.

J. W. B. RADIO
2, Barnfield Crescent, Sale, Cheshire. M33 1NL.

100 DIODES 85p. 50 transistors 95p. 10 switches 90p. 10 Leds £1·15. All mixed. Lists 15p. Sole Electronics, E/E, 37 Stanley Street, Ormskirk, Lancs L39 2DH.

NO LICENCE EXAMS NEEDED

To operate this miniature, solid-state Transmitter-Receiver Kit. Only £12·95 plus 35p P. & P.

'Brain-Freeze' 'em with a MINI-STROBE Electronics Kit, pocket-sized 'lightning flashes', vari-speed, for discos and parties. A mere £5·95 plus 35p P. & P. Experiment with a psychedelic DREAM LAB, or pick up faint speech/sounds with the BIG EAR sound-catcher; ready-made multi-function modules. £6·85 each plus 35p P. & P.

LOTS MORE! Send 30p for lists.

Prices include VAT.

BOFFIN PROJECTS
4 CUNLIFFE ROAD, STONELEIGH EWELL, SURREY. (E.E.)

TURN YOUR SURPLUS capacitors, transistors, etc. into cash. Contact COLES-HARDING & CO., 103 South Brink, Wisbech, Cambs. 0945-4188. Immediate settlement.

DIGITAL WATCH BATTERIES, any sort 75p each. Send SAE or 15p with number or old battery to Disclec, 511 Fulbridge Road, Werrington, Peterborough PE4 6SB.

Wanted

WANTED: ELECTRONIC COMPONENTS, Redundant Stock, Test Equipment, Tools, Machines, Hardware; Factories cleared. Immediate cash decision. Contact: Mr. Quirk, "Q" Services Electronic (Camberley) Ltd, 29 Lawford Crescent, Yateley 871048, Camberley, Surrey.

ENTHUSIAST seeks schematic diagram for Hallicrafters receiver SX 28. O. Fontana, PO Box 309, Manzini, Swaziland.

For Sale

NEW BACK ISSUES of "EVERYDAY ELECTRONICS". Available 75p each Post Free, open PO/Cheque returned if not in stock. BELL'S TELEVISION SERVICES 190 Kings Road, Harrogate, Yorkshire. Tel: (0423) 55885.

Books and Publications

"ELECTRONIC AND MICROPROCESSOR BOOKS". Send SAE for descriptive list of micro, electronic IC project books and solderless breadboard. Educational Data and Technical Services, 59 Station Road, Cogenhoe, Northampton NN7 1LU.

WHY NOT START YOUR OWN BUSINESS REWINDING ELECTRIC MOTORS

A genuine opportunity to success. LARGE PROFITS. You can't help but make money if you follow the easy, step by step, instructions in our fully illustrated Manual showing how to rewind Electric Motors, Armatures and Field coils as used in Vacuum Cleaners, Electric Drills and Power Tools. NO PREVIOUS KNOWLEDGE IS REQUIRED, as the Manual covers in 13 Chapters, where to obtain all the work you need, materials required, all instructions rewind charts and how to take data, etc. A goldmine of information. How to set up your home workshop and how to cost each job to your customer. £4·50 inclusive of P. & P. U.K. CWO to:

INDUSTRIAL SUPPLIES
102 Parrswood Road, Withington, Manchester 20, Dept. EE

Service Sheets

BELL'S TELEVISION SERVICE for service sheets on Radio, TV etc. £1 plus SAE. Colour TV Service Manuals on request. SAE with enquiries to BTS, 190 King's Rd, Harrogate, N. Yorkshire. Tel: 0423 55885.

SERVICE SHEETS from 50p and SAE. Catalogue 25p and SAE. Hamilton Radio, 47 Bohemia Road, St. Leonards, Sussex.

Educational

COURSES—RADIO AMATEURS EXAMINATION. City and Guilds. Pass this important examination and obtain your G8 Licence, with an RRC home study course. For details of this and other courses (GCE, professional examinations, etc), write or phone: THE RAPID RESULTS COLLEGE, Dept JR1, Tuition House, London SW19 4DS. Tel: 01-947 7272 (Careers Advisory Service).

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next available issue of Everyday Electronics for .... insertions. I enclose Cheque/P.O. for £............................

(Cheques and Postal Orders should be crossed Lloyds Bank Ltd. and made payable to Everyday Electronics)

NAME ....

ADDRESS ....

....

Send to: Classified Advertisement Manager
EVERYDAY ELECTRONICS
GMG, Classified Advertisements Dept., Room 2337, King's Reach Tower, Stamford Street, London SE1 9LS.
Telephone 01-261 5942
Rate:
24p per word, minimum 12 words. Box No. 60p extra.

Company registered in England. Registered No. 53626. Registered Office: King's Reach Tower, Stamford Street, London SE1 9LS.

Miscellaneous

PRINTED CIRCUITS. Make your own simply, cheaply and quickly! Golden Fotoka Light Sensitive Lacquer—now greatly improved and very much faster. Aerosol cans with full instructions. £2·25. Developer 35p. Ferric Chloride 55p. Clear Acetate sheet for master 14p. Copper-clad Fibre-glass Board approx. 1mm thick £1·70 sq.ft. Post/packing 60p. WHITE HOUSE ELECTRONICS, PO Box 19, Castle Drive, Penzance, Cornwall.

MK14 CORNER. Interface Board, includes flag driven mains relays, Led Indicators for all Serial I/O, D/A and single step chips, and prototype area; also suitable for other Microcomputers; PCB and circuit £3·95. Replace calculator display with ½in FND 500's; PCB, filter, instructions £1·95. Ready Built replacement Keyboard £11. Useful notes on MK14 75p. Rayner, 'Kismet', High Street, Colnbrook, Bucks.

TUNBRIDGE WELLS COMPONENTS, BALLARD'S, 108 Camden Road, Tunbridge Wells. Phone 31803. No lists, enquiries S.A.E.

LEARN ELECTRONICS THE EASY WAY. Build—amplifiers, oscillators, detectors, testers, flashers, metronomes, etc., more than 25 projects, with our multi-kits, complete instructions manual supplied. Send £15·00 to—MAJOR OAK SERVICES, 33 Lillian Avenue, London W3.

Situations Vacant

INDUSTRIAL ELECTRONICS: Are you an electronic wireman/tester or prototype wireman? Have you had an apprenticeship followed by at least 5 years practical experience? If so we can offer you employment as an instructor with good promotion opportunities and pensionable security at Bristol and Swindon Skillcentres. Starting salary £6,000 p.a. rising by two increments to £7,110 p.a. For more information contact Miss A. Curran MSC TSD, 11 Park Place, Clifton, Bristol. Telephone Bristol 20661.

INDUSTRIAL ELECTRONICS: Are you an electronic test technician or service mechanic? Have you had an apprenticeship followed by at least 5 years recent practical experience with a manufacturing or servicing organisation? If so we can offer you employment as an INSTRUCTOR, with good promotion opportunities and pensionable security, at Gloucester, Bristol and Swindon Skillcentres. Starting salary £6,000 p.a. rising by two increments to £7,110 p.a. For more information contact Miss A. Curran MSC TSD, 11 Park Place, Clifton, Bristol. Telephone Bristol 20661.

PLEASE MENTION EVERYDAY ELECTRONICS WHEN REPLYING TO ADVERTISEMENTS

MAIL ORDER ADVERTISING

British Code of Advertising Practice

Advertisements in this publication are required to conform to the British Code of Advertising Practice. In respect of mail order advertisements where money is paid in advance, the code requires advertisers to fulfil orders within 28 days, unless a longer delivery period is stated. Where goods are returned undamaged within seven days, the purchaser's money must be refunded. Please retain proof of postage/despatch, as this may be needed.

Mail order Protection Scheme

If you order goods from Mail Order advertisements in this magazine and pay by post in advance of delivery, EVERYDAY ELECTRONICS will consider you for compensation if the Advertiser should become insolvent or bankrupt, provided:
(1) You have not received the goods or had your money returned; and
(2) You write to the Publisher of EVERYDAY ELECTRONICS summarising the situation not earlier than 28 days from the date you sent your order and not later than two months from that day.
Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claims and what evidence of payment is required.
We guarantee to meet claims from readers made in accordance with the above procedure as soon as possible after the Advertiser has been declared bankrupt or insolvent.
This guarantee covers only advance payment sent in direct response to an advertisement in this magazine not, for example, payment made in resoonse to catalogues etc. received as a result of answering such advertisements. Classified advertisements are excluded.

INDEX TO ADVERTISERS

Published approximately the third Friday of each month by IPC Magazines Ltd., Kings Reach Tower, Stamford St., London SE1 9LS. Printed in England by Index Printers Ltd., Dunstable, Beds. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Subscriptions: Inland £9.00, Overseas £10.00 per annum payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex. Everyday Electronics is sold subject to the following conditions namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, excluding Eire where the selling price is subject to V.A.T., and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

THE NEW PIL SHOWROOM

Pil are pleased to announce the official opening of their new 1500 sq. ft. showroom to the public.

Offering a range of some 350 electrical measuring instruments manufactured by around 60 manufacturers, both British and international.

Pil can cater for practically every electrical measurement problem for any user on an ex-stock/short delivery basis.

The showroom facilities and its technical back-up are available to everyone from export houses and overseas users, buyers engineers, to do-it-yourself enthusiasts and hobbyists.

Instruments Electrical the service and calibration division can provide full guarantee facilities as well as offering their normal repair and calibration service.

For an immediate solution to your instrument problems, contact the Instrument Group at Instrument House.

Factory/Repairs 01-639 0155
North London Showroom 01-965 2352

PIL
AN IEC GROUP COMPANY

Showroom/Sales/Export 01-639 4461
Open Mon. to Fri. (ring for Sat. opening times)

INSTRUMENT HOUSE, 727 OLD KENT ROAD, LONDON SE15
TELEPHONE: 01-639 4461 TELEX: 8811854 (INSTEL)


STEP INTO A NEW WORLD
WHEN YOU DISCOVER MAPLIN
For beginners or professionals, the Maplin catalogue will help you find just about everything you need for your project.
Over 5,000 of the most useful components — from resistors to microprocessors — clearly described and illustrated.
Send the coupon for your copy and STEP UP TO MAPLIN SERVICE NOW
Post this coupon now for your copy of our 1979-80 catalogue price 70p.
Please send me a copy of your 280 page catalogue. I enclose 70p (plus 46p p&p).
If I am not completely satisfied I may return the catalogue to you and have my money refunded.
If you live outside the U.K. send £1.35 or ten International Reply Coupons. I enclose £1.16.
NAME
ADDRESS
E/E/9 80
MAPLIN
MAPLIN
ELECTRONIC SUPPLIES LTD
All mail to:-
P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 554155.
Shop: 284 London Road, Westcliff-on-Sea, Essex. (Closed on Monday).
Telephone: Southend (0702) 554000.
Catalogue now available in all branches of WHSMITH Price £1.00