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Hobby Electronics

September '80
ISSN 0142-6192
55p

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- A Versatile Touch Operated Switch
- An Inexpensive Bench Power Supply

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FROM BASICS TO MICROCOMPUTERS THE EASY WAY

SEPTEMBER 1980
Vol. 2 No. 11

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Hobby Electronics

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NEWS & INFO

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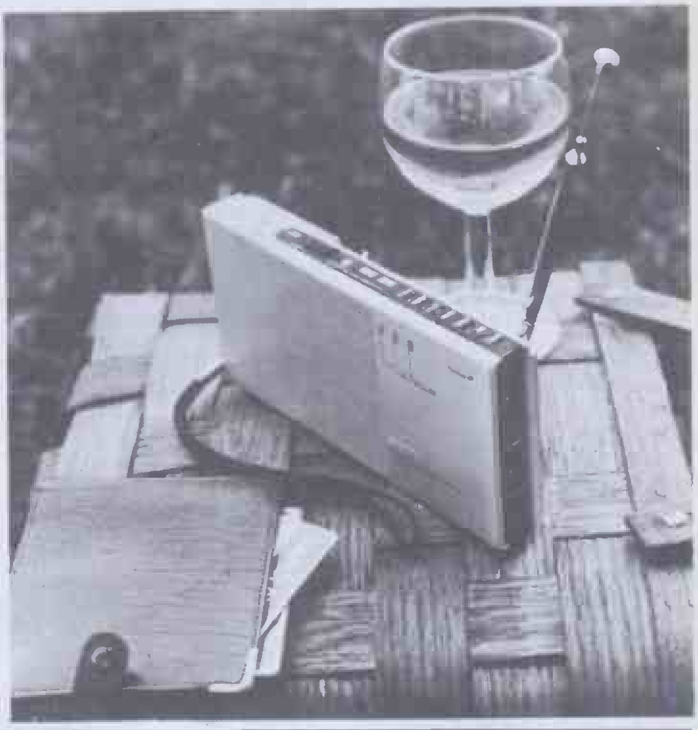
Monitor

Touch Tranny

Full marks to Sony for their latest portable radio. The ICF-M20L has been designed with the blind and partially sighted in mind. The radio can be operated without any kind of visual reference, all the controls are 'touch buttons' and have a 'pip tone' to tell the user that it is being operated correctly. The tuning is taken care of by IC scanning techniques, up to 14 stations can be stored in the radio's memory on all of its three bands (7 on VHF and 7 on MW/LW). To aid control identification all of the touch-buttons have raised dots and the radio can be easily be operated with just one finger, making it ideal for people with handicaps that limit movement.

The ICF-M20L weighs in at just 380 grammes and measures 179 x 85 x 26mm, making it small enough to fit into a handbag or coat pocket. Price is expected to be around £55. For further details contact Sony (UK) Ltd, Pyrene House, Sunbury Cross, Sunbury-on-Thames.



The Game Column

At last, and not to put too fine a point on it, about time too! Squark, squeek and flashing light fans everywhere pay attention now, we would like to introduce you to Fabulous Fred. Fred is a ten game (nine button) hand-held or desk top machine. Most of the games are fairly conventional, Memory Tune, Mindbender etc, all of these have been around for some time now under various guises. However, we can now add 'Catch The Comet', 'Space Attack' and 'Baseball' to the list, all good fun, should keep the peace for a few hours or until the batteries run out.

Fabulous Fred and his jolly repertoire of noises and flashing lights should be available for around £25 (or less if you shop around or wait a few weeks). Optim Toys Ltd are the people to speak to, they live at: 45 South Street, Bishop's Stortford, Herts.

Atari have announced another cartridge for their video computer system, it's called Adventure and goes something like this: The scene is a medieval kingdom somewhere inside the back of your telly. This is a particularly nasty place, infested by hungry, multi-coloured dragons and evil magicians. You, the player has the unenviable task of finding the golden chalice and returning it to the Enchanted castle. Of course the dragons, magicians and not forgetting the wicked Black Bat all do their best to prevent you carrying out this task. You too can enter fantasy land for around £29, NIC in Tottenham has his shelves groaning under the weight of games, why not pop round sometime.

Sonic Surveys

Forgotten your tape measure? Not to worry, for just £189 (plus VAT) you can dispense with that cumbersome yard-stick and get into the wonderful world of ultrasonic range finding.

This system from Survey and General Instruments Ltd is actually quite clever. The slave unit (left) is placed on whatever you wish to measure and the master unit sited at the appropriate distance. The master unit emits a 25 kHz signal which is picked up by the slave and retransmitted as a 40 kHz signal. This effectively cancels out any spurious reflections which might otherwise affect the accuracy of the reading. The Ultraset, as its known to its friends, has an effective range of 40 metres and an accuracy of ± 0.2% (up to 30 metres) and 0.3% (up to 40 metres). The readout shows the distance in centimetres, this is derived by calculating the time taken for the beam to travel the distance between the two units. SGI Ltd are to be found at:
Fircroft Way, Edenbridge, Kent TN8 6HA.

Vintage Wireless

That's the name of a catalogue from the Vintage Wireless Company. This really unusual publication is just full of obsolete valves, restored vintage wireless apparatus and large wooden and metal things with coils wound round them. Real connoisseur stuff this, they've even got those loudspeakers that look like ear-trumpets. If you are a collector or need any spare parts, data sheets etc then this is one publication you cannot afford to miss. It costs £1.00 and can be obtained from: The Vintage Wireless Company, 64 Broad Street, Staple Hill, Bristol, BS16 5NL.

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POLYESTER CAPACITORS: Axial lead type.
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n 9p; 18n 10p; 22n, 33n 11p; 47n, 68n 14p; 100n 17p; 150n, 220n 24p; 330n, 470n 41p; 680n 52p; 1µF 64p; 2µ2 82p; 4µ7 85p.
160V: 39µF, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1µF 22p; 1µ5, 2µ2 32p; 4µ7F 36p.
1000V: 10nF, 15n 20p; 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1µF 175p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n 5p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1µF 22p; 1µ5 30p; 2µ2 34p; 4µ7 60p.

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ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). 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, 8, 10, 8p; 15, 22, 47, 32, 50 12p; 63, 100, 27p; 50V: 50, 100, 220, 25p; 470, 32p 1000, 60p; 40V: 22, 33, 10p; 100, 12p; 2200, 3300, 85p; 4700, 98p; 35V: 33, 10p; 330, 470, 32p; 25V: 10, 22, 47, 100, 8p; 160, 220, 250, 15p; 470, 25p; 640, 1000, 35p; 1500, 40p; 2200, 45p; 3300, 77p; 4700 85p; 16V: 10, 47, 68, 7p; 100, 125, 8p; 220, 330, 14p; 470, 20p; 1000, 1500, 30p; 2200, 36p.
TAG-END TYPE: 450V: 100µF 180p; 70V: 4700, 165p; 64V: 3300 98p; 2500 90p; 50V: 3300 135p; 2200 99p; 40V: 4700 130p; 4000 92p; 3300 93p; 2500 85p; 2200 85p; 2000+2000 120p; 30V: 4700 110p; 25V: 15,000 195p; 6400 120p; 4700 100p; 3300 85p; 2200 60p.

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	RANGE	VAL	1-99	100+
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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

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S-Dec 350p T-Dec 400p
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FND357	120
MAN3640	175
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LCD 3½ Digit	875

SWITCHES
MEC. Black body, Red, Grn. Blue, Yel. Tops

SRL Latching	125
SRM Momentary	125
TOGGLE: 2A 250V	
SPST	32
DPDT	44
4 Pole on/off	54

SUB-MIN TOGGLE

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

SLIDE 250V:

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

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VOLTAGE REGULATORS

		+ ve		—ve	
1A	TO3				
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	95p	LM323K	625p	TAA550	50p
LM300H	170p	LM325N	240p	TBA625B	95p
LM305H	140p	LM326N	240p	TDA1412	150p
LM309K	135p	LM327	270p	78H05	595p
LM317K	350p	LM723	39p	78HG5	650p

SWITCHES Miniature Non-Locking
Push to Make 15 Push Break 25
ROCKER: SPST on/off 10A/250V 30
ROCKER: Illuminated (white) Chrome bezel Lights when on: 3A 240V 80
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way 43
ROTARY: Mains 250V AC. 4 Amp 50

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

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Dielectric		0 2 365pF with slow motion Drive	450p
100/300pF	205p	00 208/176	395p
500pF	250p	00 208/176 with slow motion drive	410p
6:1 Ball Drive 4511/OAF	145p	C804-5pF: 10: 15: 25: 50pF	250p
Dial Drive 4103 6:1/36:1	775p	100, 150pF	335p
Drum 54mm	59p	'L' 3x310pF	725p
0-1.365pF	325p	00.3x25pF	550p
00-2.365pF	395p		

DENCO COILS
'DP' VALVE TYPE

Range 1 to 5 Bl., Rd., Tl., Wht.	106p	RFC 5 chokes	120p
6-7 BYR	95p	RFC 7 (19mH)	133p
1.5 Green	130p	13; 14; 15; 16; 17	110p
'T' type 1 to 5, Bl, Rd. Wht. Yl	128p	18/1.6	116p
B9A Valve Holder	35p	18/465	132p
RDT2	120p	TOC 1	110p
		MW5FR	112p
		MW/LW SFR	134p

VEROBOARD

	0.1 (copper clad)	0.15 (copper clad)	0.15 (plain)
2½ x 3¼"	66p	59p	34p
2½ x 5"	75p	69p	39p
3¾ x 3¾"	75p	75p	—
3¾ x 5"	86p	92p	63p
2½ x 17"	240p	202p	125p
3¾ x 17"	296p	260p	178p
4¾ x 17"	387p	—	280p

Pkt of 36pins 20p 'DIP' Board 326p
Spot face cutter 107p 'VQ' Board 144p
Pin insertion tool 147p Veroblock 350p

DIODES

BA100	10
BY126	12
BY127	12
CR033	158
OA9	45
OA47	18
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5401/2	15
IN5403/4	20
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

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NOISE
Z5J 180p

BRIDGE RECTIFIERS

(plastic case)	p
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
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

DIAC
ST2 25

SCRs Thyristors

0.6A/200V	30
0.8A100V	30
0.8A200A	35
1A100V	42
1A200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A300V	59
12A500V	92
15A700V	195
2N4444	140
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	130
16A100V	95
16A500V	150
25A800V	295
25A1000V	480
T28000D	120

TTL 74

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7454	20
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74111	68
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74119	125
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74121	42
74122	55
74123	95
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74126	55
74128	74
74132	70
74136	65
74141	85
74142	195
74143	350
74145	90
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74148	145
74150	150
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74154	140
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74159	185
74160	99
74161	99
74162	99
74163	99
74164	120
74165	120
74166	155
74167	240
74170	230
74172	420
74173	120
74174	105
74175	82
74176	90
74177	90
74178	149
74180	90
74181	290
74182	88
74184	145
74185	145
74188	299
74190	135
74191	135
74192	135
74193	135
74194	105
74195	198
74196	130
74197	90
74198	195
74221	140
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74LS

74LS00	13
74LS01	13
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74LS08	23
74LS09	23
74LS10	20
74LS11	32
74LS12	32
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74LS21	32
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74LS47	85
74LS48	120
74LS55	70
74LS63	150
74LS73	40
74LS74	40
74LS75	48
74LS76	45
74LS83	105
74LS85	105
74LS86	45
74LS90	50
74LS92	75
74LS93	75
74LS95	115
74LS96	180
74LS107	45
74LS109	75
74LS112	80
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74LS114	49
74LS122	70
74LS123	95
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74LS125	60
74LS126	60
74LS132	95
74LS136	55
74LS138	70
74LS139	90
74LS145	120
74LS147	210
74LS148	175
74LS151	96
74LS153	85
74LS155	96
74LS156	96
74LS157	76
74LS158	85
74LS160	120
74LS161	98
74LS162	110
74LS163	118
74LS164	115
74LS165	155
74LS166	175
74LS173	105
74LS174	147
74LS175	110
74LS181	295
74LS190	120
74LS191	125
74LS192	125
74LS193	125
74LS195	126
74LS196	120
74LS197	120
74LS221	120
74LS240	225
74LS241	225
74LS242	232
74LS243	232
74LS244	225
74LS245	270
74LS247	135
74LS248	135
74LS249	135
74LS251	130

CMOS★

4000	18
4001	18
4002	24
4006	92
4007	22
4008	82
4009	40
4010	48
4011	24
4012	24
4013	45
4014	85
4015	85
4016	42
4017	82
4018	88
4019	48
4020	99
4021	105
4022	95
4023	25
4024	75
4025	25
4026	180
4027	48
4028	82
4029	105
4030	60
4031	225
4032	125
4033	175
4034	210
4035	125
4036	365
4037	115
4038	118
4039	360
4040	105
4041	80
4042	80
4043	95
4044	95
4045	175
4046	130
4047	98
4048	65
4049	45
4050	48
4051	80
4052	80
4053	80
4054	130
4055	135
4056	135
4057	1900
4059	575
4060	130
4061	1225
4062	995
4063	120
4066	58
4067	430
4068	26
4069	26
4070	30
4071	25
4072	25
4073	25
4075	25
4076	99
4077	48
4078	30
4081	88
4082	28
4085	90
4086	90
4089	150
4093	89
4094	240
4095	105
4096	105
4097	350
4098	115
4099	190
4160	125
4161	125
4162	125
4163	125
4174	130
4175	120
4194	125
4408	790
4409	790
4410	790
4411	1020
4412F	1520
4412V	1520
4415F	850
4415V	850
4419	320
4422	570
4432	1050
4436	1050
4440	999
4450	350
4451	350
4452	—
4490F	750
4490V	750
4501	28
4502	125
4503	75
4506	75
4507	60
4508	325
4510	99
4511	150

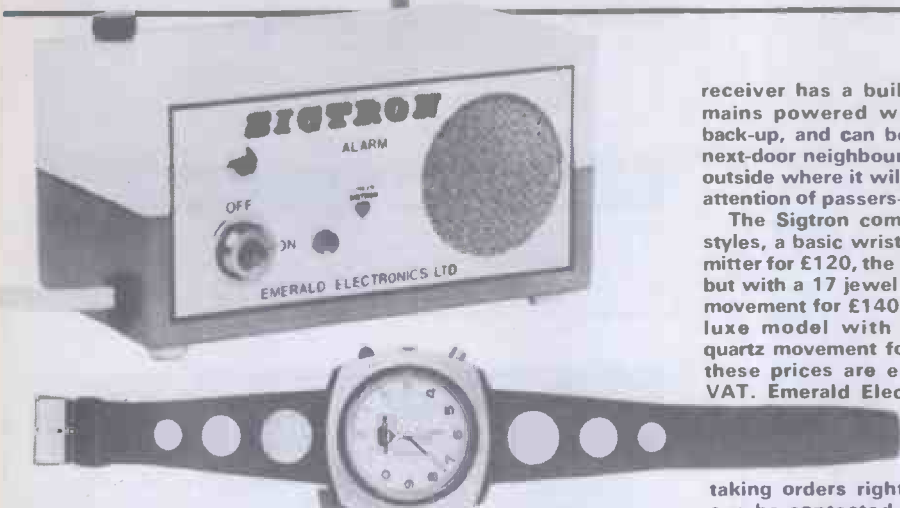
LINEAR ICs

2102-2	225
2114	299
2708	495
4136	395
6502	995
6800	800
709C 8 pin	35
710	67
733	125
741C 8 pin	17
747C	78
748C	36
753	150
810	159
81LS95	130
881LS96	130
81LS97	140
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	160
AY-1-6721/6	210
AY-3-8500	390
AY-3-8910	850
AY-5-1224A	235
AY-5-1230	450
CA3011	110
CA301B	68
CA3020	186
CA3023	191
CA302BA	80
CA3035	235
CA3043	275
CA3045	365
CA3046	71
CA3048	214
CA3059	176
CA3080E	65
CA3081	190
CA3085	85
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	85
CA3140	48
ICL7106E	795
ICL7107	975
ICL8038CC	340
ICM7205	1159
ICM7216A	1950
ICM7217A	790
ICM7555	89
LD130	452
LF356	90
LM10	395
LM300HX	170
LM301A	23
LM308	70
LM318	205
LM324	45
LM339	70
LM348	90
LM349	125
LM379	375
LM380	80
LM381	145
LM382	125
LM386	99
LM387	150
LM1458	40
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
M252	625
M253AA	1150
MC1304P	280
MC1310	149
MC1312P	195
MC1458	45
MC1488	85
MC1489	90
MC1495	350
MC1496	92
MC1710	79
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
NE518	210
NE543	210
NE544	185
NE555	22
NE556	55
NE560	325
NE561	395
NE562	410
NE564	425
NE565	120
NE566	160
NE567	170
NE570	750
NE571	420
RC4136	10
S5568	225
SAB3209	425
SAB3210	250
SN76003	240
SN76013	140
SN76023	140
SN76033	195
SN76477	175
TAA621	250
TBA120	70
TBA641	250
TBA800	90
TBA810	70
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TL061	54
TL071CP	45
TL074	140
TL081	42
TL082	70
TL083	95
TL084	120
UAA170	150
UAA180	150
Z80	990
Z8014	1099
Z80CTC	595
Z80P10	860
ZN1034E	200
ZN1040E	685
ZN414	80
ZN424E	130
ZN425E	415

TRANSISTORS

AC125	35
AC126	25
AC127	22
AC128	20
AC141	27
AC142	28
AC176	25
AC187	26
AC188	24
ACY17	60
ACY18	60
ACY20	53
ACY21	35
ACY22	60
AD140	70
AD149	75
AD161	42
AD162	42
AF114	60
AF115	60
AF139	40
AF178	70
AF180	70
AF186	50
AF239	42
BC107	10
BC108	10
BC108B	11
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC117	20
BC119	23
BC137	20
BC140	26
BC143	26
BC147	59
BC148	8
BC149	10
BC153	20
BC154	13
BC157	10
BC158	10
BC159	11
BC160	28
BC167A	11
BC168C	10
BC169C	10
BC170	15
BC171	11
BC172	11
BC177	15
BC178	14
BC179	15
BC182	10
BC182L	10
BC183	10
BC183L	10
BC184	10
BC184L	10
BC187	22
BC212	9
BC212L	9
BC213	9
BC213L	9
BC214	10
BC214L	10
BC307B	12
BC328	12
BC338	12
BC441	27
BC461	27
BC477	35
BC516	40
BC517	40
BC547	10
BC548	7
BC549	10
BC557	15
BC558	10
BC559	10
BCY70	14
BCY71	14
BCY72	16
BD131	42
BD132	42
BD133	50
BD135	30
BD136	30
BD137	30
BD138	35
BD139	30
BD140	30
BD145	175
BD695A	85
BD696A	85
BDY17	195
BDY60	110
BDY61	165
BF115	26
BF167	30
BF173	25
BF177	24
BF178	25
BF179	30
BF180	39
BF194	10
BF195	11
BF196	12
BF197	12
BF198	16
BF200	29
BF224A	18
BF244	24
BF256	45
BF257	30
BF258	28
BF259	28
BF594	20
BF595	20
BFR39	25
BFR40	28
BFR41	28
BFR79	24
BFR80	24
BFR81	24
BFX29	28
BFX84	28
BFX85	28
BFX86	28
BFX87	28
BFX88	28
BFY50	21
BFY51	21
BFY52	20
BFY71	20
BRY39	39
BSX20	20
BSY65	30
BSY95A	18
BU105	115
BU205	125
BU208	215
E113	38
E176	56
E421	250
MJ2955	90
MJE340	54
MJE370	58
MJE371	54
MJE520	65
MJE521	74
MJE2955	99
MJE3055	70
MPF102	66
MPF103	38
MPF104	36
MPF105	40
MPF106	40
MPSA05	15
MPSA06	16
MPSA12	22
MPSA55	22
MPSA56	22
MPSU06	56
MPSU56	60
OC28	120
OC35	125
OC36	130
OC41	125
OC42	48
OC44	55
OC45	30
OC70	35
OC71	28
OC72	35
OC76	36
OC77	76
OC81	35
OC82	50
OC83	48
OC84	45
OC140	110
OC170	85
OC171	45
TIP29	31
TIP29C	60
TIP30	32
TIP30C	43
TIP31A	38
TIP31C	50
TIP32A	40
TIP32C	55
TIP33A	54
TIP33C	70
TIP34A	63
TIP34C	75
TIP35A	135
TIP35C	105
TIP36A	145
TIP36C	255
TIP41A	105
TIP41B	185
TIP42A	50
TIP42B	65
TIP120	72
TIP121	90
TIP142	125
TIP147	145
TIP2955	72
TIP3055	65
TIS43	60
TIS44	45
TIS90	20
TIS91	24
ZTX107	11
ZTX108	11
ZTX109	11
ZTX300	13
ZTX301	15
ZTX302	20
ZTX303	25
ZTX304	17
ZTX314	24
ZTX326	45
ZTX341	20
ZTX500	15
ZTX501	15
ZTX502	17
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
2N526	58
2N696	36
2N697	25
2N698	40
2N699	30
2N706	19
2N708	19
2N918	33
2N930	18
2N961	61
2N1131	22
2N1132	24
2N1302	35
2N1304	50
2N1305	35
2N1671B	120
2N2160	350
2N2219A	22
2N2220A	23
2N2222	20
N2369	15
2N2476	125
2N2484	25
2N5172	13
2N2497	22
2N2646	48
2N2894	30
2N2904	24
2N2905A	22
2N2906	22
2N2907	22
2N2926G	10
2N3053	19
2N3054	55
2N3055	48
2N3121	40
2N3133	43
2N3135	33
2N3250	30
2N3442	40
2N3568	20
2N3663	14
2N3702	10
2N3703	10
2N3704	10
2N3705	10
2N3706	10
2N3707	10
2N3708	11
2N3709	11
2N3710	10
2N3711	10
2N3713	215
2N3771	179
2N3772	195
2N3773	283
2N3819	20
2N3820	45
2N3822	130
2N3823	70
2N3866	90
2N3903	20
2N3904	18
2N3905	18
2N3906	17
2N4037	52
2N4058	17
2N4061	17
2N4062	15
2N4069	12
2N4859	65
2N4871	50
2N5135	42
2N5136	42
2N5138	20
2N5172	13
2N5179	60
2N5180	80
2N5191	70
2N5305	40
2N5457	32
2N5458	32
2N5459	32
2N5485	35
2N5777	45
2N6027	40
3N128	112
3N140	112
40311	80
40313	125
40316	86
40317	52
40324	85
40326	52
40327	62
40348	105
40360	43
40361	45
40362	42
40407	52
40408	68
40411	280
40412	65
40467	95
40468	60
40578	190
40594	95
40595	98
40603	90
40636	130
40673	95

News from the Electronics World



Risk Watch

This rather bulky looking watch conceals a miniature radio transmitter with a range of around 100 metres. Now before you start jumping to conclusions, it has absolutely nothing to do with secret agents. The idea is that an elderly or infirm person can quickly summon help in emergencies. The radio receiver has a built-in alarm, mains powered with battery back-up, and can be sited in a next-door neighbour's house or outside where it will attract the attention of passers-by.

The Sigtron comes in three styles, a basic wriststrap transmitter for £120, the same model but with a 17 jewel mechanical movement for £140 and the deluxe model with electronic quartz movement for £160. All these prices are exclusive of VAT. Emerald Electronics are taking orders right now, they can be contacted at: Willowburn Trading Estate, Alnwick, Northumberland NE66 2PQ. By the way, just in case you're wondering, they are Home Office approved though a small licence fee may be levied.

Errata

We're definitely getting better, only three very small ones this month. First, the Equitone, the layout diagram on page 22 shows the Earth and Input connections transposed. On the left hand side of the diagram the input leads are the top two connections and the bottom connection is Earth. Still on the subject of overlay diagrams, the one on page 43, Pass The Loop suffered from an attack of wrong IC numbering. IC 1 is actually IC 2 and vice-versa. Last but not least, you guessed it the overlay diagram on page 58, Gas Detector shows two IC 1s, in fact the IC on the bottom left hand side of the diagram is IC 2.

Anyone want a job as an overlay checker, pays not too good but we're fun to work with.

Laser Liquidator

It's a constant source of worry to us, the way electronics is being used to make deadly weapons even deadlier. Here we have a Maverick Air-to-ground missile. The Maverick employs a laser guidance system developed by the Hughes Aircraft Company in the USA. So far, three low-level, long-range tests have all resulted in direct hits. No, we won't be presenting it as a project in HE!

Books

Babani Books Ltd have just produced a very comprehensive catalogue for their range of books. The good news is that it's free, just send an SAE to ; Bernard Babani Publishing Ltd, The Grampians, Shepherds Bush Road, London W6 7NF and they'll send you one by return.

Video Confusion

Strange, isn't it? With something like five different video cassette systems all trying to become accepted as a standard and yet another system coming in the autumn the video industry is now trying to convince us that we need Video Discs.

Now, for everyone who is trying to keep up with all this, you'll soon be able to spend your money on a disc system from the Victor Company of Japan (JVC to their friends) aided and abetted by our own Thorn EMI (bless 'em) who will try to extract the maximum number of pound notes from your wallet and at the same time convince you this will become the accepted standard and not a useless piece of junk should some other system triumph. You've got to admire their nerve.

Actually, this one does look good, the player accepts a 10 inch plastic, grooveless disc neatly sheathed in a sort of case that stops you getting your grubby fingerprints all over it. Each disc will play for 2 hours (1 hour per side), in full sparkling technicolour, don't forget though you can't record on videodisc.

The basic player has a diamond or sapphire stylus with an electrode that senses variations in capacitance between the stylus and the disc. Microscopic pits are moulded into the disc in much the same way as grooves are pressed onto conventional audio discs. The plastic is actually electroconductive so the depth of the pit will vary the capacitance between the surface and the stylus. The clever stuff starts with another excursion into the wallet when you purchase the Random Access unit. This will enable you to replay your disc at fast and slow motion speeds or even still frames. You'll also be able to programme in a variety of different sequences so you can skip the boring bits.

The last trick concerns the possibility of this system being used for audio-only recordings. Because the information on the disc is digitally encoded the quality is super-high, this, however, is still at the experimental stage.

If all goes well the VHD/AHD (Video/Audio High Density) system should be on sale around the end of next year. Thorn and JVC are naturally confident this system will become the global standard, we shall see. If you just can't wait then Thorn may be able to help you out with further information. Their address is: Thorn House, Upper St Martins Lane, London WC2 9ED.

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If you do not have the Issue of H.E. which includes the project — you will need to order the Instruction reprint as an extra. **45p each.**

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An easy to follow book suitable for all ages, ideal for beginners. No Soldering. Uses an 'S Dec' breadboard. Gives clear instructions with lots of pictures. 16 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S Dec and the components for the projects.
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Hobby Electronics

ON SALE SEPTEMBER 12th

Kitchen Timer

This handy little gadget will soon take pride-of-place on the kitchen shelves. It'll accurately indicate periods of up to six and a half minutes in thirty second steps. All the components are easy to obtain and it shouldn't take more than a couple of hours to build.

Freezer Alarm

Still in the kitchen, we've cooked up another winner for you with this little freezer alarm circuit. Should the temperature rise above a pre-determined level then the alarm will sound. Anyone who has ever seen a freezer full of unfrozen food will know how valuable this little project could be!

Light Dimmer

Here's one for those afraid of bright lights. This all new dimmer circuit will fit into the standard light switch socket. It'll let you control your lighting from a harsh glare to a warm seductive glow, just right for those long winter evenings in front of the telly. It might even save a few bob on the electricity bill too!

Doorbell

Just in case you've fallen asleep, safe in the knowledge your freezer's OK, the lights are low (courtesy the HE Light Dimmer), the meal was perfect (thanks to the HE Kitchen Timer), you'll be glad to know that the HE Nobell Doorbell will wake you up. This novel little circuit faithfully re-creates the sound of a mechanical door-knocker. No prizes for guessing why we called it the Nobell.

Temperature Controlled Soldering Iron

If we've tempted you into building any of these projects then you should know about our Temperature Controlled Soldering Iron project next month. You'll be able to build all of the projects without worrying about burnt out bits anymore.

Home Electronics

To round it all off we will be taking a look at some of the benefits electronics has brought to the home. The homely Tina Boylan looks at some of the gadgets on sale today and some of the labour saving devices we can expect in the next few years.

The items mentioned here are those planned but unforeseen circumstances may affect the actual contents.

Inside Teletext

Most of us have seen Teletext at some time, you may even have a receiver equipped with a decoder. So for all of you that have ever wondered how it works, Gwyn Morgan, head of Engineering Promotions of the BBC looks at the present system and reveals, exclusively for HE, some of the developments taking place

FOR MANY TECHNOCRATS and engineers some of the fun has gone out of Teletext. With the first stages of teletext development over, production firmly in the hands of the big semiconductor companies and receiver manufacturers, a market in Britain that will take teletext ownership to around 200,000 sets by the end of 1980 and with the editorial teams leading the current stage of development, there seems to be little novelty for the technocrats to get to grips with. Well, if like me you are fascinated by electronic ingenuities come with us as we take a look behind the doors of the research labs and committee rooms, there we will find some very interesting developments.

Teletext today is well established as a technical standard and looks set for market success — probably catching up and passing the video-recorder market in Britain this year or next. Teletext tomorrow needs thinking about and there are plenty of people doing just that.

The key to extending Britain's teletext system lies in anticipating the ever reducing costs of digital storage. Almost without exception today's teletext decoders store just one page of CEEFAX or ORACLE. That means a page store of some 7 kbits (7 thousand bits). If predictions of the falling costs of storage are correct then before the end of the 80s we will be able to afford enough storage for one super quality full colour still picture or a thousand teletext pages or various combinations of the two.

But before we launch off into the future we should get the past and the present into perspective to get a better idea of just how these developments are likely to come about.

The CEEFAX editing room at the BBC, copy for each page is written on typewriter type keyboards.

Early Days

The rumblings of teletext began in the second half of the sixties in the BBC Designs Department, without any publicity. Work was concentrated on developing a simple kind of printer that would be acceptable in the home — small, quiet and without the need for ink or inky ribbons. The method of sending the signals posed no problems. Ways of sending digital signals in the field blanking period were already being developed jointly in the European Broadcasting Union. That system, called ICE (Insertion Communication Equipment), has been in use with the BBC for many years.

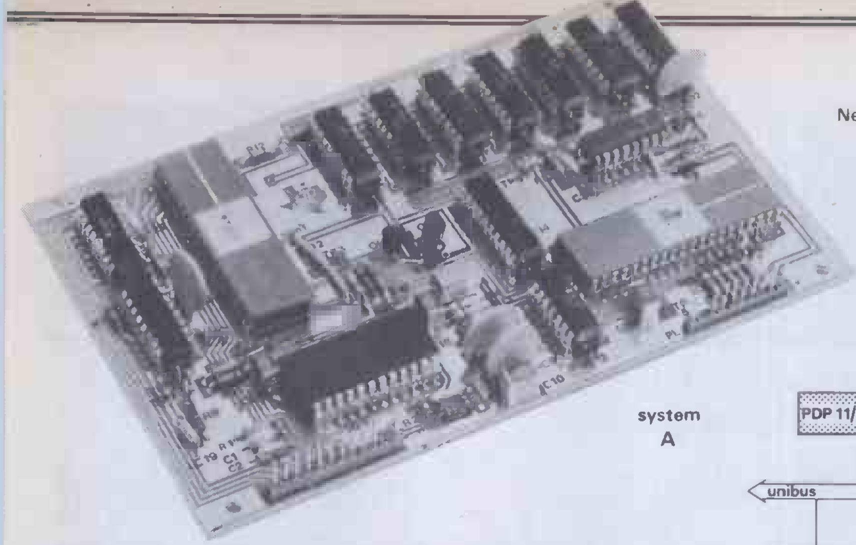
The real breakthrough to the kind of teletext we know today came about in 1968 when Peter Rainger, then at the BBC Designs Department, and now Deputy Director of Engineering at the BBC, realised that the Character Generator ROMs (Read Only Memories) that were being developed for computer terminals could be used in domestic receivers, so that instead of printing the words on paper they could be printed on the screen of an ordinary television set.

From that point the development work got well underway with investigations of potential data rates and ways of sending the data. One idea that was investigated was to use an extra subcarrier in the television signal but that was thrown out in favour of sending the data in short, fast bursts on some of the unused lines in the television field blanking period, just as with ICE.

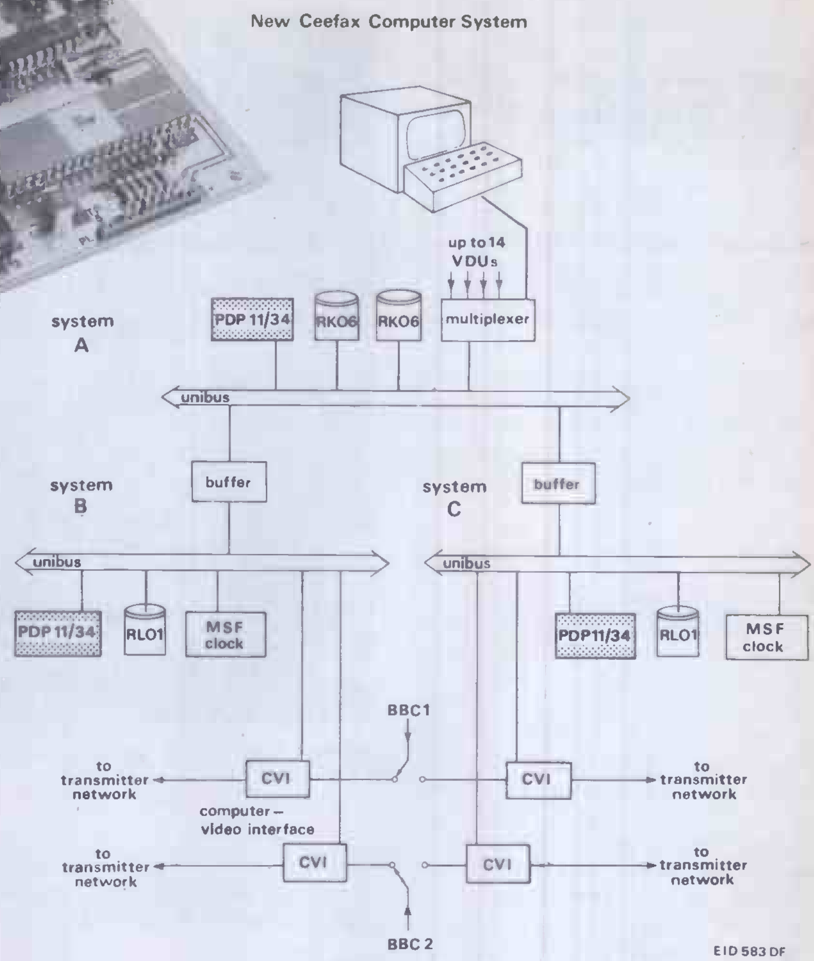
At first the BBC worked on two separate systems, "Teledata", for ordinary pages of text, and "Teletitles" on a different television line carrying subtitles for the deaf. It soon became obvious that the two ideas could be amalgamated and the same decoder could be used for both services. This passed all the benefits of mass production onto a decoder for subtitling that might otherwise have only a limited market. It's ironic that in the USA where much of the semiconductor technology used in teletext was developed thay are still to get teletext under; however they have instituted "Deafax", a service that carries only subtitles and at a relatively slow data rate.

Teletext Grows Up

Teledata and Teletitles together became CEEFAX and the first public announcements were made in 1972. The IBA announced their ideas for ORACLE soon after and the BBC, the



Above. A Texas Tifax Teletext decoder. This single board is all that is needed to decode teletext signals.



Right: Block diagram of the present CEEFAX system. Three PDP11 computers are used.

IBA and the British Receiver Industry got together in what must be one of the most effective committees that has ever been formed. In little more than a year the group hammered out the specification that is now the cornerstone of teletext. A great deal of development work was squeezed into that year. The BBC's mobile laboratory was packed full of test equipment and a great many transmission variations were tried out — different numbers of characters in a row, different numbers of rows, addressing alternatives and, above all, the effect of increasing the data rate.

The test transmission started with a data rate of around 3.5 Mbits/sec during each data line. The data rate was pushed up to 4.5 Mbits/sec with no measurable reduction in the teletext service area and finally increased to more than 6 Mbits/sec, again with little reduction in the extent of the teletext service area. The receiver industry representatives on the teletext committee were most insistent that the teletext standard would not be determined by the performance of the television receivers of the day. Everyone involved was keen to push the data rate up as far as possible and the manufacturers' opinion was that future receivers would provide much improved IF performance. They were right and though the IF boards for the first teletext receivers had to be handpicked, teletext has moved on to become an ordinary part of the production line. Yet another step towards reliable and stable performance has been the introduction of surface acoustic wave filters (SAWFs) which drastically reduce the number of adjustments that need to be made during alignment and promise more stable performance during the life of the receiver.

The first teletext specification (or the ''White Book'' as it became generally known in the trade) was published in May 1974. It was in 1974 too, that the system first left the hands of the engineers and the world's first teletext journalist got his hands on the keyboard of a teletext Visual Display Unit. That was Colin McIntyre, appointed as Editor of CEEFAX. In order to get in the maximum amount of practice at writing in the teletext format of 24 rows of 40 characters he even typed all his notes and letters in that shape for a year or so.

Scope for Development

The first teletext specifications laid down some very important ground rules for the service while at the same time giving it enormous scope for development and expansion. The most important aspect of all is the way that Britain's teletext system is said to have a fixed format. What it means in this context is that the blocks of data come in a well defined, regular order, that is repeated on each television data-line. The data for a single row of a teletext page is always carried on one complete television line. This direct correspondance between the position on the data waveform and the position and location within a teletext page imparts considerable 'ruggedness' to the system.

This technique is particularly valuable when applied to the address codes that 'label' every data line to indicate where the decoded text belongs. The addresses are broadcast with a special error correcting code called a Hamming code (after its inventor). It is very important that the addresses are correctly recognised because even if a viewer would put up with occasional errors in the display under poor reception conditions then it is very important that all information is correctly identified for the pages it belong to.

Furthermore, thanks to this synchronous characteristic the decoder is more easily able to find the framing code that identifies the start of the data signals. If the system were not synchronous then the data signals for rows of text would begin and end anywhere on a television line and the decoder would have a much more complex and difficult job in deciding where the start and finish of a page was and where each began and ended. With Britain's synchronous teletext system it is very much easier to build a decoder that will give a continuously up-dated clock in the top right-hand corner of the pages as well as provide other "user-friendlies" (as the Americans call them), such as numbers that rotate to tell you when to expect the new page to arrive.

Graphics

From the outset teletext has had a system of graphics which takes up no more space in the decoder memory than an ordinary page of text. The graphics system uses the same digital codes as those that are used for letters and numerals, but to trigger off the start of a graphic section after an ordinary section of alpha-numerics, needs a control character. The control characters are not seen on the screen but because of the synchronous format, in the present system, they have to take up a place in the display. They usually appear as a blank space. The decoder will recognise particular 8 bit codes as control characters and will trigger off the appropriate form of display.

With alpha-numerics the image on the screen of each letter, numeral or sign is generated by the character generator ROM. With graphics the image that appears on the screen is generated directly by the bits in each character code byte.

Graphics images are made up by taking the space that would normally be occupied by a letter or numeral and dividing it into six rectangles, three high and two wide. The individual rectangles are 'switched on' by one of the six bits in a character code so that each character code has two meanings. One of the meanings produces an alpha-numeric character on the screen and the other produces a simple graphic image. The decoder knows which to produce because the control characters switch-in a particular mode of operation until either the end of a row or until the next control character appears and changes the operation. Every control character has a different job. There are different control characters for each of the

Above: An example of the enhanced teletext system capable of transmitting still pictures in full colour.

different colours that can be displayed in either the graphics mode or on the alpha-numerics mode.

Enhancements

In 1976 a second specification was published for teletext and this introduced some enhancements to the 1974 teletext transmission that was put on trial for two years. The new specification made it easy to draw a colourful map of Britain against a background of blue sea, and it made it possible to join areas of different colour together as well as providing some further options.

Previously, a control character that changed the colour of the graphics display would leave a blank space on the screen but by using the new 'hold graphics' control character, the blank space could be 'painted-over' to join up the two coloured areas.

That is the situation today and that 1976 specification will set the standard for teletext for many years to come. But it is possible to provide more sophisticated options than are available on today's teletext receivers and some of these enhancements can be introduced without making any change at all in the specification of the transmission. For example, one section of the address codes was originally known as the 'time code'. This time code address is totally independent of the alpha-numeric time that appears in the top right of every page.

The original idea was that by labelling each page with a regular time address as well as the ordinary page number, a single page number could carry different information, perhaps every minute of the day. This would multiply the number of pages available enormously. But it is not necessary to think of the time-code as a time. Instead, think of it simply as a number and it means that every one of the 800 different page numbers that could be specified in teletext can also be given 3,200 more sub-numbers or 'sub-codes' as they are now called.

One of the applications for this is to classify pages so that, for example, any pages about football might carry a sub-code 2000 while all pages about horse racing might carry the sub-code 2100 and all pages about the weather might have the sub-code 3000. Put that advantage together with the option of a 'don't care button' (available with the General Instrument Microelectronics decoder) and you have a way of automatically sifting through the pages you want to see.

If you wanted to see all the pages that were in the transmission on the subject of football you would press the don't care button three times instead of specifying a specific page number but then you would instruct

The contents page of the current teletext system, all tastes are catered for.

the decoder to look for all pages that had the sub-code 2000. The decoder would recognise this in the transmission and display them rapidly one after another as they passed by. This is the electronic equivalent of flicking through the pages of a book, but selectively.

Telesoftware

There is another development of teletext that also requires no changes in specification. This is called 'telesoftware' and it was originally devised by mathematician W. G. Overington. Since then it has been enthusiastically followed by John Hedger of ORACLE and engineers in Mullard. There are some telesoftware pages on the air at this moment and if you dial up one of them you would find, not a readable teletext page, but a page full of an apparently meaningless jumble of letters, figures and symbols. But this would not be meaningless at all to a 'more intelligent' teletext receiver.

An intelligent teletext receiver has a more or less conventional teletext decoder but in addition has a microprocessor and some extra memory. Microprocessors need a computer program or software before they will produce any answers and the apparently meaningless teletext pages are, in fact, the software commands for a microprocessor. Once the program has been loaded into a telesoftware decoder, the receiver becomes interactive. No longer do you just read the page and then perhaps dial another one but you can use the receiver to make calculations or play games or follow a programmed learning exercise.

A telesoftware page displayed on a telesoftware decoder might ask you questions. Using the ordinary remote control key pad you would insert numerical answers so it will calculate just what it ought to ask you next or once it has received all the information it needs from your answers, it will calculate the final answer to your problem — your mortgage repayments if ever the interest rate goes down!

Telesoftware decoders could make the programmable television games that are available now seem very old fashioned because using telesoftware the broadcasters will be able to think up new games perhaps as often as they think up new versions of the 'Little and Large Show'.

Just as there are creative script writers for comedies and dramas so there will have to be creative programmers for telesoftware. But instead of using a typewriter they will be using a keyboard of a VDU and instead of writing in English they will be writing in a computer language. An experimental trial of telesoftware is about to get under way under the auspices of the Department of Education and with the joint efforts of some decoder makers like Mullard, Educationalists at Brighton Polytechnic and of course, ITV ORACLE and BBC CEEFAX.

W. G. Overington's original ideas for telesoftware had in mind a special microprocessor that would receive a programme in the form of a machine code. More recent opinion seems to be leaning towards the use of a high level language. The telesoftware field trial that is being carried out with the aid of the Department of Education, will use a form of the computer language "BASIC". This means that the telesoftware decoder will not only need additional memory and, of course, a microprocessor, but will also need a device called an 'interpreter'. The interpreter will convert the commands in whatever language is finally chosen, into the specific commands that operate the microprocessor chosen by whichever company happens to be manufacturing that particular telesoftware decoder.

Mega-Memory

Telesoftware is one development of teletext that will certainly demand more memory but as the price of digital memory tumbles then teletext will be able to provide yet more sophisticated services. Imagine a television set with a memory of say 7 million bits. This would be able to store a complete still picture with an extremely high definition. It could be used, for example, to store the goal kick in a football match under the control of the viewer but it could do more than that, it could be used with teletext to provide instant access to perhaps a thousand teletext pages of the kind we have today or again, using teletext, it could be used to receive still pictures.

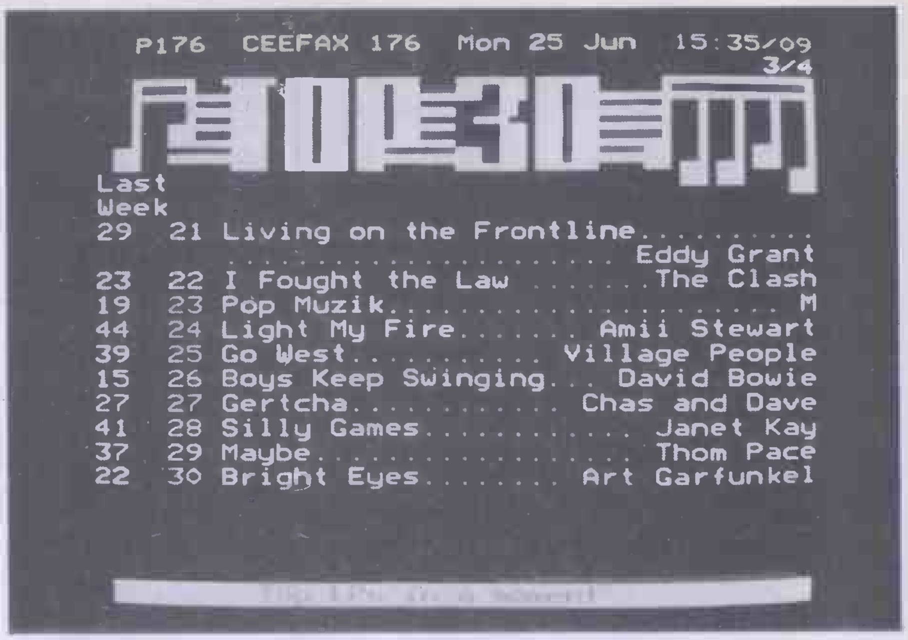
The still-pictures might be just part of a frame so that around a small still-picture in the corner of the page, there could be a text of a story. The still-picture could be used in all sorts of ways — to illustrate a news story or advertise a product or provide a Snoopy cartoon-strip or carry animated jokes. The data for these special still-pictures would be broadcast along with the conventional teletext signal. A small portion of the still picture would be transmitted every time the teletext magazine turned around. Because there would be an enormous amount of detail in each still-picture and because only a small amount of the picture could be transmitted every few seconds, then the image would take quite a long time to build up, perhaps even a few minutes, but that need not be a particularly important drawback as the main purpose of teletext would remain the same — broadcasting words and figures.

The still pictures could have excellent definition. The quality would be as good as the RGB output from a studio TV camera: they could even have a full grey scale as well as fully saturated colours and there would be complete freedom from cross colour patterns.

But still-pictures represent the extreme possibilities. Between that and the kind of teletext pages we see today, there would be a whole hierarchy of developments. High among the list of needs would be improved definition for graphics incorporated into the existing transmission.

Yet another important contribution, that would come from the freedom to use more memory in a teletext decoder, would be the ability to underline words, to change the colour of letters within a single word, the provision of an extended alphabet that allowed for accents as in French, German and the Nordic languages. It would be possible to display the words with proportional spacing. Instead of the present typewriter style of display where each character takes up the same space, whether it be a thin letter like an 'i' or a wide letter like an 'm', then with proportional spacing each letter could take up the space it needed to make a good display on the page.

The key to operating the teletext enhancements is the use of the presently unused address codes. There are only 24 rows in a single teletext page but the addresses can specify up to 32 row numbers. Row numbers 24-32 are free for new applications. One application of these extra rows would be a way of providing improvements to the basic appearance of a teletext page. The page would be transmitted in the conventional way as now and could be received on the kind of decoder that receives teletext today, but a more advanced decoder would be able to recognise the other rows as commands that actually applied to earlier parts of the page. For example, say it was necessary to underline three words in one particular teletext row. The commands for the enhanced facilities would be broadcast on a row numbered somewhere between 24-32 but that row would follow immediately after the row that needed underlining and the extra command row would only need to be recognised by the more advanced decoder.



An example of a 'rolling page'. The number in the top right hand corner beneath the clock denotes this is the third of four pages.

Linked Pages

The potential is really enormous. One of the ideas that has been proposed by John Chambers of the BBC Research Department is a system of linked-pages. It would rely on the decoder being able to store several pages (with 7 megabits of memory — 'several' could mean up to 1000!) and it would give the viewer instant access to these pages at the touch of a button on a keypad. Once the viewer has chosen any particular page the decoder would automatically file away a set of related pages as they appeared in the transmission by obeying commands hidden in the transmission of the first page. When the viewer was ready to read one of the pages that was related or 'linked' to the first there need to be no waiting time because the page would already be stored in another part of the decoder's memory.

One other refinement that Chambers described is a page-check-word. This is a very short digital message that enables the decoder to check positively and automatically whether a page has been completely and correctly received. This would have applications beyond the domestic decoder to business computer systems where perhaps several hundred pictures are to be stored automatically.

The Future

So teletext is by no means standing still. Just as we had television in black-and-white and later in colour, so we can extend the teletext service without making present day decoders redundant. The potential reduction in the cost of storage is very considerable.

Engineers at the BBC Research Department are investigating storage by laser holograms. One day soon we may well be using holographic video storage, they make present day video recorders with all their whirring wheels and delicate mechanics seem like medieval carts. It is theoretically possible that a single 1 cm crystal cube could store some 3½ hours of television programmes. The storage would be by "volume holograms", laid layer upon layer within the cube. Each hologram would provide a digitally coded message to a replay machine. But we are very many years away from achieving that potential. Much sooner, perhaps 1988 or 1990, it may be possible for us all to afford at least 7 million bits of storage in our television receivers. As that day comes nearer so we can look forward to some exciting extensions to the teletext service we have at present, but do not let it put you off enjoying today's teletext service today. **HE**

Micromix

A simple to build, cheap and versatile mixer which can be easily adapted into a multi-input device. A superb project for the beginner.

WELL, they said it couldn't be done! It was impossible to make a mixer to combine music and microphone signals with only one active component and costing only £2.50 for the bits. So we did it — and proved them wrong.

The majority of currently available cassette recorders and decks do not incorporate any facilities for mixing. They are primarily intended for direct recordings from tuner or record deck preamplifier. This makes it difficult to produce a recording on which speech via a microphone is to be recorded together with background music from, say, a second recorder, tuner or similar, such as when making a tape to accompany a slide or cine show.

This simple mixer overcomes the problem as it can mix the output from a high impedence (50k) microphone with a high level signal from a tape deck, tuner etc. The output of the mixer is fed to the high level of the recorder (tuner, aux, etc.).

The circuit revolves around IC1, an operational amplifier used in what is known as a summing mode i.e. it adds together the two input signals. In order that different microphone sensitivities can be used with different levels of music signal, to get just the mixture of voice with music which you require, both inputs are fully adjusted with the use of pots.

The circuit really couldn't be simpler, yet it gives an equivalent performance to, and the same versatility as expensive commercial mixers.

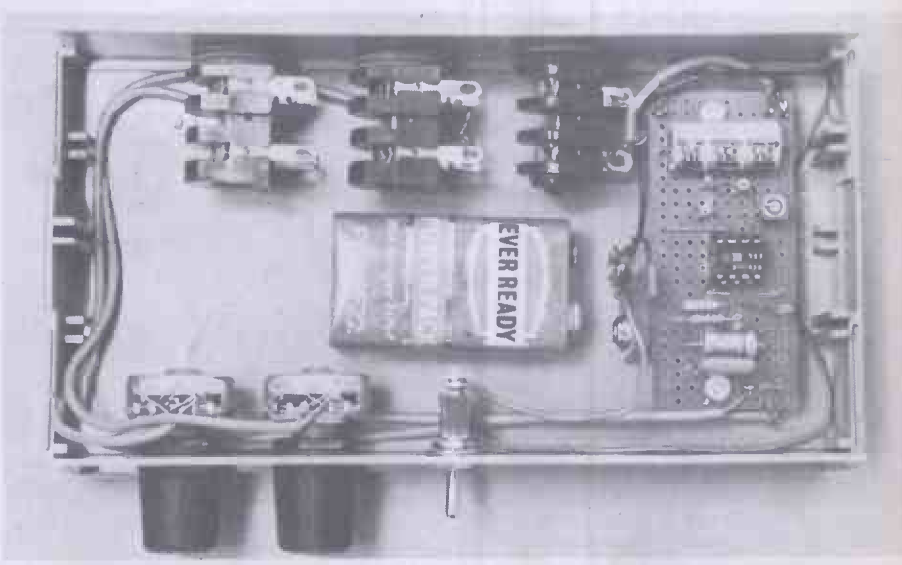
The result is a truly professional recording. You can combine voices with recorded music, or guitar solos with radio broadcasts — you name it, the Micromix'll do it.

Construction

Our layout for the mixer circuit is shown in figure 2. As you will see, we have used our usual sized, 10 x 24 hol, piece of 0.1'' matrix vero board. So the usual techniques apply.

Remember to break the track where indicated, in the diagram of the underside of the board, prior to insertion of components. Then solder in the wire links where necessary, and then the components, leaving IC1 till last. As usual, the IC socket is not absolutely necessary but it makes things easier if used.

Now, although we mounted our



Above. The insides of Micromix — neat and tidy as all good projects should be.

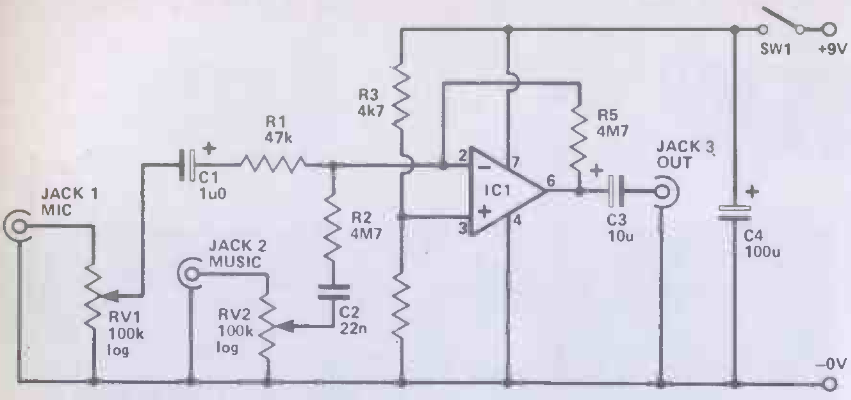


Figure 1. Micromix's circuit diagram.

Parts List

RESISTORS (All ¼ W 5%)

R1	47k
R2, 5	4M7
R3, 4	4k7

POTENTIOMETERS

RV1, 2	100k log

CAPACITORS

C1	1u0 10 V electrolytic
C2	10u 10 V electrolytic
C3	100u 10 V electrolytic
C4	22n polyester

SEMICONDUCTORS

IC1	LF351

MISCELLANEOUS

SW1	single-pole, double-throw toggle

3 × ¼" jack sockets
2 x knobs
Battery & clip, case to suit, screened cable

How it Works

The circuit diagram of the mixer is shown in Figure 1, and is a conventional amplifier based design. IC1 is used as a form of inverting amplifier, but it has two input signals. The voltage gain of the amplifier is equal to the value of R5 divided by the value of the input resistor. The signal applied to the "music" input is fed to R2 via level control VR2 and DC blocking capacitor C4. The value of R2 gives only unity voltage gain here (4M7 ÷ 4M7 = 1). The situation is rather different at the "mic" input, where the signal is applied to R1 via level control VR1 and DC blocking capacitor C1. The lower value of R1 results in a voltage gain of some 100 times (4M7 ÷ 47k = 100). This inbalance in the input sensitivities is necessary merely because the microphone signal will normally be about 100 times smaller than the music signal, and the higher amplification at the "mic" input is needed to boost this signal to an acceptable level.

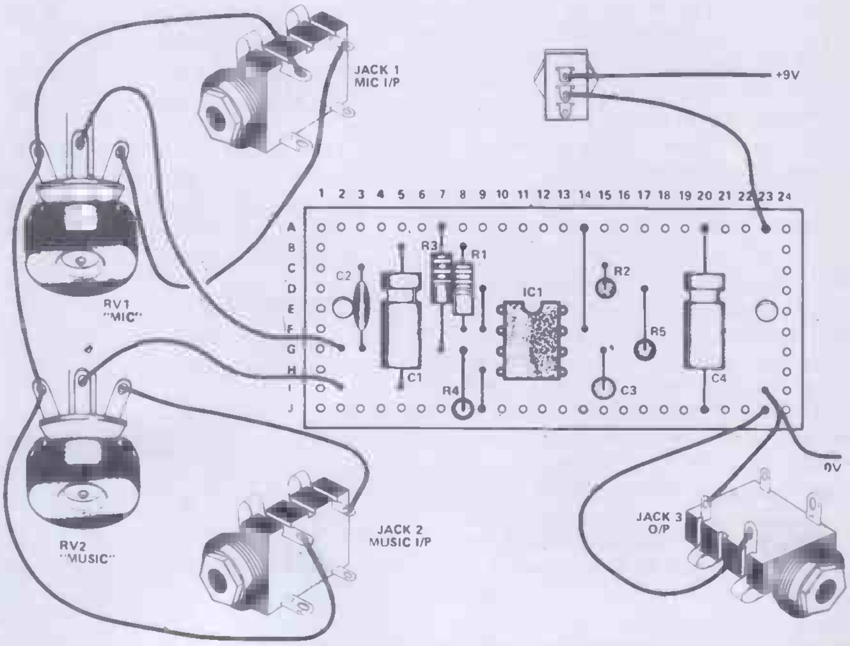
R3 and R4 are used to bias the non-inverting input of IC1 and C2 provides DC blocking at the output. SW1 is a straightforward on/off switch. The current consumption of the circuit is about 3mA so battery operation is ideal for this project.

whole circuit into a plastic case, you may find it better to put yours into a suitable metal one to help screen the circuit from mains hum and other electrical interference. Ours works quite well as it is, but if positioned too close to other electrical machinery or mains wiring a level of mains hum is encountered.

For the same reason, interwiring between the board, the potentiometer and the input and output sockets should be screened cable, the screen taken to 0V.

If you are adventurous you may wish to add further inputs to the mixer simply by adding more resistor / capacitor / potentiometer arrangements to pin 2 (the input) of IC1. So if you require another microphone input, add a 47k resistor, a 1uF capacitor and a 100k log pot. Likewise, if you require another music input add a 4M7 resistor, a 22nF capacitor and a 100k log pot. The number of inputs can, in theory at least, be extended indefinitely but above more than half a dozen or so, mains hum and noise may become a serious problem.

Obviously, for a stereo unit two mixer circuits are required, one for each channel but the on / off switch and battery can be common to both channels. **HE**



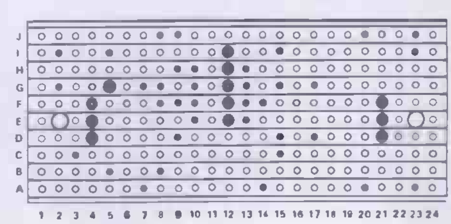


Figure 2. Overlay of the veroboard along with necessary connections.
Below — the underside of the board showing track breaks.

Buylines

The builder should have no trouble in obtaining any component in this project. If you do then we tentatively suggest that you are going to the wrong supplier. The parts are all commonly available!

Component cost (i.e. excluding the case and hardware) is around £2.50.

O Level Q & A

If you're taking the AO-level exams next year you'll be interested to know that we're starting a new series to cover the syllabus. Nick Walton, head of Physics at a London school, will be withus for the next few months, hopefully making those exams a little easier.

OBVIOUSLY you have an interest in electronics or you would not be reading this now; but has it occurred to you that if you have been an avid reader of HE for the past 18 months — or any of the many other electronics magazines that struggle to follow where we lead *(we're pretty broad-minded at HE and now you have your hands on the best we won't hold the others against you!)* then you may well know enough about the subject to be able to get yourself an exam qualification in electronics, without a huge amount of effort or extra knowledge.

Sadly, we live in a world dominated by a need for qualification, often gained by sitting an exam. So if you can't beat 'em why not join 'em? Most O-level and CSE Physics courses these days contain a little electronics together with delights like calorimeters, black bodies (cor!) and streaking by Archimedes that you would sooner bury in the past.

Electronic Examinations

Electronics used to be regarded as a branch of electricity which itself was (and still is) regarded as a branch of Physics. But with the arrival of the micro-electronics revolution (it has already started with calculators and digital watches, home computers — but boy, you ain't seen nothing yet compared with what's to come) electronics is now regarded as a subject in its own right. This is reflected in the exam scene right across the board from courses offered at Universities involving electronics, down to ordinary level for ordinary people like you and me. Did you know you can take A-level these days in Electronics Systems (if you can find somewhere or someone that will teach it to you?) This is set by the Associated Examining Board and they have also just brought out an O-level Electronics, as have the Oxford Board. One course which is now quite well established is the London University Exam Board's Electricity and Electronics at A-O-level (that's Alternative Ordinary level with the status of O-level if not a little better).

We've thought for some time now it would be worth looking at the course in some detail — and if you happen to think it is child's play then why not try to find a school or college that is a centre for the exam and would let you sit it as an external candidate? Or, if you are still at school and have a friendly science department you might be able to persuade them to take you through the course. (Be prepared though to be told details of cuts and other rather nasty realities, though I did hear of one school in North London where a physics teacher took a group of pupils through the A-level Electronics Systems course entirely in break times and lunch hours).

Incidentally, your approach would be very much in line with one of the stated aims of the course which is "to allow the pupil to see his studies as a personal expression of his interests . . ." which in plain language can be taken to mean he can use what he has picked up on the way to get him an AO-level pass. Oh, and while we're talking about *him* there is absolutely no reason why that need not embrace *her* as well — why on earth shouldn't girls enjoy it just as much? Electronics I mean.

The Right Course

So let's have a quick glance at what it all involves. The scheme is organised into seven parts with 1-5 being the syllabus proper, part six a practical project and part seven a case study in which you have to find out and write about a topic of your own choice revelant to your studies.

If you are still undaunted by all that and not itching to see what the next lot of Beasties are up to or whether that super bird that played Pass The Loop is featured again, we might look a little closer at the way the syllabus is organised into its five parts. Part one deals with energy since you cannot really start anything without a bit of that. You have to know the relative merits of fossil fuels (coal and oil), nuclear, solar, geothermal, wave and tidal, and of course how these convert to electricity and how the National Grid helps it on its way to the sockets in our houses. You can't really make much progress without some basic electrical concepts, so the second part looks at what voltage really is (did you know that a volt is actually a . . . No? Well then . . .), it looks at resistors, capacitors, inductors and finishes up with the theory of resonance. With that under your belt, a section (number three) on transducers follows. A transducer is a device which changes one form of energy into another, like a microphone which receives energy as sound waves and converts it into little pulses of electrical energy. Other transducers considered are loudspeakers, record pickups, the thermocouple and light sensitive devices.

Active Components

Moving on towards the real stuff, section four looks at active components (though it does seem something of a matter of opinion what you think of as active; they include, for instance, as active a PN junction diode). Also considered are the Zener diode, the light emitting diode (LED), the NPN transistor and the transistor as a switch. There is simple logic and you have to know about various gates like the NOT gate and its friends the AND, OR, NOR and NAND gates. The section finishes with the old chestnuts the multivibrators (both bistable and astable). So many projects involve these that it would be a good investment to understand them properly. The fifth and last section is the real nitty-grotty and is entitled 'Electronic Systems.' You have to know about meters (who doesn't?), the oscilloscope (principles, not circuit details), the amplifier likewise and its close relation the operational amplifier (Op Amp). The principles of feedback are encountered here, a theory by no means confined to electronics. By this time you should be able to devise simple circuits to perform useful functions and to round it all off you have to know how information can be stored on tape and disc.

The practical project is something you have to understand properly and could well be the sort of gadgets you see in HE. By the time you have built the little beast you will almost certainly know what every component does. On the other hand you may be able to get it going without having a clue what anything does but that would not really be good enough.

Close Study

Your final task would be a case study extending to about a thousand words — somewhat less than the length of this article — on any electronic or electrical topic you choose. A list can be supplied and titles can range from Citizen Band Radio, Digital Techniques, or even for sheer jargon generation "The Use of Myoelectricity as a proportional control signal for upper limb prostheses" which out jargons Rick Maybury's jargon generator for its total transitional capability (!!) The exam board does expect much of the material of the course to be developed through individual practical work and it also suggests that for each group of four students there should be available a cathode ray oscilloscope, a signal generator, a power pack, a multimeter and electronic logic components (either discrete components, integrated circuits or commercial modules). Additionally they say that it would be desirable to have access to a double beam oscilloscope, an electronic voltmeter and and RF signal generator — all of which may suggest that the enthusiast who does it all in his bedroom might need to find ways of moving his bed elsewhere.

Further Reading

Even in a series of articles you cannot expect everything you need to be covered in the fullest necessary details. The board itself recommends a couple of books: Using Semiconductors by J. Hughes and T. M. Johnston and published by Heinemann, and Basic Electronics Books 1-5 published by Hodder and Stoughton. To these two I would add a recent and excellent addition to Ian Sinclair's collection, called Electronics for the Service Engineer (Technical Press); or indeed any relevant title you can find by Ian Sinclair in the HE Book Service, e.g. Introducing Amateur Electronics. Other good books recently published that I would recommend are Electronics for Technicians 2 by S. A. Knight (slightly mathematical but beautifully explained) published by Newnes Butterworth, also Practical Electronics by Barry Woollard (McGraw Hill) again clearly written and with emphasis on a practical approach, and finally Basic Electronics Circuits by P. M. Buckley and A. H. Hoskyns which teaches you by getting you to build up circuits and which also has a useful section on exam questions. Having said all that, you have to realise that books are pretty personal things, and an author I think is great might be the biggest pain of all time for you — and vice versa. Like HE constructional projects, exam courses or anything else, I guess you just have to suck it and see. **HE**

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To keep things easy we've done away with the rather more conventional seven segment displays and their associated counter and driver ICs and used one, four-digit multiplexed display (see How it Works for a detailed discussion of the term multiplex) along with a single four-digit counter and driver IC from GI Microelectronics.

The four-digit display comes ready mounted onto its own PCB with all connections on one edge. This of course makes it ridiculously simple to use and easy to mount, as either on a front panel or on to a PCB (as we have done in this project).

IC1, the General Instruments Microelectronics chip AY-5-4007D is a remarkable device and must have many more uses, such as frequency counters, voltmeters etc. In fact, its use in the Reaction Timer must merit as one of its simplest applications. However, it does the job well end we have no grumbles.

A simple voltage regulator, two common chips and a handful of transistors, resistors and capacitors make up the rest of the circuit which keeps the display and its counter/driver chip running. It includes a pseudo-random time delay before the display lights up to indicate the start condition. This means that the individual whose reactions are under test does not know when the device is to commence timing and he is therefore always taken unawares.

Parts List

RESISTORS (All ¼W, 5%)

R1	4k7
R2,5,6	100k
R3,4	10M
R7	10k
R8,9,10,11, 12,13,14,15	330R

CAPACITORS

C1	100n polyester
C2	1u0 polycarbonate
C3	100n ceramic

SEMICONDUCTORS

IC1	AY-5-4007D four digit counter/display driver
IC2,3	4001 quad 2-input NOR gate
IC4	7905 —5 V regulator
Q1-5	BC212L PNP transistor
D1,2	IN4148 diode
DISPLAY	NSB 5881 multiplexed, 4-digit, 7-segment display

MISCELLANEOUS

PB1,2	push-to-make switches
SW1	single-pole, single-throw, miniature toggle switch

Case (see Buylines)
2 x PP3 battery connectors

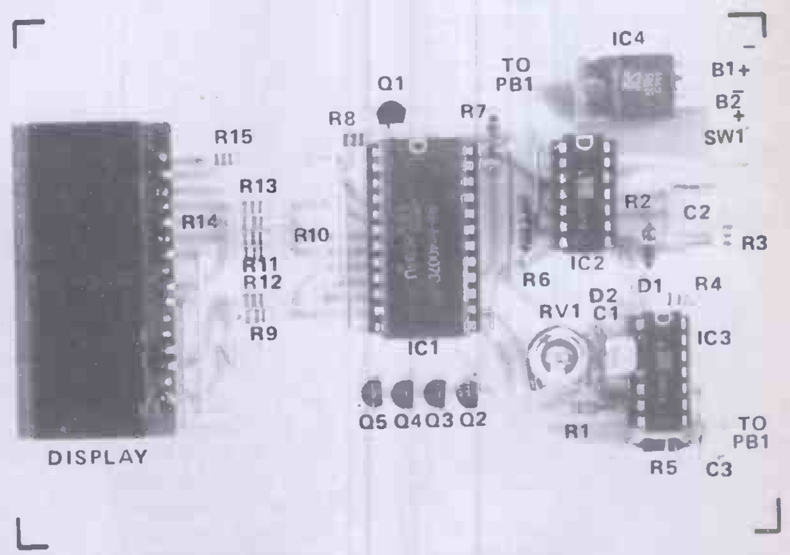


Figure 1. PCB overlay of the project. Make sure that all ICs are inserted correctly. The 4-digit display board is mounted onto the main PCB — Fig. 4 overleaf gives greater detail.

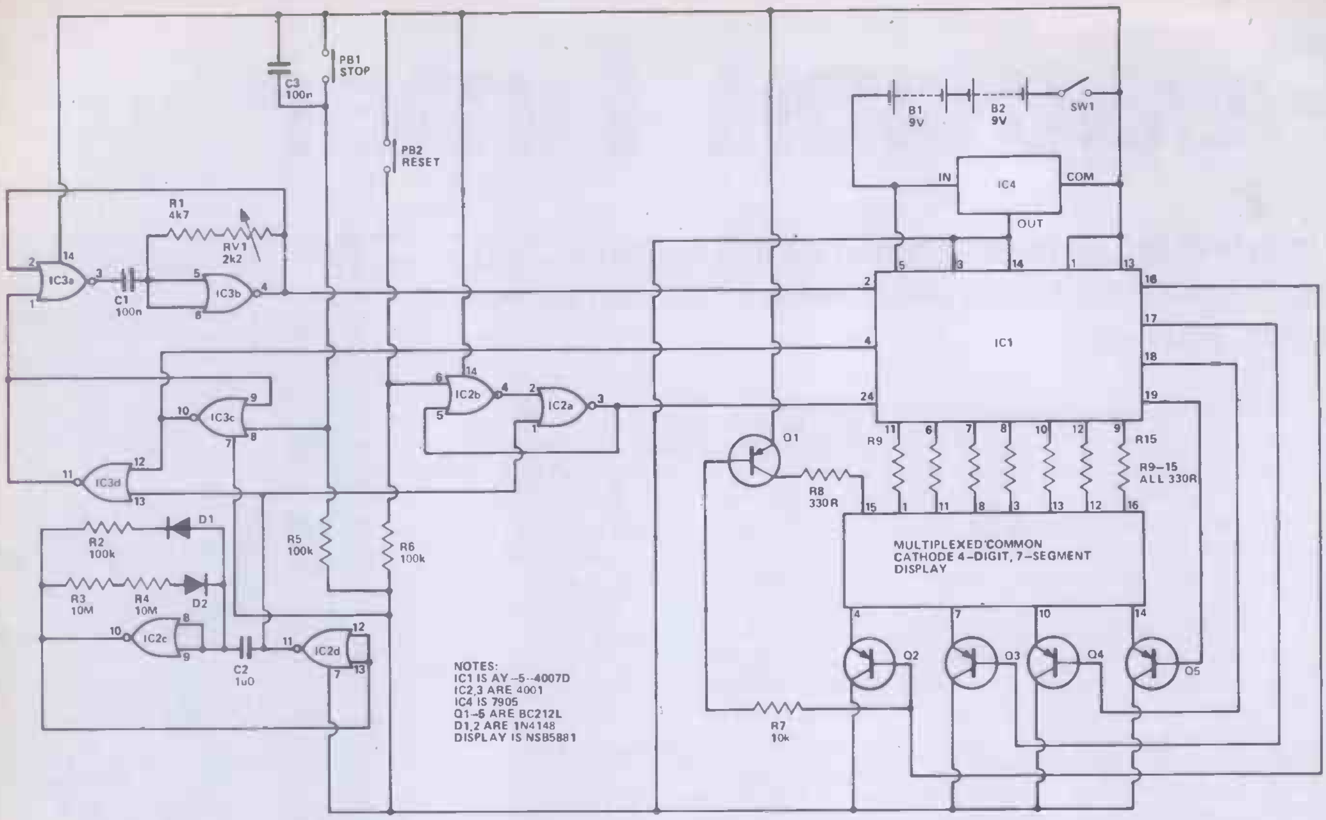
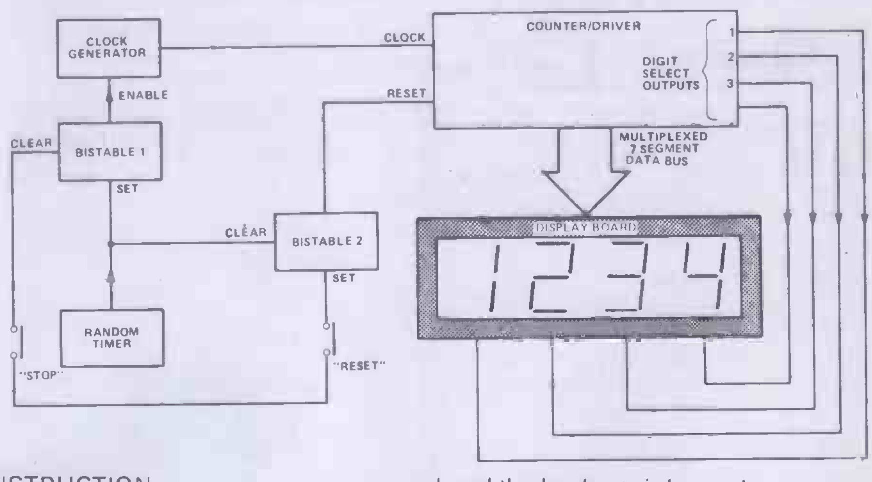


Figure 2. The circuit diagram. From this you can see how IC1 is basically the heart of the project.

Figure 3. The Reaction Timer in block form showing the display board as a separate entity within the circuit.



How it Works

The block diagram of figure 3 shows the main function of the various sections of the circuit. We shall first assume that the display section ie the counter/driver and multi-plexed display board needs only two inputs for correct function — a clock or pulse input to be counted and a RESET input to zero the four digits as well as blanking them (ie turn them off).

The action of the reset button is as follows. Pressing the switch sets bistable 2, consisting of IC2a and b, which holds the display in its reset position. A bistable is simply a switch with two inputs, whose output remains on when a pulse is received on the set input. It will not turn off until a second pulse is received by its clear input. After a length of time determined by the pseudo-random timer (IC2c and d and associated components R2, 3, 4, D1 and 2, and C2), bistable 2 is cleared enabling the display section to start counting. As well as clearing bistable 2, the timer sets bistable 1 (IC3c and d) which enables the clock generator, thereby sending pulses to the counter. The clock generator consists of R1, RV1, C1, IC3a and b. RV1 allows the clock frequency to be fine tuned.

When the player presses the "stop" button, bistable 1 is cleared which disables the clock generator. There are no more pulses to be counted by the counter so it appears stationary. Pressing the "reset" button clears the display ready for the next cycle.

Transistors Q2-5 switch each digit on in turn as IC1 transmits along the "seven-segment data bus" the information to that corresponding digit. This reduces the number of interconnections necessary between the counter/driver and the display. The standard term for this method of interfacing is "multiplexing" — quite a common idea in the field of computing.

CONSTRUCTION

The PCB layout is neat, uncluttered and makes construction fairly easy so we do advise that you use our design. Make all links first, using short lengths of stiff wire or old resistor/capacitor leads that you have cut from previous projects. It is most convenient to solder in the links first as this way you can make sure they are flush to the board and perfectly straight, reducing the risk of short circuits. Use a fine pair of long nosed pliers (if you have them) to bend the leads at right angles, to make the links fit perfectly.

Next, all resistors should be fitted, followed by capacitors, diodes and transistors. Mount IC4 flush to the board with its pins at right angles through the correct holes. Make sure that all semiconductors are the correct way round! We advise the use of IC sockets for IC1, 2 and 3.

The four-digit display board mounts flat on the PCB and is connected to the underside of the PCB via short wire links as in figure 4.

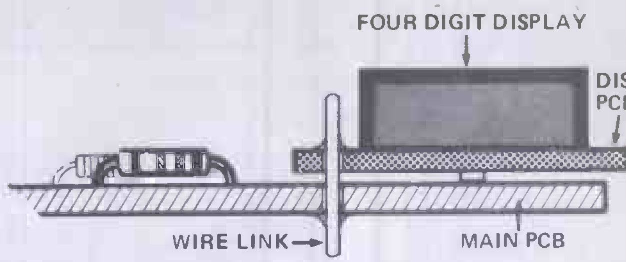


Figure 4 (above), showing details of the method of mounting the display board to the main circuit board. By soldering the wire links in the appropriate places, under the main and above the display board, adequate connections are made.

One of the lovely girls on the HE staff, Sue, timing her reactions with the completed prototype.

Solder the links to the underside of the main PCB and the topside of the display board.

Connect SW1, PB1 and 2, and the two batteries, then switch on and try it. It should work with no problems, although nothing may seem to happen for 10-15 seconds if the display is blanked. When the display lights up it should start from zero and continue until you press the stop button.

HE

Buylines

The multiplexed display type NSB 5881 and IC1, the AY-5-4007D will be the only two devices which may cause you trouble but any of the mail order companies, eg Marshall's, Technomatic, who advertise in HE should be able to help you. All other components are common and should cause no problems.

We have used our adding machines and abaci (plural of abacus?) to work out an approximate price (for components only) at £18 for this project. Obviously the cost of the PCB and case will depend on where and what you buy. The case is type BOC 708 from West Hyde.

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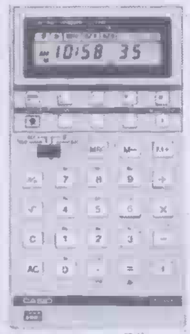

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Intellivision

All work in the HE office stopped for a couple of days, nothing unusual you might say, but wait until you hear the reason. Rick Maybury, playful as ever, explains.

THE TV GAMES SCENE has been pretty quiet over the past year or so, Atari have introduced new game cartridges with admirable regularity but there has been an almost complete lack of new machines. Now all this has changed with this exclusive review of the long-awaited machine from Mattel. We're actually feeling quite smug. This will be the first review of the Intellivision you'll see, simply because we've managed to get hold of one of only a handful of machines in the country, so remember, you saw it here first.

Pricey??

The Intellivision is due to be launched around September, the selling price is expected to be around £200. Before you get too incensed, we can fairly say that it's worth it. Anyway, given a few months it'll certainly come down to a more respectable level. If that sort of money still daunts you then we can reveal that the Intellivision is going to be the first games machine offered on a rental basis and extensive credit facilities will be available too.

So let's take a look at where your £200 (or around £6 monthly if you rent) will go. The games console or 'Master Component' as Mattel prefer to call it contains a 16 bit microprocessor, most games have only a four bit device, one or two have an 8 bit micro.In simple terms this means that the graphics will be as good, if not better, than some of the 'Pub and Arcade' games.

Play The Game

The controllers are a good example of ergonomic design, comfortable to use for prolonged periods, provided you remember that button pushing is not a matter of applied pressure but timing. People were walking around for a couple of days complaining of sore fingers. Rather than provide a selection of controllers for different games, Mattel have designed an all-in-one controller that has a joystick type action, numeric keypad and side buttons for 'rapid fire'. The main directional control consists of a small disc, pivoted in the centre, so just by pressing it on one edge any one of 16 positions can be selected. This type of action is much smoother than a conventional joystick, especially noticeable on fast games like Space War and Football. The side buttons came in for some criticism, doubts were expressed as to their life-span. I'm happy to report that over a dozen butch and burly Modmags employees did their utmost to destroy the controllers, particulalry during tense moments in the Armour Battle game, the controllers survived intact save for some rather deep scratches on the fire buttons. We still can't explain these.

Amazing Space

Initially, only a dozen or so game 'Carts' will be available; the soccer game comes with the Master Component. The most popular game in the office was undoubtedly the 'Armour Battle', similar in many respects to a conventional Tanks game but with the added advantage of around 240 'battlefields' and a 3D perspective view. This game lent itself to rather good tactical play, invisible mines could be dropped for the unwary to run onto. Not a game to tire of.

The football game came a close second. At the start of play the players emerge from the tunnel to the cheers, hoots and whistles of the crowd. You can only control one man at a time but the other men in the team are under computer control and will always be in the best positions for passing and tackling. Best feature of the soccer game comes with throw-ins. If a ball should be kicked off the pitch a little man from the appropriate team automatically crosses the pitch and throws the ball back into play — amazing stuff. The pitch is actually only ever seen in part. The area where the action is 'pans up and down the pitch. Its rather like watching Match of the Day!

Keyboard Add-On

The story isn't over yet, the Mattel Intellivision has one more trick up its microprocessor sleeve and that's an add-on keyboard unit just bristling with microprocessors and various other multi-legged ICs. Having spent in the region of £300 for the keyboard and plugged in your Master Component you'll now have a microcomputer with 16k of memory capable of decoding and supplying information in the Teletext/Prestel format, running software in Microsoft Basic and of course playing some pretty mean games that you can now write yourself. The computer comes with a four track cassette deck built in, using an audio track in conjunction with the programme data.

The Intellivision is without doubt the best TV game yet. It is destined to become the market standard for a few years to come. The keyboard option makes it a serious contender for the microprocessor market, so start saving now!

The author would like to thank Bob Denton at Advance Consumer Electronics, Unit 3, Fulton Road, Wembley, Middlesex for the loan of his Intellivision. Maybe he'll get it back one day. Thanks too, to Tony Dean at Silica Shop for helping us track one down. **HE**

Into Digital Electronics

BY IAN SINCLAIR

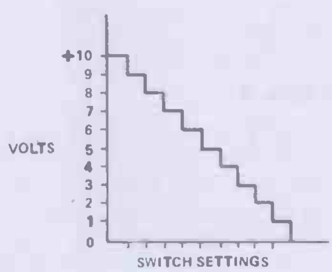
Ian Sinclair returns with a new series aimed exclusively at the newcomer to Digital Electronics. In part one we look at some of the ways electronics are helping us to count. In the coming months Ian Sinclair will deal with all of the most important aspects of this most important branch of electronics.

WHAT IS IT THAT frightens so many people away from digital electronics? Does the word digital conjure up pictures of advanced mathematics, or do you just wonder what possible use you could make of these circuits? Perhaps you've browsed through descriptions, and wondered if you were reading the same language as they were written in. Your worries are at an end, for the usual HE service is here, to provide you with a clear and right-from-the-beginning guide to the new electronics where everything is happening so quickly.

Finger Trouble?

The word digital sounds as if it might have something to do with fingers and there is indeed a connection. When we're very young (and sometimes when we're a bit older, too) we count on our fingers. Later on, we usually get out of that habit, but it's not a bad description of how computers do their counting. The difference is the number of fingers and how fast they can be used. Our standard allocation of fingers and thumbs totals ten, so it's not very surprising that we count in tens, and place figures in columns to show how many units, tens, tens of tens (hundreds) and so on, each figure represents.

When we come to try to do something similar in electronics, though, there's no obvious way of using ten of anything. We could, of course, imagine a transistor working from a 10 V supply, with its bias adjustable (Fig. 1.1) so that the collector voltage could be changed in 1 V steps from zero to ten. Now from what you know (don't you?) about transistor bias, what do you think would be the chances of things staying that way? Quite right, pretty low! As the transistor warmed up, the bias would change, and the collector voltage would alter. Not a promising start.



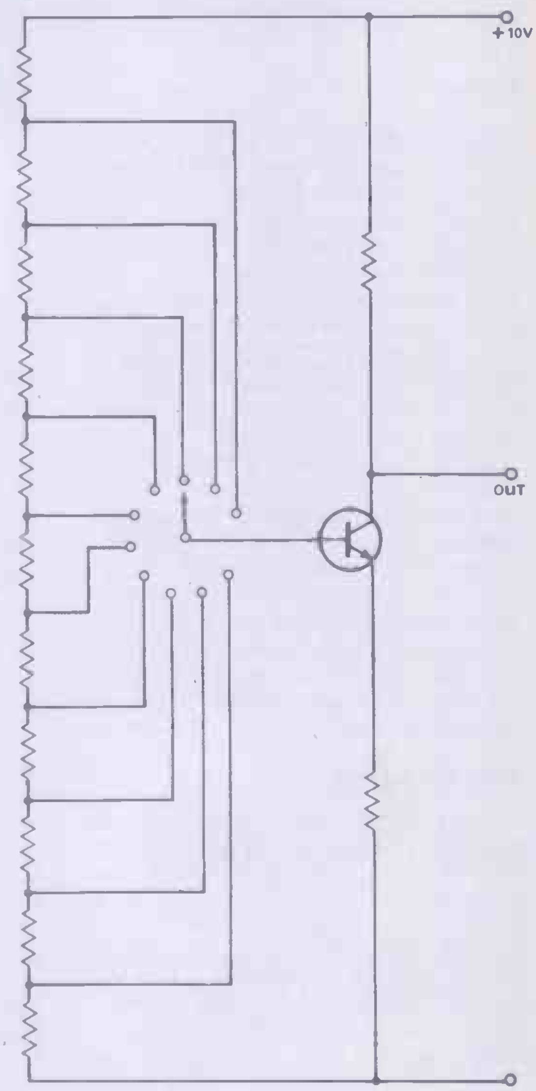


Fig. 1.1 Yes, you could use a transistor to count in a scale of ten — but it's a fearsome method, and the reliability would be poor. The step diagram above shows how we can use a voltage gradient to count from 1 to 10 in one volt steps. This method is not, however, very practical.

Two's Company

No, the really natural counting system for electronics is a scale of two. Its pretty easy to set an electronics system to be either fully on or cut-off, two *states*, as they're called, which can be set quite definitely. A transistor which is fully on, or bottomed, has a collector voltage of nearly zero (Fig. 1.2), and it's not difficult to make this state stable, meaning that it's not easily upset by changes of temperature or anything else. For example, the transistor in Fig. 1.2 is bottomed, and will stay that way because of the resistor which connects the base to the supply voltage. Provided that the resistor is not of too high a value, there will be more than enough current flowing into the base to keep the transistor collector voltage bottomed no matter what happens in the way of temperature changes, ageing of components and all the other things that can beset transistor circuits.

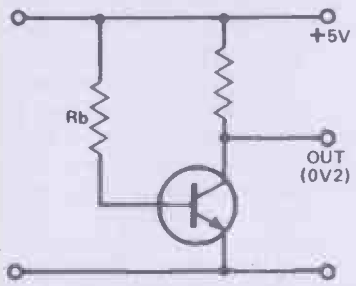


Fig. 1.2 Saturating or bottoming the collector voltage of a transistor. Connecting the base to the positive supply voltage makes sure that the transistor is passing as much current as the resistors permit.

The cut-off state is equally stable. As long as you keep the base voltage of a transistor below 0.5 V, there will be no collector current flowing unless the transistor is quite hopelessly leaky. These two conditions can be used in several ways. Two of the most important of these uses are in digital logic circuits and in digital counting circuits. We're going to start with digital logic circuits for the very good reason that they're simpler, and we'll move on to look at the counting circuits later.

Easy as Falling off a Log (ic)

Now you've probably come across the word logic many times before in articles dealing with digital circuits, but you've probably never seen it explained. Logic means a system for arriving at a conclusion starting from facts. If a cricket ball suddenly thumps through your window (fact), you start looking for someone with a cricket bat (logical conclusion). If you thump the first guy you meet who's carrying a tennis racquet, you've been illogical! Logic is about thinking clearly, as mathematics is, but the language of logic is ordinary English (or close to it), and it doesn't *have* to be expressed in symbols. Like mathematics, though, logic is a lot tidier and shorter if we do use symbols to express what we mean.

No, No, Yes, Yes, No

Now logic has been studied for a long, long time, several thousand years, and yet it took centuries for people to realise that each step in a logical argument could be simplified so that it consisted of a question which could have only two possible answers — yes or no. Logic, remember, is about getting conclusions from facts, and 'maybe' answers aren't much use for that purpose. Fig. 1.3 shows a simple logic process (is the kettle heating?) broken down into a set of these YES/NO steps just to illustrate what is needed. What's that? You don't need to use transistors to put the kettle on? Of course you don't, but the fact that *any* logical process can be broken down into a set of questions, each of which must have a YES or NO answer, does have a lot of uses. YES and NO are two *states,* and we can use the two stable states of a transistor to represent them. We can, for example, decide that a cut-off transistor, collector at supply, represents YES and a bottomed transistor, collecter at 0 V, represents NO; which opens the way to using transistors for any sort of logic operation.

Now this way of looking at logic problems was invented a long time ago by a self-taught genius called George Boole, and he worked out a system for writing down logic problems in a kind of mathematical shorthand, and of solving the problems using what is now called Boolean Algebra. Boolean Algebra was at that time just a curiosity, a fascinating sideline for people with nothing more urgent to do, until much later it gradually dawned on engineers that telephone switching circuit problems could be solved by using Boolean Algebra. It didn't take engineers very long after that to find that Boolean Algebra was almost indispensible in computer design — and it's been a top-priority topic ever since. Moral is that no piece of truly *scientific* research (as distinct from a lot of so-called 'social science') is ever really wasted.

Do IC Digits?

We're not here to do a course on the theory of Boolean Algebra, though, our task is to show how digital ICs can be used. Digital ICs, like any digital circuits, use signals which are either zero volts (transistor bottomed) or supply volts (transistor cut-off). We could, of course, call these NO and YES signals, but we usually shorten the description a bit more by referring to zero volts as 0 and supply volts as 1. The input or output of any digital circuit will consist of just these voltages, perhaps a signal which changes between 0 and 1 at intervals. We can forget about waveshapes, amplitudes, phase shifts and all these problems of linear circuits; all we're interested in is the two levels 0 and 1. That, incidentally, can make digital circuits a lot simpler than most linear circuits.

Long before digital transistor circuits were invented, logic circuits were built using switches. A switch is another device which is either off or on, and that's why the first use of Boolean Algebra was in switching circuits. The great advantage of the transistor is that its switching action doesn't rely on any mechanical contacts making or breaking. The switching of a transistor can therefore be much faster, with none of the bouncing, sparking and contact-wear problems which plague mechanical switches.

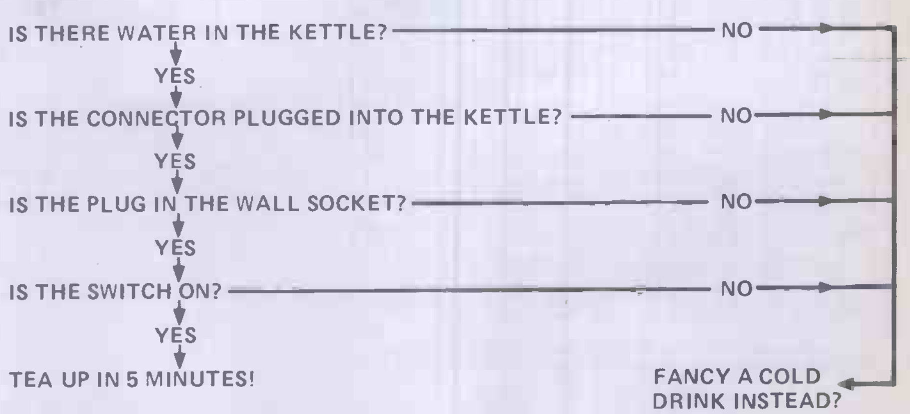


Fig. 1.3 YES/NO decisions for the kettle problem.

How are we going to learn about all this, then? The easiest way, of course, which is the HE practical way. We'll knock up circuits which make use of digital ICs, show what they do, and what they could do. We're not going to build our own computer, nor gadgets for playing the National Anthem every time a tap is turned on, but we are going to understand how these things *can* be done. What we will do is to put signals into digital ICs, using switches (mainly), and see what comes out (using LEDs). Once you understand what each of these circuits does, the way is clear to understand more complicated circuits, and that's what it's all about.

If Euronovice . . .

Now if you've followed the Linear ICs articles, you'll have met the Eurobreadboard before. If you're new to this style of circuit construction, then the Eurobreadboard is a system for building circuits without the use of soldering. The Eurobreadboard (Fig. 1.4) is a plastic block which is perforated with holes at 0.1" spacings. Under the holes are metal clips, so that a component leadout wire which is pushed through a hole is held by the clip underneath, and makes electrical contact to the clip. The clips aren't separate, but are grouped in fives, so that any one of a line of five can be used. These lines are indicated by letters A-D and numbers 1-25, so that 22A is a group of five contact points and 16B is another group. The lines are spaced so that normal sized ICs, such as the ones we're going to use will fit with one lot of pins on column A and another on B or one lot on C and the other on D. Big ICs like microprocessors can be fitted on these same columns or on the larger space between columns B and C.

Using these lettered and numbered lines, we can connect up circuits very quickly, test them, take them apart and then move on to the next bit of work without needing to wait for a soldering-iron to heat up. How do you build the circuits? Simple, when we make use of the letters and numbers. For each bit of work on digital ICs, we'll plug in one or more ICs into the board. They don't go in just any-old-where — they have to be plugged into lines which are indicated in the text. Connections can then be shown by printing the line number and letter for each connection. If it sounds complicated, that's just because we haven't started yet — it's a lot easier to do when you have a Eurobreadboard, with the IC, all ready in front of you. Having said that — let's start.

Preparing the Board

Before we can start, we need to prepare the board with the switches for putting in voltage signals and the LEDs for reading them off. The switch is a quad changeover, meaning that there are four sections of switch and the output of each section can be switched between two contacts. These switches are available from RS Components, Watford, or Maplin, and work out a lot more convenient than any other switch arrangement. The switch unit has 16 pins, four for each block, and is plugged into the Eurobreadboard in the position shown in Fig. 1.5. To make the connections to the switch, wire links then have to be added. These links should use insulated 0.5mm single-core wire, because stranded wire is useless for breadboards, and Maplin sell a suitable wire as Bell wire. So long as it's about 0.5mm diameter, insulated and single strand, it'll do fine. Each link will need about 8 mm of insulation stripped off — I use a little Bib stripper and cutter which has served me well for more years than I care to remember. Measure out the length of wire you need for each link (roughly — there's no need to do a Rolls-Royce job on it) and just plug the ends of the wires into the lines on the board which are indicated by the numbers and letters. For example, if you have to connect 8D with Y2, then one end of the wire goes into any hole in line 8D and the other end goes into *any* hole along the edge line which is marked Y2. The two long links connect the X1 lines to the X2 line and the Y1 line to the Y2 line. These four lines are going to be used for battery (or power supply) connections, with the + connections to X1 and X2 and — connections to Y1 and Y2.

Now add the LEDs and their 1k0 resistors as shown in Fig. 1.7. When we use the board, the LEDs will glow to indicate a voltage across them, so that a glowing LED indicates a logic 1 (+5 V in this case) and a LED which is

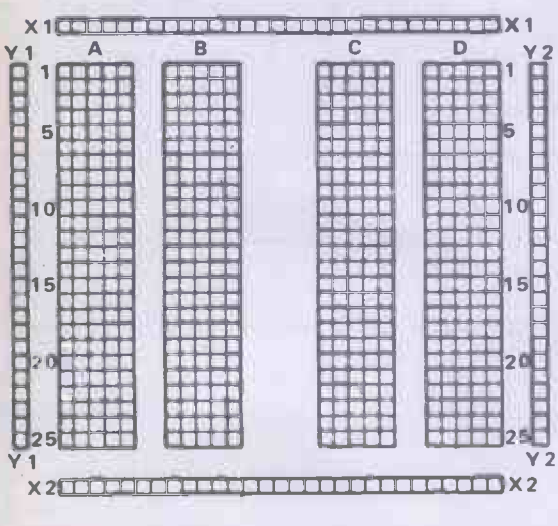


Fig. 1.4 The EUROBREADBOARD, on which all the circuits are constructed.

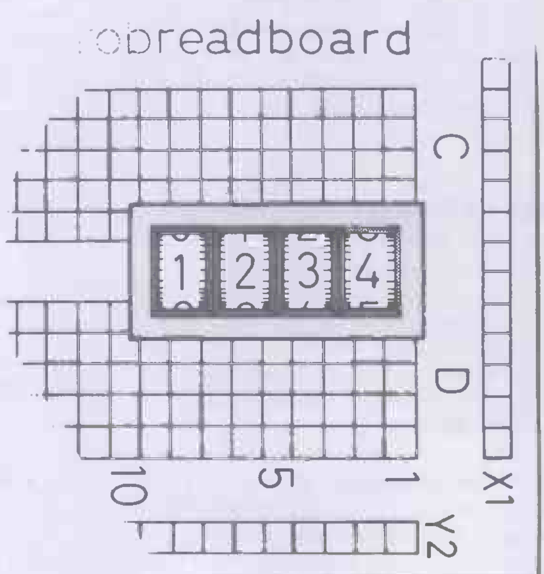


Fig. 1.5 Position of the Quad DIL switch on the Eurobreadboard.

SWITCH LAMP		
1C TO 2C	1D TO Y2	Y1 TO Y2 (NEGATIVE)
3C TO 4C	2D TO X1	X1 TO X2 (POSITIVE)
5C TO 6C	3D TO Y2	
7C TO 8C	4D TO X1	
	5D TO Y2	
	6D TO X1	
	7D TO Y2	
	8D TO X1	

Fig. 1.6 Wire links for the switches. These ensure that the switches operate correctly (UP for 1, DOWN for 0). Leave these connections in place.

LED'S:	
LED1 ANODE ON A7	CATHODE ON Y1
LED2 ANODE ON A5	CATHODE ON Y1
LED3 ANODE ON A3	CATHODE ON Y1
LED4 ANODE ON A1	CATHODE ON Y1

4 x 1k0 RESISTORS:
A7 TO B7
A5 TO B5
A3 TO B3
A1 TO B1

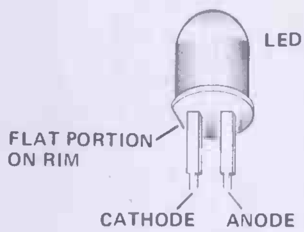


Fig. 1.7 The LED connections. No wire links are needed, because the components themselves bridge the gaps. Note which end of the LED is the cathode.

not glowing indicates a logic 0. We don't use all of them each time, but it's handy to have four of them ready on the board. The resistors prevent too much current from flowing through each LED, and our connections from the ICs are made to the resistors each time.

LED, Kindly Light

LEDs have to be connected the right way round if they are to be of any use and the Maplin LEDs have a particularly simple identification. There's a small flat segment on the plastic case of the LED, and the nearest metal lead to that end is the cathode lead, the one which plugs into line Y1. The anode wires plug into the lines A7 to A1 as shown — the spacing is because of the width of each LED. The resistors then connect across to the lines in column B, and our connections are made there. The switches are numbered already, and the LEDs follow the same pattern, with LED 1 on the left when the Eurobreadboard label is right way up.

Now at this point it's advisable to test the switches and LEDs to make sure that everything's working as it ought to — that way, you don't get any silly holdups later when you're using the ICs. The simplest way of testing is to use each switch to control one LED by linking B1 to C1, B3 to C3, D5 to C5 and B7 to C7. Now connect up a 4½ V battery to provide some power.

The type 1289 is useful — it has a fairly long life when used with the type of ICs we shall be investigating, and its + and — are clearly marked. For making the battery connections, I bought a pack of car-type LUCAR connections in Halford's. These are a tight slide-fit on to the battery tags, and they can also be clamped onto single-strand wire. Use a **red** insulated wire for + and **black** for —ve — it saves a lot of time when you are trying to get things going. The + (red) wire plugs into any hole along X1 or X2 and the — (black) wire plugs into any hole along Y1 or Y2. With the battery in place, and the board right way up, so that the Eurobreadboard label reads right way up, try each switch. Moving the slider of a switch up should cause its LED above it to light, moving the slider down should extinguish the LED. Try each switch in turn, making sure that it switches on and off correctly. If there's a rogue, check that the LED is the right way round and that the switch pins are connected into the correct places.

LEDs don't take kindly to being connected wrong way round, and there's a chance (not inevitable) that one which has been A for T will not work when you put it the right way round. If that happens, you're out of luck and you'll need another LED some time — no hurry because we don't use all four right away. With the 1k0 resistors specified here, though, there should be no damage to LEDs even if they are wrongly connected.

Next month then, it's down to work on the first IC, a 74LS132. The ICs we're using are all of the type called TTL Low Power Shottky. That's rather a mouthful, so we'll just refer to them as the 74LS types, because each type number starts with 74LS. They have several advantages over other types, one of which is that you can't damage them by handling the pins. Unlike CMOS ICs, TTL ICs can't be ruined by the electrostatic voltages you get from sitting on nylon seat-covers or walking along woollen carpets. The main drawback of the 74 family was that they needed a lot of current and a 5 V supply, but the 74LS types need very little current, and are quite happy at 4½ V, so we can use a battery supply.

If you do make use of a mains supply, make sure that it's set at 5 V, no higher. Don't trust any switch or dial readings for this, take a voltmeter reading, because higher voltages can damage these ICs.

Meanwhile, if you want to get your orders in ready for next month, here's a buying list for this month, next month and for the rest of the series (if you're rich!) **HE**

Parts List

Starter Pack:
1 Eurobreadboard
4 x LED, standard size (5 mm diameter)
4 x 1k0 ¼W resistors. All obtainable from Watford Electronics
1 x Quad DIL switch
Single-strand wire
Power supply (5V) or No. 1289 battery and Lucar Connectors.

Remaining Items:
ICs—
1 x 74LS132
1 x 74LS75
2 x 74LS76
1 x 74LS90
1 x 74LS47 (may be difficult — substitute 7447 if necessary)
1 x 74LS82
1 x 7-segment display such as DL707

Other components—
1 x 560R ¼W resistors
1 x 470 μF (1000 μF also useful to interchange) capacitors
7 x 47R ¼W resistors

What's In a Name

This month's What's In A Name has absolutely nothing to do with part-time bus conductors. Our word this month is Semiconductor, the keystone of modern electronic technology as Rick Maybury explains.

IT'S NO ACCIDENT THAT ENGLISH has become the language of science. English is the only language that has the capacity to form compound words with such precision. This makes life relatively easy for us, almost without exception the words and phrases we'll be looking at in this series are made up from two or more familiar words. Our word this month falls neatly into this category, it's 'Semiconductor', the word most readily associated with modern electronic technology.

One hundred years ago you could say with some degree of authority that a material was either a conductor (it would conduct electricity) or an insulator (it wouldn't conduct electricity). Today, as we have come to expect, things aren't so clear-cut. The word Semiconductor implies that the material so named is neither one nor the other, yet for reasons that should become obvious later we cannot use the term resistor.

Two substances have become synonymous with the word semiconductor, both are elements, the first is called Germanium, a greyish metal, not really used much outside electronics, the second is Silicon, famous for chips and sand, not to be confused (as it often is) with Silicone.

Germanium was the first material to be used in any quantity for semiconductor manufacture, today it has been largely superseded by silicon although the basic manufacturing process is the same.

Current Affairs

The difference between conductors and insulators is actually quite subtle, it's all down to the presence (or absence) of free electrons. These are loose electrons that run around inside conductors; by adding certain impurities to silicon or germanium in a process known as 'doping' you can either cause an excess of free electrons (this we call 'N' type) or conversely deprive the material of free electrons, leaving 'holes' which are effectively positively charged particles (this is known as 'P' type). In either case the material is now known as a semiconductor.

Up the Junction

Now the story really gets interesting, by fusing two pieces of semiconductor material (P and N type) together we get what is known as a junction at the point where they meet. It's to be expected that we should now have a PN junction. This is the basic unit in semiconductor electronics. At the junction strange things happen, the free electrons and the hole tend to 'migrate' across the junction forming an area called the depletion layer.

Now try to imagine a battery connected across this junction, the positive side connected to the N type and the negative side of the battery to the P type, under these conditions no current will flow, this we call 'reverse bias'. In simple terms the positive side of the battery has drawn all the electrons from the depletion layer and the negative side has removed all the holes, the movement is caused by simple electrostatic attraction — unlike polarities attract. If we now connect the battery the other way round the opposite happens, the positive side now pulls the electrons through the P layer, the negative side of the battery attracts the holes, current now flows quite happily. We have here the semiconductor diode, the electronic one way street, clever isn't it?

As you might expect the story doesn't end here. By varying the proportions of the impurities you can make the basic semiconductor diode do quite strange things. Adding successive layers of semiconductor material to our basic PN junction will produce transistors (three layers, two junctions), thyristors (four layers, three junctions) and ultimately Integrated Circuits which incidentally is the subject of next month's 'What's In A Name'. See you then. **HE**

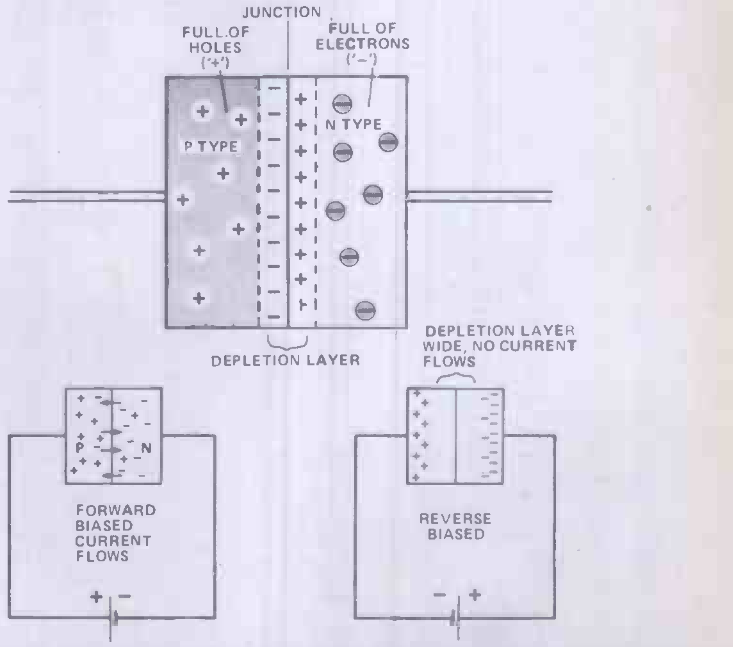
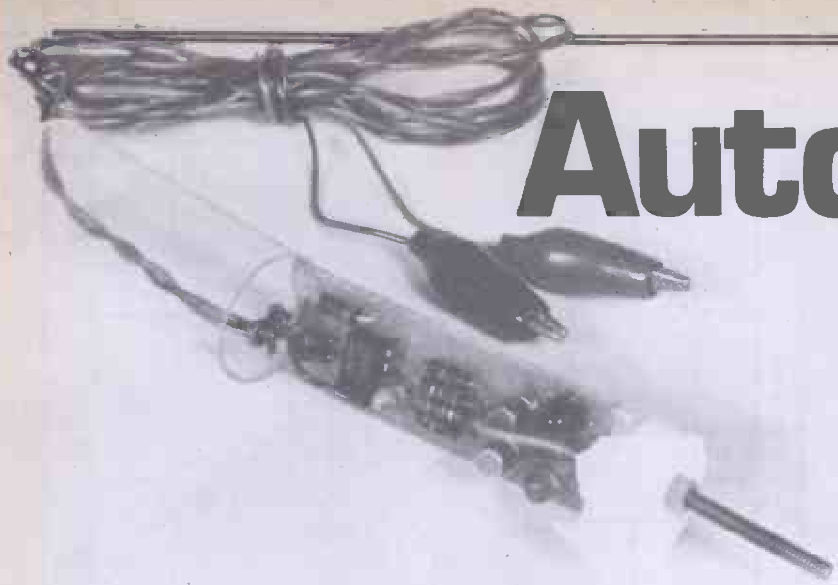


Figure 1. A typical PN Junction in each of its three possible states. Top: The Junction in its dormant state. Bottom left: In the forward biased condition. Botom right: A PN Junction reverse biased.



Auto-Probe

When it comes to probing faults or otherwise in a vehicle's electrical system, a multimeter has distinct disadvantages. This highly convenient probe is very useful in those awkward places so often encountered; it's also simple to build and inexpensive.

THE DIFFICULTIES of tracing a fault in a vehicle's electrical system using a multimeter are probably familiar to most readers. As that accursed Murphy's law generally has it, you have to contort yourself into an awkward position before you can see where to put the test prod, or prods, and having done that, find that you can't twist yourself sufficiently to see the multimeter face.

Damned annoying isn't it!

Then again, a multimeter can give you a false indication. No, not possible, you cry. It sure is though. If, for some reason, you're measuring the voltage at a particular point and it happens to be connected to the battery via a low, but significant, resistance how do you detect the presence of that low resistance?

A voltmeter measurement won't show it. If that low resistance is the fault, an ohmmeter measurement may well be impossible.

Sorting out the wiring can be a nightmare — especially on motorcycles.

This project gives clear indication of the six conditions one usually finds in an automotive electrical system. These are:

- Short to +ve supply
- Short to —ve supply
- Open circuit
- Connection to +ve supply via an intermediate impedance
- Grounded via an intermediate impedance
- Connection to a fixed, inter-mediate (low) voltage level

The Auto-probe is smaller, cheaper, easier to interpret and easier to use and read than a multimeter. It is the sort of device that can be left in the tool kit in the boot of your car or stored in the glove box. It is a worthwhile addition to any mechanically-minded handyman's array of gadgets.

The Auto-probe can be used on 6 volt or 12 volt systems, with minor changes to the circuit values.

To get an idea of how it can be used, and how useful it is, let's take a look at a few typical problems encountered in vehicle electrical systems.

The Problem

Let us consider the case of a car radio that has 'stopped working'.

Looking at the panel lights, you observe that they aren't lit up when the set's turned on. Obviously, it would seem to be a supply problem. Wriggling, upside down, under the dashboard, you check the fuse and find it intact. Taking the Auto-probe, you attach its supply leads to the rear connection of the cigarette lighter or the ignition switch. Both lights should blink on and off. If they don't then you'd have to reverse the connections and mentally castigate yourself for being a twit. No worries though, it's protected against twits.

Touching the probe on the radio's B+ connection, the red LED glows steadily. Aha! This shows the probe tip is connected to the supply. Touching the probe onto the radio's ground lead results in a blinking red LED. Hmm, it's connected to supply via an impedance. It seems the ground connection isn't grounded.

Some jiggling and scraping at the radio's ground lead earthing point results in a steady green LED and a burst of music . . . well, more likely, commercials.

Suppose you wish to know if your car has an ignition ballast resistor. This is a resistance inserted in series with the ignition coil primary during normal running, but is shorted out when the starter is operated so that the coil receives a voltage 'boost'. The resistor may be a heavy wirewound type mounted somewhere in the engine compartment or (as is common in many late-model vehicles) a resistance lead is used — they're hard to spot.

In this case, the probe tip is touched on the coil primary terminal that is not connected to the contact breaker points. With the ignition on, (engine not running) no light will show on the probe, indicating it is connected via an intermediate impedance. When you touch the starter, the red LED should burst into lusty life, indicating the resistor is shorted, as you would expect.

Tracing wiring and switch operation can be a real hassle. Does this motorbike operate its horn by supplying power or a ground connection via the horn switch? If touching the two switch contacts in turn shows first a steady green LED then a blinking red LED, the first contact is grounded and the second is clearly connected to the positive supply via an intermediate impedance, ie: the horn. If the green LED lights and then both LEDs blink when the probe is touched to the other switch contact, this would indicate that the horn is open circuit.

The circuit will cause both LEDs to blink when the probe tip is connected to an open circuit or to either side of the supply via an impedance greater than about 1,000 ohms. In an automotive environment 1,000 ohms is a high impedance!

Simple, and easy to use, isn't it?

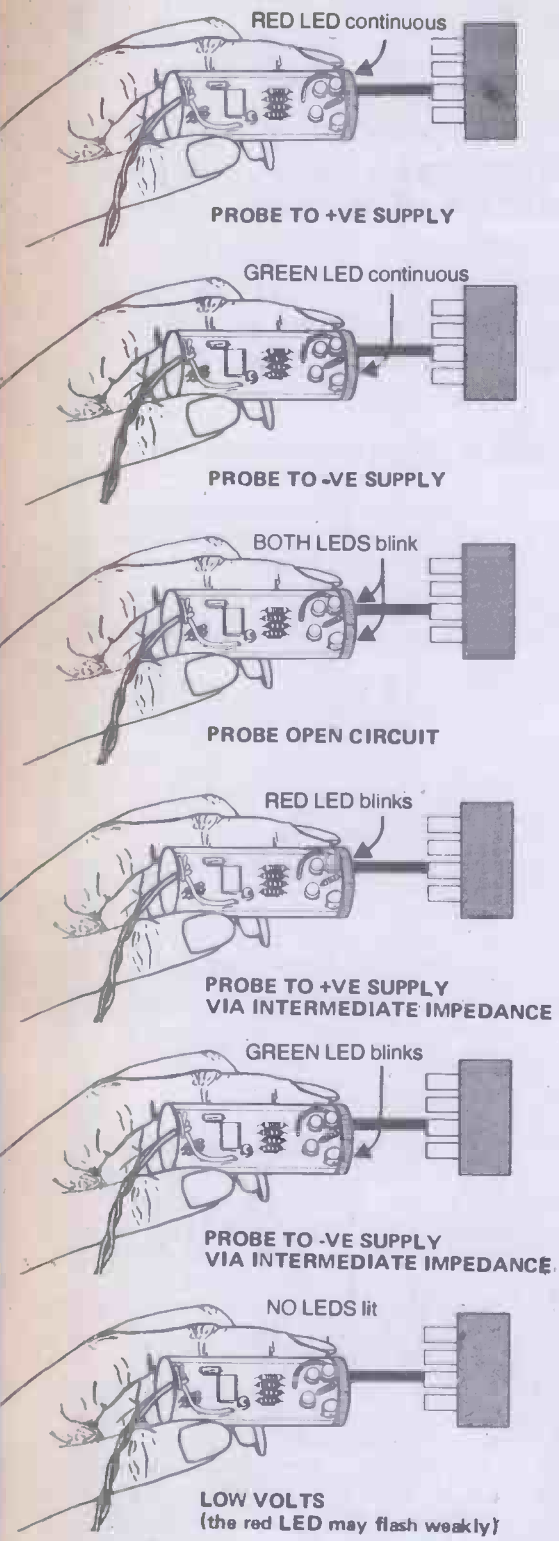


Figure 1 showing in visual form the wide variety of electrical conditions which may be encountered in automobile electric systems and how the HE Autoprobe detects them.

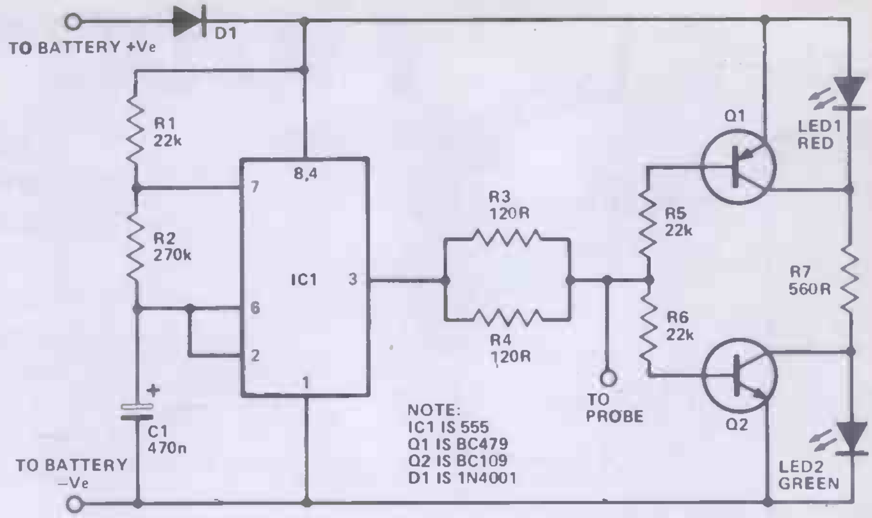


Figure 2 (above), the circuit diagram — yet another ingenious use of the 555 integrated circuit.

How it Works

Consider first the 'idle' state of the device — ie: with the probe open circuit. Diode D1 protects the whole circuit against accidental reversal of supply polarity. When the battery is connected correctly, the battery voltage (less about 0.7 volts dropped across D1) is applied to the electronics.

IC1 is the familiar 555 timer IC, connected as an astable multivibrator. When C1 charges up to 2/3 of the supply voltage, via R1 and R2, the 'high' level comparator (pin 6) detects this and sends the output high, which also shorts pin 7 to near ground. C1 thus commences to discharge via R2. When it reaches 1/3 of the supply voltage, the 'low' level comparator trips (pin 2) and C1 is allowed to recommence charging as before, since the output is sent low. This cycle repeats indefinitely, with a frequency of

$$F = 1/(0.692 \times C1 \times (R1 + 2R2))$$

With the values chosen, this is about 4 Hz. This may be varied by changing C1 or R2. The output on pin 3 of IC1 oscillates between nearly 0 V and V+ (less 0.7 volts). It can source about 200 mA.

Consider now the circuitry surrounding the LEDs. Assume at first that the voltage on the junction of R5 and R6 is about half the supply potential. Current will flow through the bases of both transistors via R5 and R6, hence both of these transistors will conduct. Each transistor will short out the LED connected in parallel. Thus neither LED will glow. If the voltage on the resistor junction (the probe connection) were to fall below 0.6 volts, or thereabouts, Q2 would be biased off and would no longer bypass the current flowing through R7 away from the green LED. Thus the green LED would light. Similarly, if the voltage on the probe were to rise to within 0.6 volts of the unit's supply rail (ie: within 1.3 volts of the battery supply, due to the action of D1) Q1 would be biased off and the red LED would light.

Now let us put the picture together and see what happens in practice. The output of IC1 is connected to the probe and the resistor junction of the LED driver circuit via a 60 ohm resistance made up of two 120 ohm resistors in parallel. There are two resistors rather than one 1W or larger resistor for reasons of physical size.

With no connection made to the probe, the 555 drives the probe alternately to the +ve and —ve rails, with the result that the LEDs flash alternately.

Shorting the probe to either rail of course forces the appropriate LED to stay on continuously. If a resistance is placed between the probe and ground, say, three possibilities occur:

1) The current flowing from pin 3 of the 555, via R3/R4, is insufficient to develop 0.6 volts across the resistance — this looks like a short and the green LED stays on.

2) The current develops sufficient voltage to turn Q2 on and the LED extinguishes on that part of IC1's cycle when its output is high. This allows the appropriate LED (green) to blink.

However, if the resistance is not high enough to allow the junction of R5/R6 to go far enough positive the red LED will not turn on. This gives green only blinking.

3) If the resistance is high enough (over 1k) both LEDs blink, giving the open-circuit response.

The same argument applies 'upside down' for a resistance to the positive rail, but the voltage across it must be 1.3 V due to D1 being in the emitter circuit of Q1. If the voltage is fixed midway, neither LED can glow, as first assumed.

Resistor R7 fixes the LED current and R3/R4 limits the 555 output current to a safe level and defines the voltage 'turnover' points.

Parts List

RESISTORS (All ¼ W, 5% unless specified)	
R1, 5, 6	22k
R2	270k
R3, 4	120 R ½ W (See text)
CAPACITORS	
C1	470n 16 V tantalum
SEMICONDUCTORS	
IC1	555
Q1	BC470
Q2	BC109
D1	1N4001
LED 1, 2	0.2" red, green. LEDs
MISCELLANEOUS	
Lengths of red and black wire	
Crocodile clips	
Pill container	
4 BA nut and bolt (for probe)	

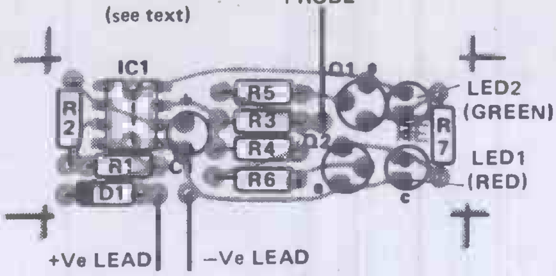


Figure 3. Printed circuit board overlay. Once completed the project will, no doubt, pay for itself very quickly by savings on costly repair bills.

Buylines

It is a distinct possibility that our readers will have problems obtaining the case for this project (i.e. the pill container) from their usual electronic hardware suppliers. You could always try the National Health

The grand total for all components in this project shouldn't be much more than around £3.

Construction

Constructing the project on a PCB is simple. First thing to do is locate the position of IC1. A link is inserted between two pads located between the two rows of holes for the IC pins. Having done that, insert the IC. Take care that you have it correctly oriented. All the other components may now be assembled and soldered into the board. Watch the orientation of Q1 and Q2, the two LEDs and C1. Refer to the overlay picture.

Now comes the testing. You will need either a 12 V battery or a power supply that can deliver around 12 V to 14 V DC. Temporarily solder battery leads and a probe lead to the board. Connect the battery leads to the 12 V supply. The two LEDs should flash. Shorting the probe lead to the negative of the supply should cause the green LED to flash.

If you cannot obtain the correct indications at this stage, look for incorrect connections or components round the wrong way. To check that IC1 is working, connect a multimeter — set to, say, the 30 V range — between the supply negative and pin 3 of IC1 (positive meter lead to the latter). The meter needle should rise and fall at about four times per second.

The pill bottle used to house this project measured 61 mm overall length (with the cap on) by 21 mm outside diameter. A 25 mm long 6 BA bolt was used for the probe. This was bolted through a hole made in the cap somewhat off-centre. The photograph shows roughly where this needs to be. Just keep it out of the way of the board. A small solder lug under the bolt head is used to attach the probe lead from the board. The battery leads should be colour-coded to avoid confusion. The convention is: red for positive, black for negative. Twist together about one metre of each colour hookup wire.

Connect the appropriate leads to the board and tie a knot close to the board (see photograph).

Drill a hole in the end of the pill bottle, near the edge, and pass the battery leads through it. The knot prevents the leads being pulled out of the board. Attach alligator clips to the ends of the battery leads.

Two small cutouts will have to be made in the lip of the pill bottle's cap so that the LEDs may be seen easily. All these details are clearly shown in the photograph of the completed project.

When the unit is assembled, give it a thorough work out.

Once you have this little project working for you, you'll be amazed how quickly electrical problems in your vehicle are sorted out. **HE**

Blast! Now what do I do? I wish I had my HE Autoprobe with me!

Talking Design

Month by month we'll be looking at the various ways electronic circuits are designed.

THE MOST USED transistor configuration is the common emitter stage. The reasons are not hard to find since it offers a reasonably high voltage gain combined with a medium input impedance.

Just how to design such a stage and what to expect from it is the subject of this month's 'Talking design'.

Figure 1 shows the outline circuit of a common emitter stage with all the important currents and voltages. Before any design work can start certain parameters must be fixed. The most important of these are the supply voltage and the gain of the transistor to be used.

For the sake of our example we will assume a gain of 100 and a supply of 9 V. The gain of a transistor is usually found in semiconductor data sheets under H_{fe}'. A range of values will usually be quoted, transistor gain varies considerably from device to device and all that one can be sure of is that the sample to hand will lie somewhere within the specified band.

Under these circumstances it is advisable to assume the lowest value and calculate accordingly. At least that way you will be certain that the circuit will function satisfactory with any device sample.

The circuit of Figure 1 shows an NPN transistor although these methods are qually applicable to PNP types, the only different being the polarity of the supply rails.

Transistor Amplifier

The circuit as it stands is intended to amplify low level analogue AC voltages, ie audio signals, and so these are coupled into the base of the transistor via C1. This has to be chosen so that its impedance at the lowest frequency to be amplified is at least ten times less than the input impedance of the stage. The input impedance of the stage will be calculated later but first attention must be directed towards the output section. In order that the circuit can deliver the maximum output swing to the next circuit the collector must be held at half the supply voltage, in our case 4.5 V. In order to define the value of R3 a collector current must be chosen.

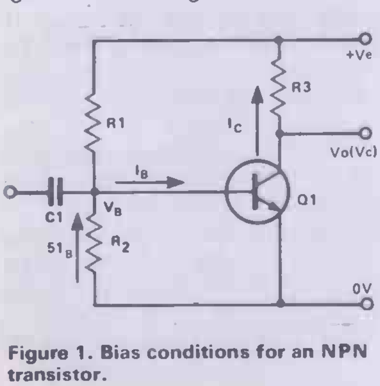


Figure 1. Bias conditions for an NPN transistor.

This is dependent upon the input impedance of the following stage. The output of the stage 'sees' the following stage as a resistance in parallel with R3. That is to say it is loaded by it. The golden rule of matching stages together is to ensure that the output impedance of your stage is at least five to ten times smaller than the impedance into which you are feeding signals. Since a transistor acts as a current source it is safe to assume that the output impedance of the stage is defined by, and is the same value as, R3.

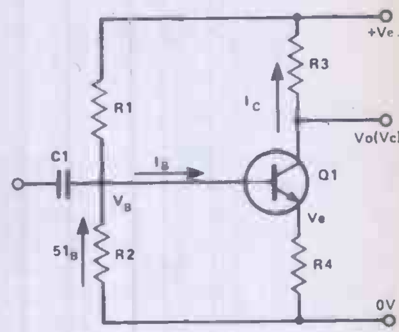
The situation changes somewhat when feedback techniques are employed, the output impedance is then less than the value of R3. How much less is dependent upon the amount of feedback employed.

As this is a small signal stage a convenient value for this current is 1mA. R3 can now be found from Ohm's law to have a value of 4.5V/1mA, = 4.5k. The nearest preferred value is 4.7k and this should be used.

Base Bias

Because transistors are current operated devices a certain amount of base bias current must be provided.

This current is nominally the collector current divided by the gain of the transistor. As already described, this varies considerably from device to device. A further complication is that the transistor base has to be held at 0.65 V above the emitter to operate in the linear region. These factors determine the values of R1 and R2 in the bias chain.



$$R3 = \frac{+V \times Ic}{2}$$

$$R4 = \frac{R3}{GAIN}$$

$$Ve = R3 \times Ic$$

$$Vb = Ve + 0.65$$

$$Ib = \frac{Ic}{Hfe}$$

$$R2 = \frac{Vb}{51_B}$$

$$R1 = \frac{(+V - Vb)}{51_B}$$

$$C1 = \frac{10}{2\pi fZ}$$

WHERE:

$$\frac{1}{Z} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{Hfe\,(re + R4)}$$

and $Ve = \frac{26}{Ic}$ Ohms

Figure 2. Calculating the values of the resistors and capacitor.

As we have a gain of 100 the base current will be 1mA/100, 10μA. A useful rule of thumb is to have five to ten times this current flowing through the bias chain. This will swamp any variations in calculated base current but reduces the input impedance. In electronics, as in anything else in this world, you don't get owt for nowt and so, if a stable circuit is to be produced, the penalty must be paid. The other requirement is to hold the base at 0.65 V. Five times our calculated base current is 50μA and since the voltage on the base if 0.65 V the value of R2 must be, again from Ohm's law, $0.65V/5 \times 10^{-5}A$, 13k. The nearest value is 12k. R1 is found by subtracting the voltage drop across R3 from the supply voltage and dividing by $5 \times 10^{-5}A$. ie $8.35V/5 \times 10^{-5}A$, 167k. The nearest value here is either 150k or 180k. Since the bias current must also flow through R1 the lower value should be chosen.

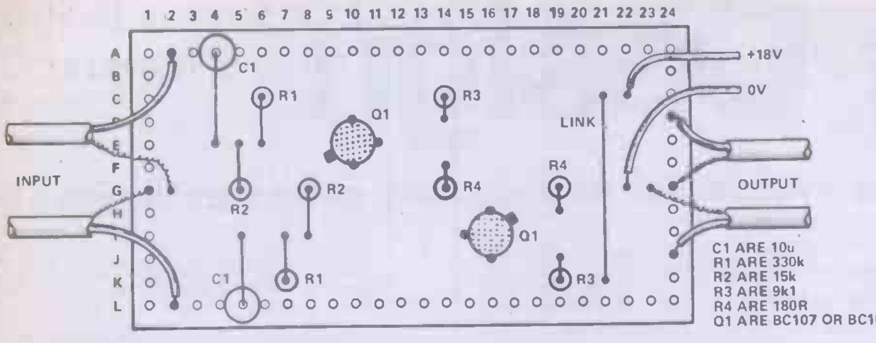


Figure 3. Simple stripboard layout for the Fig. 2 circuit diagram. This is a stereo version.

The gain of the stage depends on a hidden resistance in the emitter of the transistor. This resistance, hereinafter called r_e, the emitter resistance, is determined by the collector current. It's value, for silicon transistors, is $26/I_c$ Ohms, where I_c is the collector current expressed in milliamps. The voltage gain is $R3/r_e$.

For practical purposes the gain of any common emitter stage without negative feedback is twenty times the supply voltage, 180X in our example.

The input impedance is the parallel combination of R1, R2 and $H_{fe}Xr_e$. Putting these figures into the case in point we find that the input impedance Z, can be found by evaluating the following expression,

$$\frac{1}{Z} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{(H_{feXVe})} =$$

$$\frac{1}{167{,}000\Omega} = \frac{1}{15{,}000\Omega} + \frac{1}{2{,}600\Omega} +$$

will reveal the answer, 1790R, 1.79k.

A few minutes work on a calculator will reveal the answer, 179oR, 1.79k.

Having established this the value of C1 can be calculated. As you know the impedance of a capacitor is dependent upon frequency. The higher the input frequency the lower the impedance. At DC any decent capacitor will be, for all practical intents and purposes, an open circuit. The size of C1 is dependent on the lowest frequency to be amplified. For audio work this is 20Hz. The correct size capacitor, to give us a —3db point at that frequency, will have an impedance that is equal to the input impedance of our stage at 20Hz.

The required capacitance can be found from the expression,

$$C = \frac{1}{2\pi fZ}$$

by substituting all our known values into this equation we find that the required value is;

$$\frac{1}{3.14 \times 2 \times 20 \times 1.79 \times 10^3}$$

$$= 4.4 \times 10^{-6}F,\ 4.7\mu f.$$

It is wise to choose a value ten times that obtained from this calculation. In order to understand why consider what would happen if two circuits, both with a —3db point at 20Hz were to be connected together. With this situation the response of both amplifiers together will be —6db down at 20Hz, hardly hi-fi!

By making the input capacitor several times larger than necessary this is avoided.

Fixed Gain

Of course it is not always desirable to use the circuit without feedback an amplifier with a known voltage gain is often required. Under these circumstances the circuit in figure 1 can be modified as shown in figure 2. The only obvious difference between figure 1 and 2 is the inclusion of an extra resistance, R4, between the emitter and ground. This has the effect of defining the gain to any required value, increasing the input impedance and lowering the output impedance.

To illustrate this I will outline the design of a simple microphone amplifier with a gain of 50 running from a supply voltage of 18 V and using our transistor of gain 100.

First we find the value of R3 by letting the collector voltage equal half the supply voltage, 9V. Again choosing 1mA quiescent current for the stage gives us a value for R3 of $9\ V/10^{-3}A = 9k$. 9k1 is the nearest value.

To get the required gain from the circuit R4 must be chosen to be R3/gain. In our case the required gain is 50 so R4 becomes 9k/50=180R. Now because the current that flows through R3 also flows through R4 there will be a voltage drop across it of $10^{-3}A \times 180 = 0.18$ V. To this must be added our 0.65 V base emitter voltage to find the voltage drop across R2. This is 0.83 V. Because our transistor has a gain of 100 the bias current is the same as the previous case, 50μA. The value of R2 is therefore $0.83V/5 \times 10^{-5}A = 16k6$, the nearest value is 15k. R1's value is $(18V - 0.83V)/5 \times 10^{-5}A = 343k$ nearest value 330k.

The input impedance looking into the circuit is gain the parallel combination of R1, R2 and the impedance looking into the base. This time however the impedance is equal to the gain of the transistor multiplied by r_e plus R4. Since R4 is much larger than r_e the latter can normally be ignored. For completeness however,

$$\frac{1}{Z} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{H_{fe}(ve + R4)}$$

$$= \frac{1}{1.5 \times 10^4} + \frac{1}{3.3 \times 10^5} + \frac{1}{2.06 \times 10^4}$$

$$= 1.18 \times 10^{-4}$$

Hence $\frac{1}{2} = 1.18 \times 10^{-4}$, and Z=

$$\frac{1}{1.18 \times 10^4} = 8K45.$$

C1 is calculated from, C1 =

$$\frac{10}{2\pi fZ} = \frac{10}{2 \times 3.14 \times 20 \times 8.45 \times 10^3}$$

As it stands the stage we have just designed is suitable for amplifying low level, low impedance microphone signals sufficiently to be fed into the high impedance auxillary input of any power amplifier.

Low Power

Of course there are many uses for the common emitter stage apart from simple audio amplifiers. In fact you will find them in nearly all types of transistor equipment often in the disguises of oscillators, RF amps, DC amps, level shifters, the list could be extended indefinitely but whatever the disguise the basic design principles remain the same.

Since the circuit is so simple a PCB would be a little extravagant so the stripboard layout of figure 3 is used. A stereo version is shown and the circuit can conveniently be run from a pair of PP3's in series. Because of the low current drain the batteries can be expected to last for several months even if an on-off switch is not fitted.

HE

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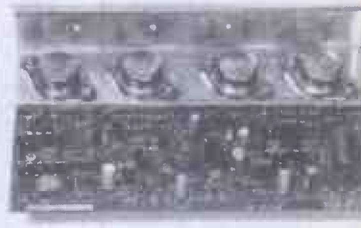

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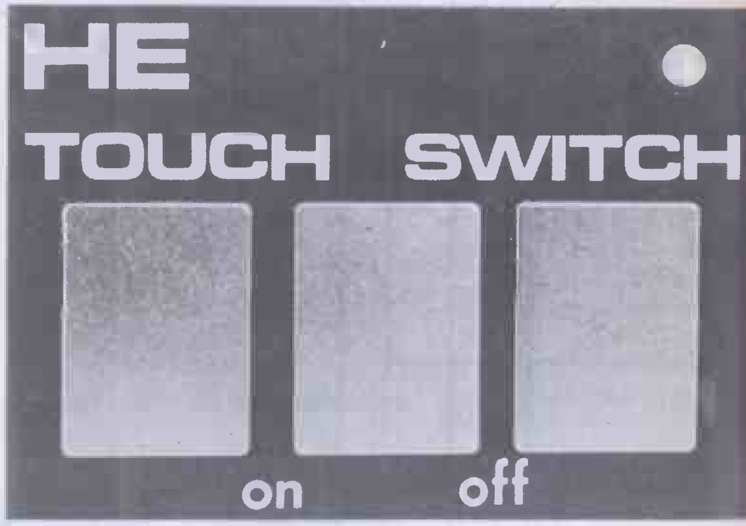
Touch Switch



A unique new design for a popular project. The HE Touch Switch uses VMOS Field Effect Transistors to turn your offs back on again. A cheap and easy to build circuit.

WOULD YOU LIKE to turn your radio, your stereo system or virtually any electrical equipment on and off merely by *touching* it? This simple touch switch can be adapted to do the job.

This unique device uses ordinary skin resistance to trigger a VMOS power transistor into conduction by touching the ''ON'' metal plates on the front panel. Once it has been touch-triggered, the transistor remains in this state (and so your electrical equipment remains on) until the device is turned off by touching the ''OFF'' plates.

Obviously the absence of any moving parts to wear out means that a touch switch has the advantage over mechanical switches of an almost unlimited operating life. The HE VMOS Touch Switch is primarily intended to suit 9 volt battery operated equipment, drawing up to a couple of hundred milliamps or so. However, there is nothing to stop the ambitious reader from connecting a relay at the touch switch output and using the relay contacts to switch mains type equipment. The sky's the limit.

Construction

No breaks in the track of the 10×24 hole, 0.1'' matrix veroboard are required so the components can be soldered in immediately, following the board layout of figure 1.

Although Q2 is a MOS device, its internal protection diode withstands higher voltages than those which can occur on human skin so special handling precautions are absolutely unnecessary.

Suitable touch contacts can be made from small bits of printed circuit board but the ones which we used are commercially available and a suitable source is quoted in Buylines.

The circuit can be cased if required, or left as ours, on a panel therefore enabling its easy insertion into equipment. It really is up to you and the use to which the Touch Switch is to be put.

Buylines

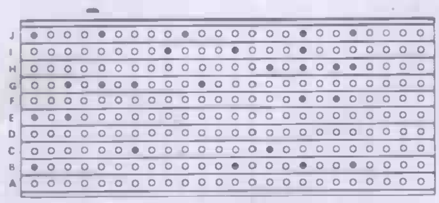
To our knowledge, the only mail order stockist of the VMOS powerfets is J. W. Rimmer, who advertise in "Hobby Electronics".

Watford Electronics stock the touch contacts which we used.

All other components should be readily available and the approximate price of the components is around £3.00.

Parts List

RESISTORS (All ¼W, 5%)	
R1	3k3
R2	1M0
R3, 4	10M
R5	270R
CAPACITORS	
C1	47n polyester
SEMICONDUCTORS	
Q1	BC109 N-P-N
Q2	VN66AF or VN67AF N-channel power VMOS (see Buylines)
LED1	0.2" Red LED
MISCELLANEOUS	
3×	touch contacts (see buylines)
10×	24 holes 0.1" matrix veroboard
1×	battery and clip



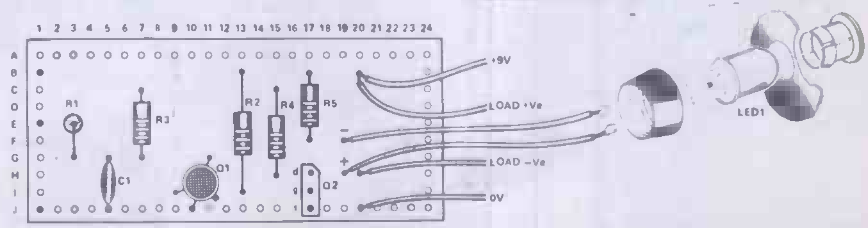


Figure 1. The veroboard layout and (above) the underside of the board. The three connections from points B1, E1 and J1 go straight to the off, central and on touch plates.

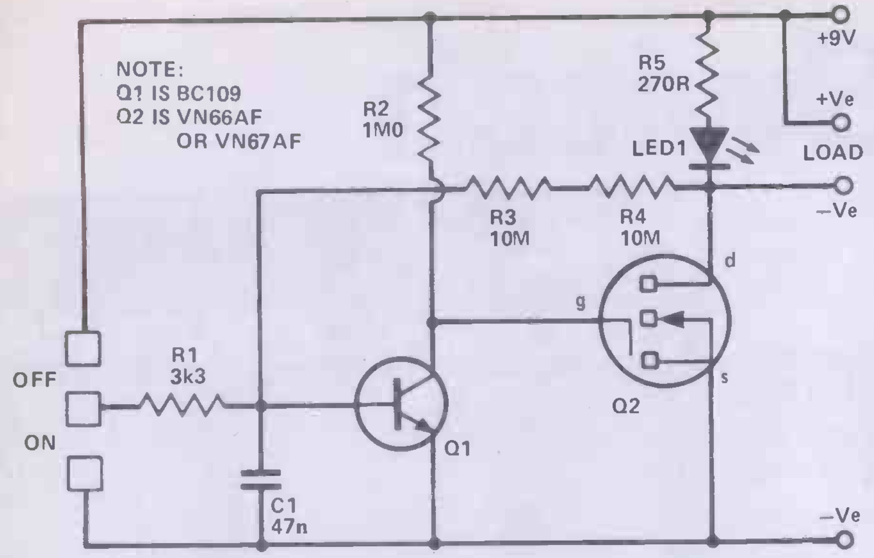
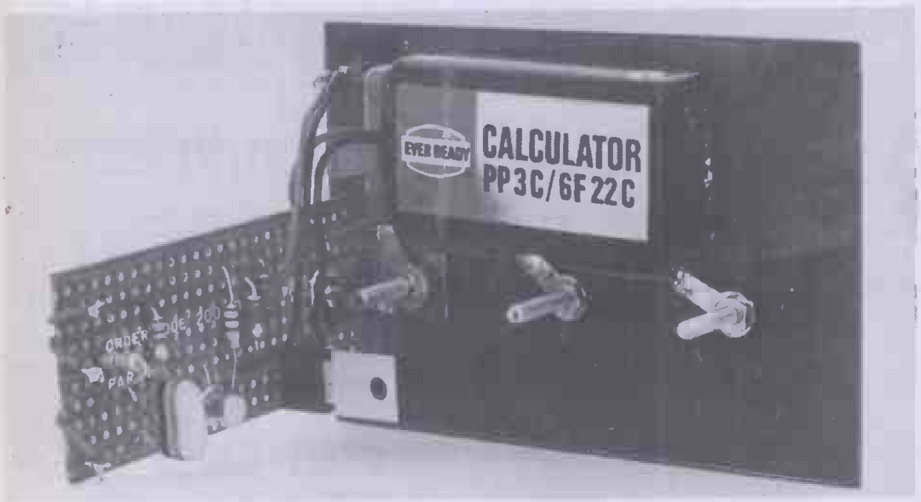


Figure 2. The HE Touch Switch circuit diagram. Q2 is a VMOS FET and needs no special handling precautions.



How it Works

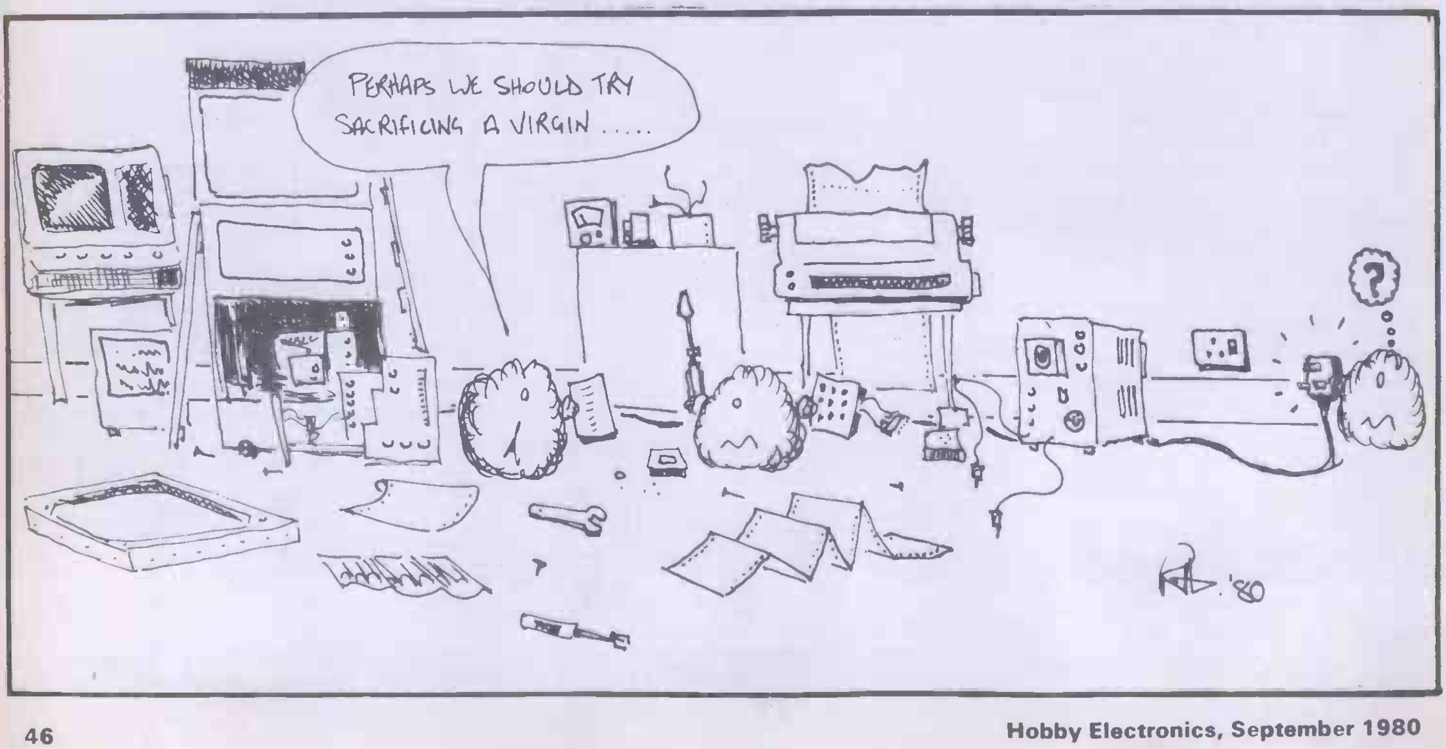
Fig. 2 shows the circuit diagram of the touch switch, which is a form of bistable multivibrator.

When power is first applied to the circuit it goes into the "ON" state, with Q2 being biased into conduction by R2. The voltage at the drain of Q2 is then at virtually the negative supply potential, and so no base current is supplied via R3 and R4 to Q1, and the latter remains switched off. Many readers may be unfamiliar with VMOS devices, such as the one used in the Q2 position. In practical terms, these differ from ordinary power transistors in that they have an extrememly high input impedance, and consume no significant input current. In fact they are voltage rather than current operated devices, requiring a gate potential of about 1 to 2 volts before they start to conduct, and just a very few volts more than this to bias them into saturation. Thus, despite its high value, R2 is quite capable of switching Q2 hard on.

If the two "OFF" touch contacts are operated, a base current for Q1 flows from the positive supply, through the user's skin and R1 into Q1, causing Q1 to switch on. Q2 then switches off as its gate potential falls to virtually zero, and power is cut off from the load. Q1 then obtains an extremely small base current via the load, R4, and R3, but this current is sufficient to keep the device switched on when the operator's finger is removed from the touch contacts. The circuit therefore latches in the "OFF" state.

The unit can be returned to the "ON" state by touching the "ON" touch contacts. This diverts the base current for Q1, causing the device to switch off so that Q2 is biased into conduction once more.

R1 ensures that an excessive base current cannot flow into Q1 if an accidental short circuit across the "OFF" contacts should occur. C1 prevents electrical noise from producing spurious operation of the unit. The current drain of the unit is an insignificant 9uA when it is in the "OFF" state, and practically zero when it is in the "ON" state.



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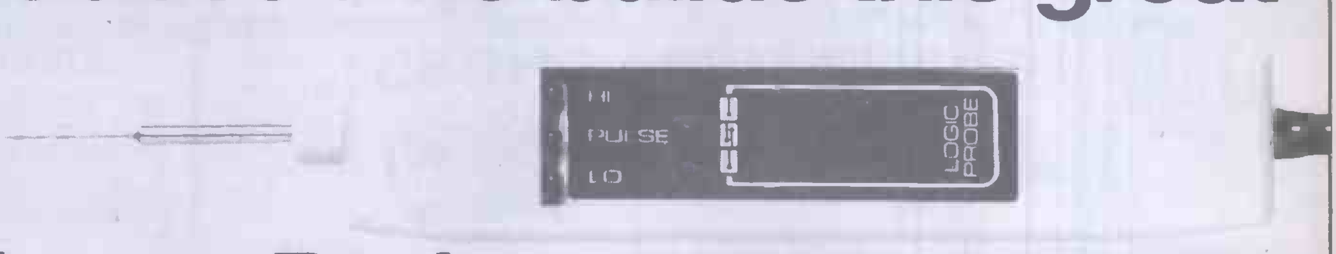

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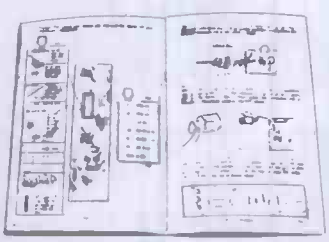

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ETI NEXT MONTH

October issue on sale September 6th - Don't miss out order your copy today.

FM Radio Control

In the course of the past year you've seen all the others produce radio control projects. You've also seen them make a right mess of the idea!

Next month ETI presents the definitive FM, easy-to-build, every-home-should-have-one, radio control. We won't spin it out over 10000 issues either, our circuit is sufficiently refined for us to be able to present full details in one issue!

If you're at all intrigued by controlling things at a distance ETI October is *the* place to be.

Einstein Relatives

Yep. The feature you said we would *never* do. A clear easily understood explanation of the Special Theory of Relativity. This is the topic that those smug little physicists are always telling us humans we can never hope to comprehend. Well we can. Just read ETI next month and see for yourself.

Also Appearing . . . .

Taking part in next month's production we also have: a Bench Amp for the experimenter; a review for the HP-41C alpha-numeric calculator; an audio signal generator; a flash trigger for quick-off-the-mark photographers plus, of course, all our usual brilliant regulars. It's got to be worth the mere 60p we ask in exchange!

Articles mentioned herein are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

Guitar Phaser

Build this easily constructed, cheap, compact and versatile phaser. An ideal project for the professional or amateur guitarist.

MANY MUSICIANS WILL know the electronic effect known as phasing. The sound produced by such a unit gives a pleasant, rhythmic, modulation of the source to which it is connected and can often, with a bit of imagination, create the illusion of flight. For this reason the effect has been referred to in the past as ''sky-riding''. With this unit the speed of the effect is continually variable over a wide range.

Of the many designs for phasers, featured in various magazines, noise has been an over-riding disadvantage for serious work by musicians.

The HE Phase 1 overcomes this and other problems by the use of some of the latest technology from Texas Instruments (TI). Recently, TI introduced a new family of operational amplifiers known as BI-FETS. For the technically minded, the abbreviation BI-FET means that the op amp has a high impedence, JFET input stage combined with a low-distortion bipolar output stage. They also feature further improvements such as low noise and low power, both vital for a professional phasing unit — low noise for a high quality sound and low power for a long battery life!

Phase 1 uses a particular IC from this family of BI-FETs having four op amps in the one 14-pin body (known as a quad device). The use of this chip, the TL 064, obviously keeps the size of the complete phaser to a minimum, enabling its construction in an extremely small and neat case.

Automatic switching

An override footswitch is provided so that the musician can bypass the phasing effect when it is not required. Another important feature is the lack of an on/off switch. We have used a stereo input socket to switch the unit on whenever a jack plug is inserted into the socket. The circuit is automatically switched off when the plug is removed.

Construction

The method of construction of the unit is entirely up to the individual, but if you want to build the unit as illustrated, the full description follows. Although a PCB is recommended the unit could be successfully built on veroboard, though we give no details. When designing the unit the primary concern was to produce a low noise, low power, high performance phaser, at a reasonable cost. With this in mind we then considered the use to which the unit would be put, eg. stage use, with all the abuse which that entails. The case chosen to fulfil these requirements was a strong alloy enclosure, of small physical size yet easy to work with.

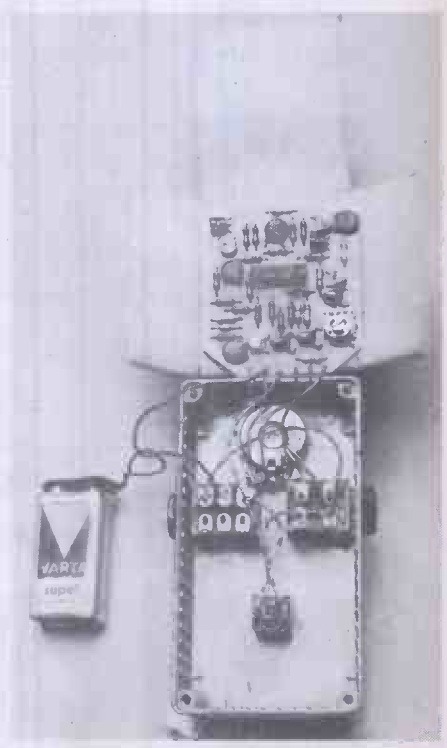
Due to the limitations of size, we used jack sockets that are smaller than usual, along with a slightly unusual method of PCB construction. A PP3 battery is used to power the unit, being the smallest of the 9 V range.

The PCB is constructed as follows. The overlay shows the location of the components with special attention drawn to the FETs, which are mounted with the flats facing the board, and the capacitors, as shown in Fig 3.

Take care

No special precautions are required for IC1 except that it should be inserted the correct way round as should the tantalum capacitors and FETs. Although we normally advocate the use of IC sockets, in this particular case, space requirements mean that the IC must be inserted directly into the PCB. You must, therefore, be careful not to overheat the device when soldering it in — likewise the FETs! When the board is completed, attention can be turned to the case.

The alloy box is easily drilled with normal drills, alternatively the larger holes may be punched with a Q-max type of punch. When the machining



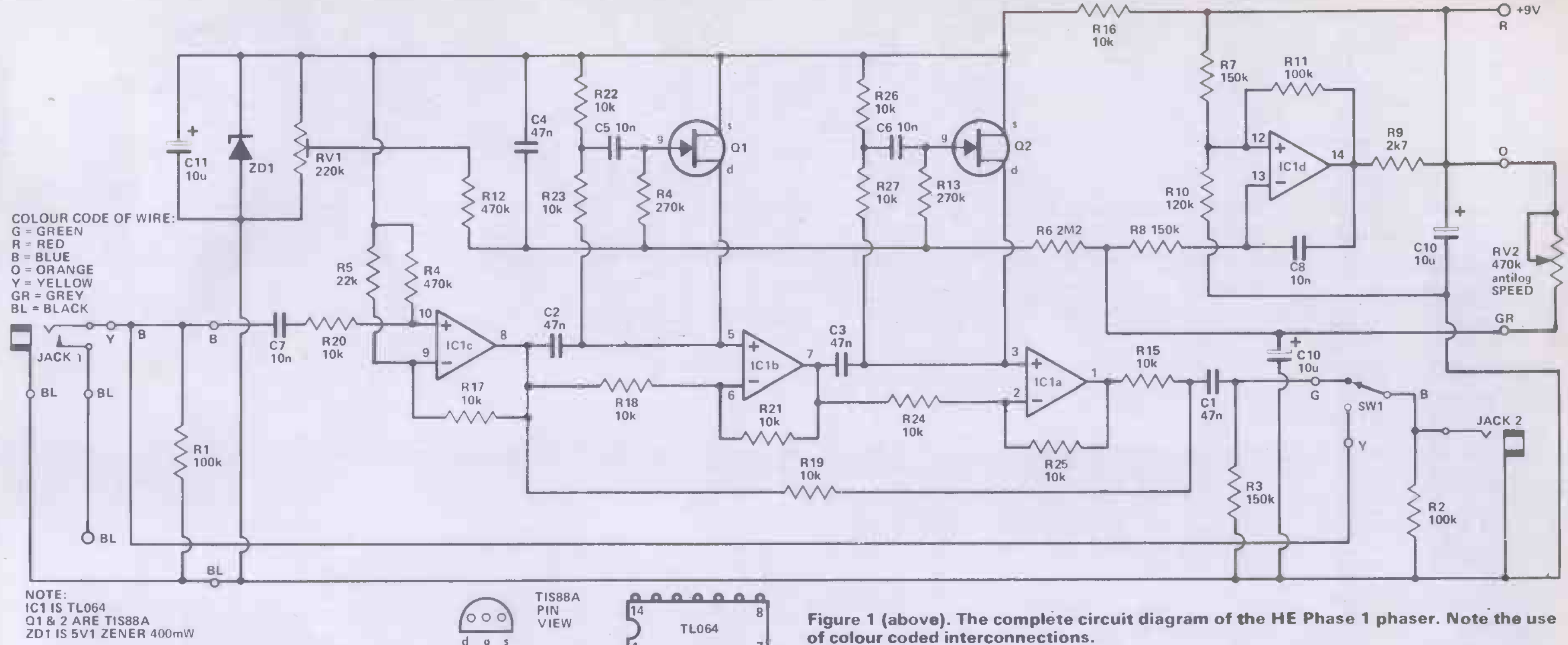


Figure 1 (above). The complete circuit diagram of the HE Phase 1 phaser. Note the use of colour coded interconnections.

How it Works

The unit was designed around the TL 064, a BI-FET quad operational amplifier. Three of the amplifiers are used in the audio chain and the fourth is used in a multivibrator circuit, to give the low frequency modulated phase sound. The audio processing chain is split into four distinct sections, these are an input buffer, two active phase shift networks and a summing mixer. The circuit diagram is shown in Fig. 1.

The input buffer is formed around the operational amplifier, IClc and has a gain of 1. The gain of the two phase shift networks is also 1 and so the unit as a whole has a unity gain. The phase shift networks consist of, respectively C2-Q1 and C3-Q2. At some frequency, say, fo, each network causes a 90° phase shift, thus 2 90° phase shifts in series give an anti-phase signal i.e. 180° out of phase (see Fig. 2). R19 feeds a portion of the buffered input signal direct to the output and if this is mixed at the output in a 1-1 proportion with the anti-phase signal the effect is to cancel out the signal at the frequency fo.

In this application the FETs function as voltage controlled resistors in the phase shift networks. These resistances determine the frequency of fo, so by applying a varying voltage to the FETs the notched out frequency can be made to sweep up and down the audio band.

IC1d forms a simple triangle waveform generator whose frequency is variable over the range approximately 0.1 Hz-10 Hz. This waveform is fed to the FET gates via resistors R6, 13 and 14. It is this varying voltage that modulates the FET gates and so gives the well-known phasing effect. SW1 is a single pole changeover switch to bypass the unit when not required. A stereo socket is used on the input of the unit to eliminate the on/off switch by connecting the negative battery lead to the earth tag, and the negative circuit wire to the ring tag. Inserting a mono plug will connect the earth and ring tags and perform the switching action.

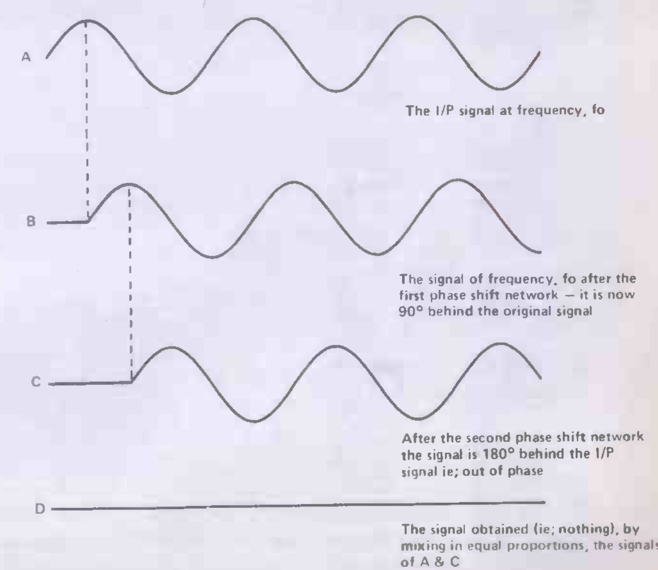


Figure 2. Waveforms within the circuit.

is complete it can be rubbed down with fine wet and dry paper to provide a good surface for a primary coat and then finally a top coat of good, hard paint.
When the top coat is dry, the sockets, pot and switch can be fitted in their respective places. The board is wired up as shown in Fig. 3, remembering to make the earth connection to the back of the pot by scraping off the plating and soldering the wire to this point.

Due to the fact that the wiring connections in the phaser are quite complex, we have tried a new technique to make things easier for you in construction — the colour coding of connecting wires. The use of colour coding is self-explanatory, really, and will present no problems to the builder — on the contrary you should find it much easier to construct a project in this way.

The tags on the sockets will have to be bent inwards to clear the PCB when the lid is screwed down. When the wiring is complete a thorough visual inspection should be made, especially of the PCB. The unit is now ready for setting up. With the preset at its centre position, fit a battery and plug a connecting lead from an amplifier into the O/P socket. Turn the unit on by plugging a lead from a guitar or similar instrument into the I/P socket. If the sound you hear has no modulation present, press the foot switch. There should be some sort of phasing though it may be irregular. Now adjust the preset for a smooth phasing sound with no discontinuity at the end of the sweep. It will now be found that the speed of the phasing can be controlled by the pot on the front. This completes the construction, except for the cutting of a piece of foam plastic to protect the board from short circuits. **HE**

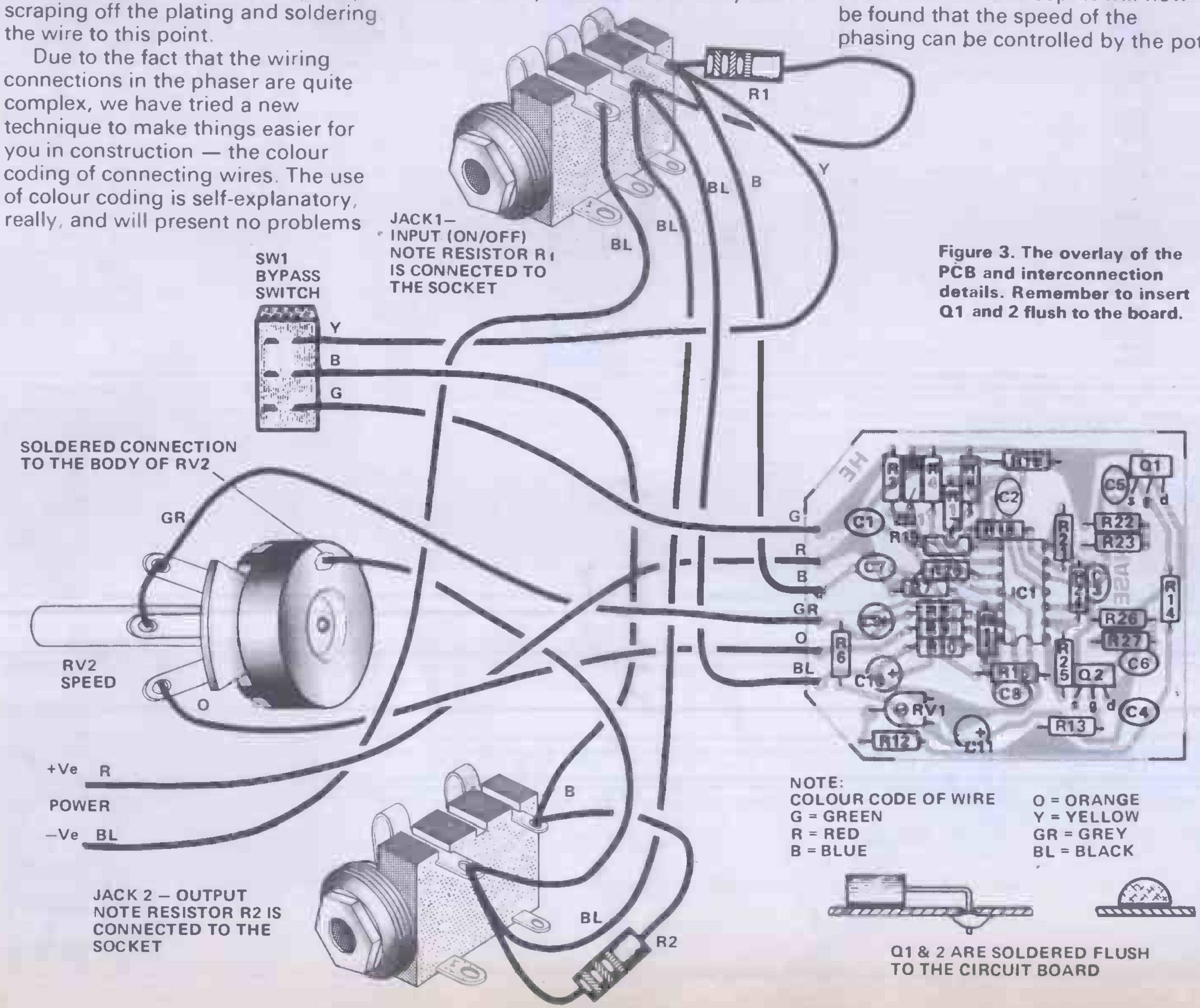


Figure 3. The overlay of the PCB and interconnection details. Remember to insert Q1 and 2 flush to the board.

Buylines

We are not quoting an approximate price for components in this project because Watford Electronics are offering a complete kit of parts, including the case and PCB for the remarkably low price of £12.

If you prefer to buy the components separately, the only problems may be with the antilog pot RV2, (try Electrovalue) and the jack sockets.

Parts List

RESISTORS (All ¼W, 5%)

R1, 2, 11	100k
R3, 7, 8	150k
R4, 12	470k
R5	22k
R6	2M2
R9	2k7
R10	120k
R13, 14	270k
R15-27	10k

POTENTIOMETERS

RV1	220k miniature horizontal preset
RV2	47k antilog

CAPACITORS

C1, 2, 3, 4	47n miniature ceramic
C5, 6, 7, 8	10n miniature ceramic
C9, 10, 11	10u 16V tantalum

SEMICONDUCTORS

IC1	TL 064 quad op amp
Q1, 2	TIS 88 FET
ZD1	5V1 400 mW zener diode

MISCELLANEOUS

SW1	double-pole, double-throw foot switch
SK1	Stereo ¼" jack socket, Cliff Products ref S3
SK2	mono ¼" jack socket, Cliff Products ref S1

Case to suit, PP3-type battery connector, knob, foam plastic.

The Watkins Factor method of development is little known and at present almost unused — is this due to the lack of a proper timer?

Development Timer

IN 1893, a photographer called Alfred Watkins noticed that the time taken for an image to appear during the development of a photographic plate was a fixed fraction of the total development time.

The Watkins Factor

The phenomenon that Watkins noticed was that the total development time was a fixed number (called the Watkins Factor) times the period taken for the plate to be seen to darken initially. Now, whereas development time varies with temperature, concentration and 'age' of the developer, the Watkins Factor does not. If you develop a film for a *fixed* period, you *must* keep these three factors constant. If, however, you develop it using the Watkins Factor you can (within reasonable limits) *forget* the age, concentration and temperature.

This is all very well, but you would have to be able to see the film as it develops. This is not feasible with modern high-speed panchromatic film, which has to be developed in complete darkness. For this reason the Watkins Factor has been all but forgotten, hardly rating a mention in modern textbooks.

Theory

In the process of developing a print, developer slowly diffuses into the paper, reacting as soon as it reaches the photosensitized areas. The reaction is *diffusion controlled*. The reason why nothing appears for the first few seconds of development (called the 'induction period') is that the developer is still working its way into the paper.

With film you can't watch it develop, with paper you can so the Watkins method of development timing should be extremely useful to the amateur who can't afford a constant-temperature bath for his developer.

The Timer

It works like this: you set the appropriate Watkins Factor (which is specific to a particular developer and paper) on the front panel control. When you put the paper into the developer, you push the switch to 'START'. As soon as the first image starts to appear, you flick it back to 'TIME'. At the end of the development period the buzzer will sound. Then pull the paper out of the dish, wash it and fix it . . . voila! beautiful prints.

It may take a bit of experiment to find the correct Watkins Factor. Once you have it, though, you need not bother too much about developer temperature and (within limits) its age and concentration.

Construction

Construction should begin with the PCB. Make sure all of the capacitors, diodes, transistors and ICs are inserted the right way round. RV2 and RV3 are 'upright' preset pots bent over to fit flat against the PCB.

Mount C4 directly onto the back of the front panel using conventional double sided adhesive pads. The buzzer mounts on the end of the case. Note that the red lead goes to the '+' buzzer connection on the board.

Make sure that you use the correct tags of RV1. Refer to the wiring diagram. It is a log characteristic pot. A linear one will not have the same calibration scale.

Setting Up

After finishing the unit, disconnect the 'TIME' and 'START' wires from SW2. Solder them together and put the most sensitive current meter you have between this joint and 0V (most medium-priced multimeters will do). Disconnect the wire which goes to the middle contact of SW2 and connect it to the + end of C4. Set RV1 to '2'. Switch on and adjust RV2 for a zero meter reading.

Current Resistance

What you have just done is to ensure that when the resistance of RV1 is at the '2' value, the current through Q1 is the same as that through Q2 (see 'How It Works'). This is to correct for differences between the two FETs which seldom have the same characteristic.

Now adjust RV3. Turn it fully clockwise and then slowly rotate it until the buzzer sounds (if it doesn't — there's something wrong). After this happens, turn it back about one-eighth turn. The timer is now fully set up.

Sound Thinking

Re-connect the unit as shown in the diagrams. Switch on and set SW2 to 'TIME'. Short out C1 temporarily to remove the charge put on it during the setting-up. With RV1 set to 2, switch SW2 to 'START' for five seconds and then push it back to 'TIME'. Five seconds later, the buzzer should sound. This device will make an interesting addition to any darkroom.

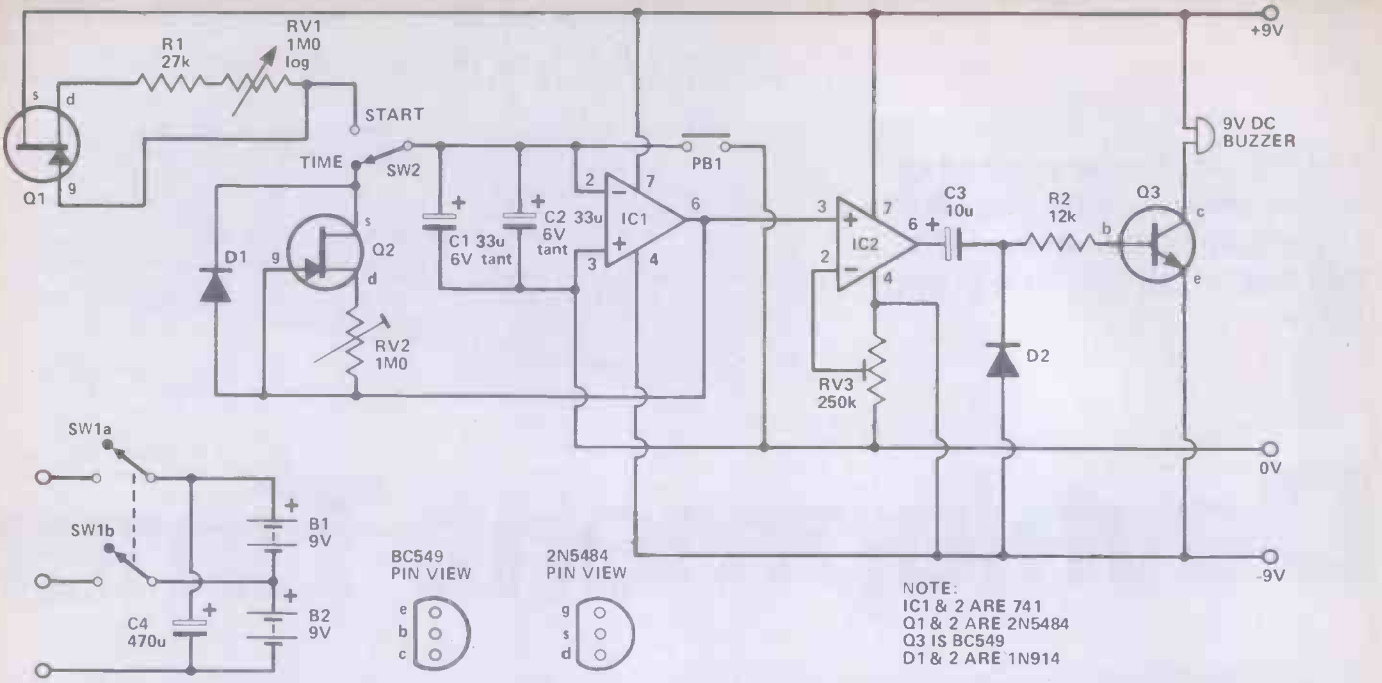


Figure 1. The circuit diagram of the Development Timer.

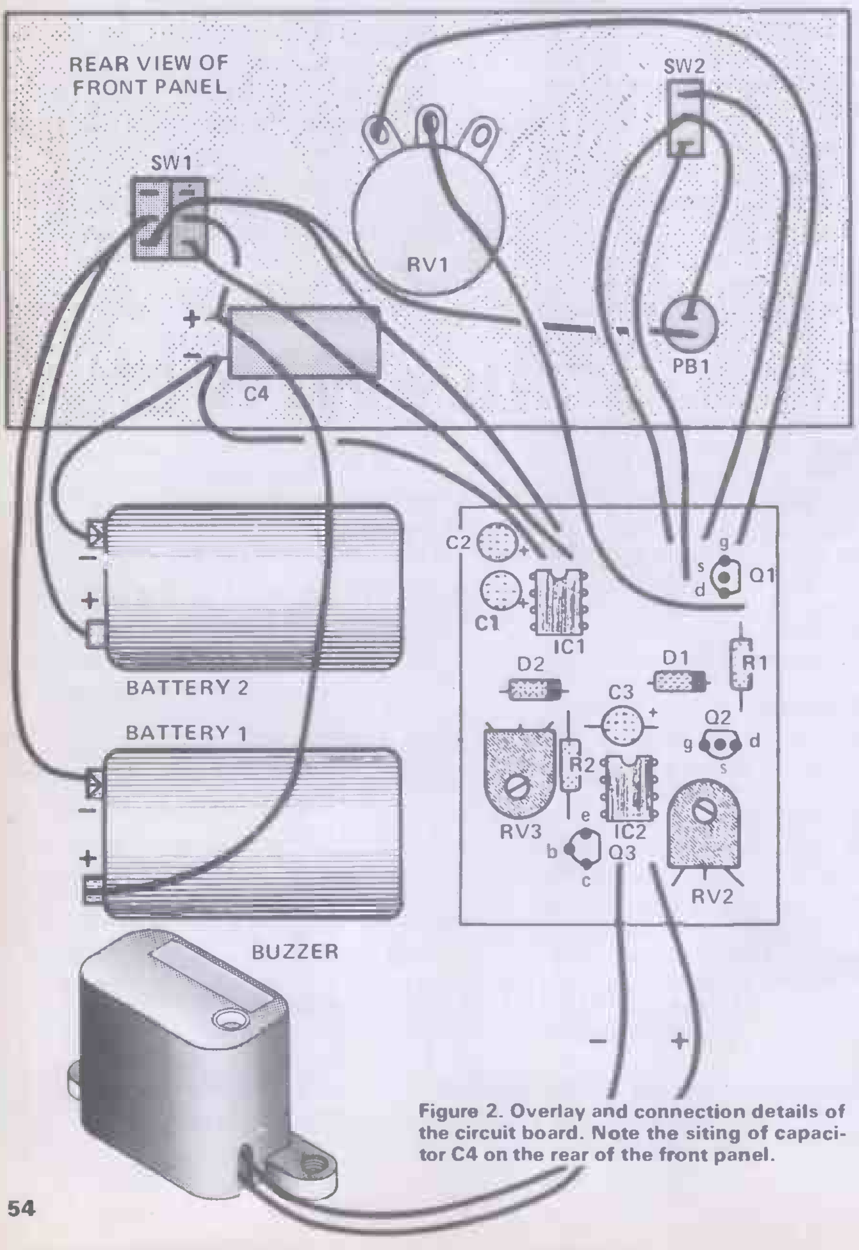


Figure 2. Overlay and connection details of the circuit board. Note the siting of capacitor C4 on the rear of the front panel.

Parts List

RESISTORS (All ¼ W, 5%)

R1	27k
R2	12k

POTENTIOMETERS

RV1	1M0 log
RV2	1M0 miniature vertical preset
RV3	220k miniature vertical preset

CAPACITORS

C1, 2	33u 10 V tantalum
C3	10u 25 V electrolytic
C4	470u 25 V electrolytic

SEMICONDUCTORS

IC1, 2	741 Op-Amp
Q1, 2	2N5484 FET
Q3	BC109 N-P-N transistor
D1, 2	1N4148 Diode

MISCELLANEOUS

SW1	miniature double-pole, double-throw toggle
SW2 pole,	miniature single-pole, double-throw toggle

9 VDC buzzer, case to suit, knob with pointer, batteries and clips.

Buylines

You should be able to obtain all parts locally with no trouble and the components (excluding case and PCB) should come to no more than about £6.

How it Works

The Watkins Factor is the ratio of two time periods. A timing circuit having one variable period, which you set, and one fixed period is arranged to indicate when the correct ratio of time periods has been reached.

This is achieved by charging and then discharging a capacitor. The time taken to charge the capacitor is varied while the discharge time is fixed. The control used to vary the charging time is calibrated in terms of the Watkins Factor.

When a capacitor is charged at a constant current, the voltage across it will rise linearly with time — or 'ramp' upwards. Similarly, when it is discharged at a constant current, the voltage across it will 'ramp' downwards. This technique allows good accuracy to be obtained in timing applications.

In this circuit, the current at which the timing capacitance is charged is varied by means of a potentiometer control.

Q1 is connected as a 'constant current' source; that is, it will only allow a constant current to pass, the amount being determined by R1 and RV1. The potentiometer RV1 sets the Watkins Factor.

When SW2 is set to START, C1/C2 will charge via Q1/R1/RV1, the voltage across it ramping upwards at a linear rate. The lower the resistance of RV1, the higher the charging current causing C1/C2 to charge at a faster rate. The converse is also true.

Q2 is connected as a 'constant current' sink — when SW2 is set to TIME, C1/C2 will discharge via Q2/RV2, these components 'sinking' the current. The discharge current will be constant and the voltage across C1/C2 will ramp down at a linear rate.

A Watkins Factor of '2' requires equal charge/discharge times for C1/C2. So that the currents through Q1 and Q2 will be equal when RV1 is set for a Watkins Factor of 2, RV2 (a trimpot) is provided to set the current through Q2. This is used to calibrate the timer.

When the timer is switched on initially, with SW2 in the TIME position, any positive voltage on C1/C2 will cause the output of IC1 to go negative, drawing current through Q2/RV2, discharging the capacitors. Any negative voltage that may appear on C1/C2 will cause the output of IC1 to go positive. This will forward-bias D1 and 'pull up' the voltage across the capacitors. The combined action of these processes ensures that the voltage across C1/C2 stabilises at zero volts.

When the timing period is commenced at the start of developing a print, SW2 is set to START. As C1/C2 charge, the output of IC1 will go negative. When the image first appears on the paper, SW2 is set to TIME. C1/C2 will then discharge, as previously explained, and the voltage across the capacitors will go to zero. At this time, the buzzer will sound.

IC2 is arranged as a 'trigger'. When C1/C2 first begin to charge, the output of IC1 goes negative. When this negative voltage passes the value of the negative voltage applied to the inverting input of IC2, set by RV3, the output of IC2 will go very rapidly to about —7 V. At the end of the timing period, the output of IC1 goes to zero volts. As this drives the non-inverting input of IC2, the output will swing rapidly from about —7 V to +7 V.

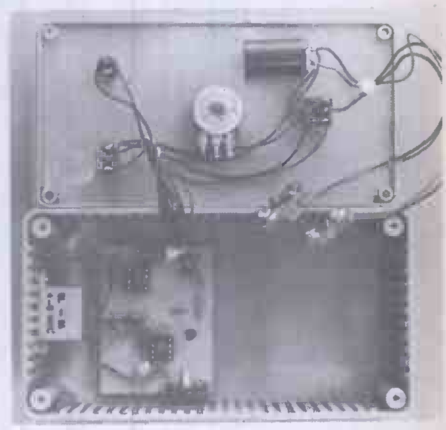
This will force a pulse of current through C3/R2, forward-biasing the base of Q3. When Q3 turns on the buzzer will sound.

C3 will take about one second to charge, Q3 will not receive sufficient base current and the buzzer will cease its cacophony. It sounds not unlike the wheeze from expiring bagpipes!

D2 discharges C3 when the output of IC2 goes low when next you turn SW2 to START.

A pushbutton, PB1, allows you to abort a timing sequence by shorting C1/C2.

Note that the buzzer will sound whenever the unit is turned on. IC2 will trigger as the output of IC1 will initially be zero and the output of IC2 will thus jump to about +7 V, setting off the buzzer.



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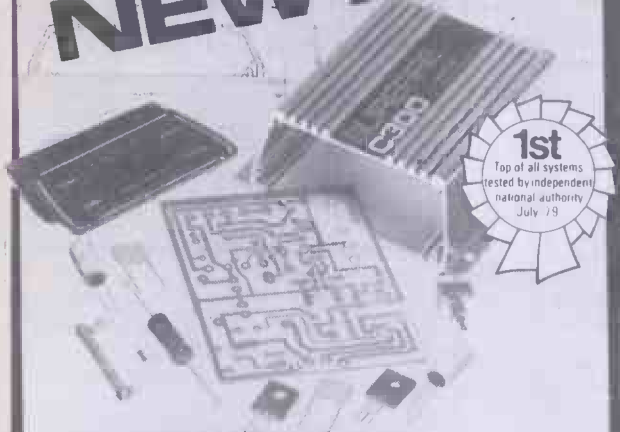

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Building Site

Back again with more constructional problems, this month Keith Brindley tackles the serious aspect of handling CMOS (but maybe it's not quite as serious as you think).

RATHER THAN TALKING about all of the seven projects featured in HE this month, I am going to pinpoint just two. This gives me a chance to muse in depth about the slightly unusual aspects of these projects and still have room later to discuss some more salient problems — those encountered with CMOS integrated circuits and the necessary handling precautions involved in their use.

But first things first, and back to the projects. The most noteworthy is undoubtedly the HE Phase 1 phaser. It's rugged, easy to build and outperforms many commercial units, costing several times as much! The area I want to cover concerns the phaser's construction. By way of an experiment we have used a new system of colour-coded interconnection wires to ease what could well be a difficult task. Of course, it's not a unique method of construction, used for some time in the electrical and electronics industry but it *is* new to HE and probably most of our readers. So, if you think it works and *is* helpful during construction of a project why not let us know — you may see it become commonplace in the months ahead.

The Reaction Timer merits consideration due to its slightly unusual 4-digit, 7-segment LED display. Usually projects employ four, separate 7-segment, single-digit displays mounted individually on the PCB. However, the convenience of the 4-digit module made it an easy choice and it has the added bonus that if you shop around you may find it cheaper than the equivalent separate devices.

Mounting the module is easy — just line it up on the PCB with the connection holes of the board and solder in the wire links. The module is double-sided, ie it has track on both sides, with plated through holes so one soldered joint on the top of the module will automatically join to all the necessary connections underneath.

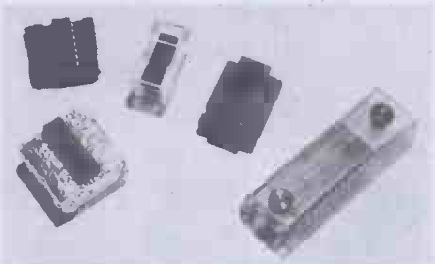

Photo 1. A collection of packaging methods for CMOS.

Photo 2. Bending IC pins manually to fit a holder.

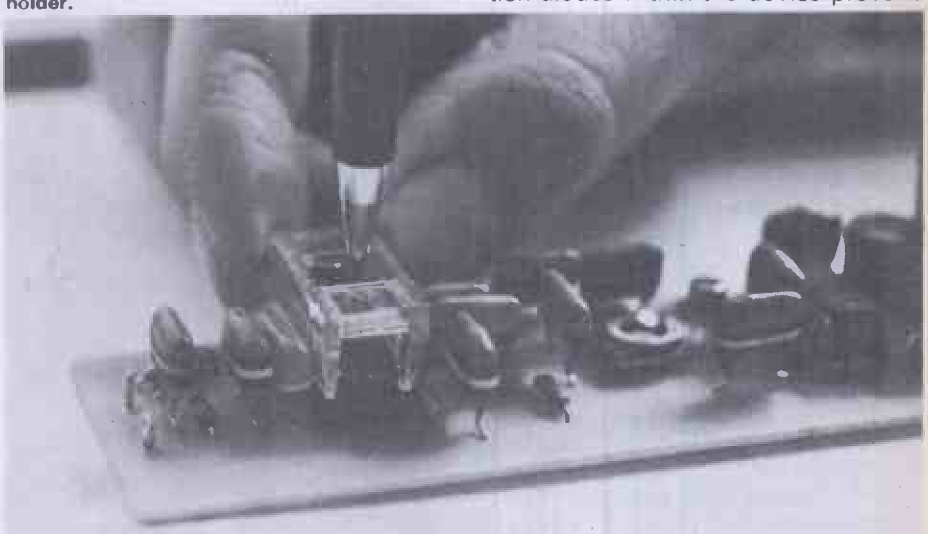

Photo 3. Using a plastic packaging holder as a hybrid insertion tool.

CMOS — With Care!

It occurred to me this month that we use CMOS integrated circuits in many of our designs, usually without too much explanation concerning the precautions which should be taken when handling them. Occasionally, somewhere underneath the Construction heading some rather blasé phrases crop up such as "be careful — CMOS are easily damaged by static" or "take care not to touch any of the pins" but overall we tend to neglect some of the important points.

Of course, that is not to say that they need any earth-shattering handling precautions. I *have* read elsewhere that unless you work on an earthed metal tray, using an earthed soldering iron and with an earthed wrist strap, you stand a good chance of exterminating your precious chips. Oh yes, I almost forgot, you mustn't wear nylon underwear (unless earthed) or any other such apparel! If you go in for these fanatical precautions then fair enough, but I think you are probably being slightly overcautious if you do.

The reason for CMOS susceptibility to damage by static is inherent in their internal circuits. Input protection diodes within the device prevent damage except when the voltage across them exceeds about 4 kV. Static voltages of over 10 kV can be quite common on the human body so in this respect, it's understandable that damage *can* happen although to be fair, it's worth mentioning that I have never "killed" a chip in this manner myself (incorrect insertion, standing on them, accidentally bending the pins outwards whilst trying to get them in their circuit — yes!).

So how do you go about handling CMOS? Well — the answer is really just to take things easy and not to overhandle the animal. They normally arrive inserted into conductive foam, or ordinary polystyrene foam wrapped with aluminium foil, or alternatively in a plastic holder of some description or another. Photo 1 shows these main methods of packaging CMOS. Incidentally, if an integrated circuit which you know to be of the CMOS family, reaches you in an unprotected manner, there's a good chance that it will not function correctly upon insertion into circuit. Your first course of action is to complain vociferously to the supplier.

The conductive foam and aluminium foil methods of packaging are usually the most convenient for amateur and hobbyist use — the foam or the foil short the pins together and to their surroundings, thereby preventing any pin of the IC having a different voltage from another pin — hence the chip can't be damaged. By holding the foam in your hand before removing the IC, all parts are automatically at the same potential.

The next step is to earth the circuit board — laying your hand flat on the work surface should do that, also hold the PCB for a few seconds. Remember that the whole procedure is simply an attempt to maintain all parts at the same potential — nominally earth.

Insertion

Most ICs come with their pins slightly splayed — this means that to insert them into their holders (and holders are normally advised) they need to be bent somewhat closer together. Theoretically, of course, (with all potentials equal) you should be able to bend the pins to your heart's content to get them into circuit but it is probably worth while still taking one or two precautions. Hold the chip by the ends between thumb and forefinger (see photo 2) and lay it edgeways onto your work surface — do this singlehanded, holding your other hand flat on the surface. Then carefully bend the body of the IC so that it is perpendicular to the surface after which turn it over and do the other side. You should find that the IC will now fit neatly into its holder. Well done — OK, you can breathe again now!

The type of IC packaging which uses a small plastic holder for each chip, seen in photo 1, can be used to advantage in overcoming this last difficulty by using it as a hybrid insertion tool. These holders automatically keep the pins of the IC at exactly the right angle which ensures a simple insertion into their PCB holder as in photo 3. Life just couldn't be easier!

Photo 4. An IC insertion tool.

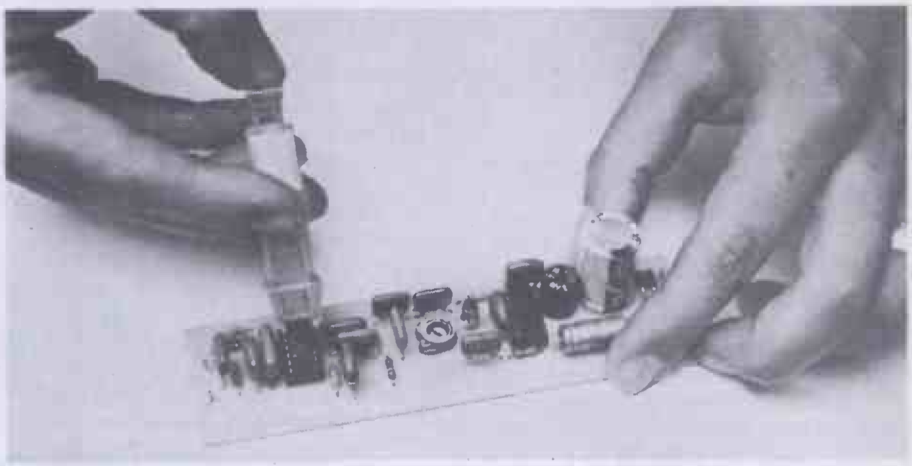

Photo 5 showing the insertion tool in use.

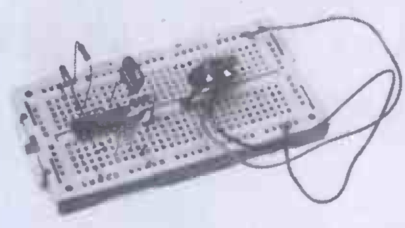

Photo 6. Our tested CMOS IC still functioning healthily.

Next, we come to one of the best methods for insertion of ICs be they of the CMOS variety or any other type of standard DIL (Dual In Line) integrated circuits — the IC insertion tool. Photo 4 shows such a tool and photo 5 shows it being used to insert an IC into circuit — the chip is inside the tool and by pushing down the centre rod the chip is "syringed" out of the tool into its holder. The particular tool in the photograph is manufactured by Vero and retails at around £2.00 not an extortionate price to pay considering its advantages in inserting all kinds of ICs — not just CMOS. A larger size for 24 pin ICs is also available.

I suppose there are many people who would query the use of CMOS in the first place — can't some less volatile components be used in their place? Well, the answer to this is yes and no! Yes, because there *are* alternative devices and, no because of CMOS versatility and power requirements. No other ICs have the same capabilities as the CMOS range coupled with the wide voltage supply (about 3-15 V) and low current requirements which they offer (not to mention low cost), meaning that the majority of circuits can be battery operated. So, you see, CMOS are a necessary evil and they will be around for a while yet.

Finally, if any of our readers are still hesitant regarding the use of CMOS just consider this: to prove the point that CMOS ICs are not quite as fragile as people tend to think, a team of intrepid explorers from the HE office ventured forth into worlds anew to destruction test a 4001 — quad nand gate. The IC was built into a breadboarded test circuit to check that all was OK. It was then removed and all, literally all, was tried to damage the device by static discharge from human beings (if you can call the HE staff human beings!) After half an hour of rigorous walking up and down on nylon carpets, touching the pins, discharging through the device to earth etc etc, the IC was inserted back into circuit and lo and behold it still worked perfectly — a happy ending — so we all had a cup of tea and went back to sleep.

See you next month. **HE**

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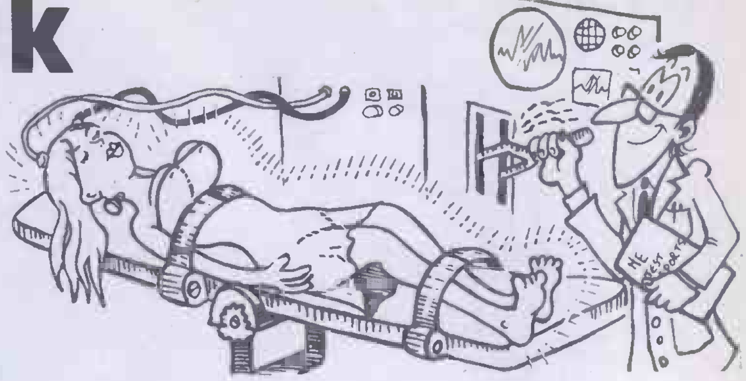
Clever Dick

Who on earth needs an electronic Wolf Whistle? Who is Clever Dick? We've some nosey and lecherous letters this month as you'll see!



LECHERY! From the depraved depths of Aldershot Derek Conchie has this smutty suggestion for our Project Team. Can we oblige?

Dear CD,

Firstly I must congratulate HE for producing such a brilliant mag. As a newcomer to electronics your publication shone out among the rows of magazines with your great covers. Well done HE!

Now some questions; How about an electronic "Wolf Whistle" project for us female-admiring motorists? I've only seen crude mechanical whistles, mostly rubbish. Secondly, I'm crazy about Space Invaders games, know anyone with a circuit diagram for such a project. What about you CD, anything in the pipeline?

Keep up the great, humorous HE mag, ideal for us newcomers with just a little knowledge.

Derek Conchie
Aldershot

A free Binder to that man. Now about this unhealthy obsession for whistling at members of the opposite sex, what a great idea! It's down on our projects list now, hopefully it'll be coming out in the coming months.

Your question about the Space Invaders brings us to the rather tricky problem of "Dedicated" TV games, machines that play just one game. Two or three years ago we would have been justified in designing such a circuit, providing of course someone had done all the donkey work by producing a "chip" like the old AY-3-8500 "ball and paddle game". These days dedicated chips are almost non-existent, the market has moved over to the programmable game with a vengeance. It would be almost impossible to design such a game without going the microprocessor route, indeed, the Space Invader programme for the PET computer is as good as any we've seen and it even has the "Tromp Tromp" sound effects. However, all is not lost, Atari have an Invaders cartridge for their excellent system. NIC Ltd sell a hand-held version of Space Invaders for around £25 and if you are lucky (?) enough to own a PET the software will cost you £5. Don't despair though, you never know!!

Back in the late 'sixties, before the IC was unleashed onto the amateur market, there was a spate of unusual semiconductor devices coming out of American research labs. Most of them disappeared without trace but one in particular, a device known as the "Esaki" or "Tunnel Diode" crops up every once in a while. Michael Morris has a problem with Tunnel Diodes or rather, a lack of Tunnel Diodes.

Dear Dick,

I would be most grateful if you could tell me of a company that stock Tunnel Diodes. It seems that they are unobtainable in this country, although they feature regularly in American publications.

Michael Morris
Letchworth

Tunnel Diodes, for the uninitiated, are basically the same as conventional semiconductor diodes except that during manufacture a large amount of impurity is added to the silicon. This has the effect of producing a high speed charge movement and a negative-resistance region above a minimum level of applied voltage. (If you understood all that then please explain it to us sometime). Anyhow, the upshot of all this trickery is that the Tunnel Diode can be used to make a very simple oscillator or amplifier with the addition of just one or two components. It has the added advantage of being able to operate at extremely high frequencies, well into the Gigahertz region. Now to answer your question Michael, Tunnel Diodes are available in this country, a morning spent phoning around semiconductor manufacturers turned up this address: International General Electric Co of New York, Park Lorne, 111 Park Road, London NW8 7JL.

Unlike most hobbies electronics is a pretty solitary pastime, so it was with interest we read this letter from George Edwards.

Dear Dick,

I would be grateful if you could enlighten me on the following: I have not seen any mention in HE of the activities of electronics clubs. Having left school nearly 60 years ago I'm lacking somewhat in the maths and calculations department, but understand the practical and constructional side of electronics. So, I would like to join, help or form any club where discussions and exchanges of ideas, etc, are fostered, any information would be greatly appreciated.

My last question concerns two ICs that I'm having difficulty in identifying. They are both 8 pin and bear the numbers QPHB 849 and PJUZ 267N, any ideas?

George Edwards
Abercynon
(Mid Glamorgan)

Your first question is relatively easy to answer, there are very few clubs about, the only national organisation we know of is the British Amateur Electronics Club (BAEC) they can be found at "Dickens", 26 Forrest Road, Penarth, South Glamorgan, which, judging by the address, must be pretty close to you. Incidentally, the man you need is Cyril Bogod. He should be able to put you in touch with someone nearby. We will be only too happy to give a mention to any other electronics clubs if they would like to write to us at our usual address.

The IC mystery isn't so easy to solve, none of our reference books could shed any light on these devices, can anyone help?

Please try to keep your letters as short and to the point as possible and remember we can't make personal replies unless it's a matter of life or death. Letters in this category should be clearly marked "Matter of life or death" and enclose an SAE.

What a nosey person William Leung is, why? Well read on and find out.

Dear Car Ignition, (See HE April '80)

I would like to congratulate everyone at Hilarious Electronics for making us open our eyes and laugh at the jokes you lot produce.

Since I am writing this letter to you, who are you? I know you are Clever Dick but who is the person that sits at his (or her) desk reading our letters and calls her (or him) self CD? Could it be the Editor?, the Managing Director?, OR a ghost from the deep blue yonder?!

Anyway, how about giving your project team a day off so they may sleep and dream up a project like some kind of audio signal Encoder/Decoder. In other easy to understand words, a gadget to encode audio signals from a microphone to a tape recorder to prevent the odd spy listening to our cassettes, since he or she will probably not have a decoder to decode the encoded audio signal!

One last word, HE seems to lack speed in arriving at our newsagent at the Towncentre, I feel like a Hebot walking in and out each day waiting for HE. Another last word, does HE's Managing Director have any relations working at a school in Harlow?

William Leung
Harlow

PS It's LEUNG, not as some Electronics Suppliers & people put it!!!

Since you ask I'm none of these people, you'll have to keep guessing.

Not sure exactly what you mean by the Audio Signal encoder/decoder. If, you've got problems with spies then I may suggest you read our feature on Electronic Espionage in the July issue.

Sorry about the problems in getting hold of HE, we do have a procedure for this kind of thing, let us know the name and address of your local stockist and we'll make sure he has a regular supply in future.

Lastly, a word from our Managing Director, he assures me (between beatings) that he has absolutely no relations working in any schools anywhere near Harlow, a couple in Wormwood Scrubbs perhaps — . . . . . . Argggggh, not the whip again . . . . . . Argggggh . . . . .see you . . . . . . Arggggghhhhh not again, ... next month maybe!

HE

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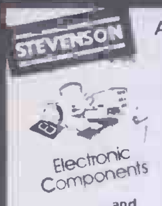

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BC109	10p	BFX29	25p	2N3702	9p
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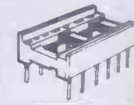
4006	95p	4042	85p	4510	90p
4007	25p	4046	110p	4511	100p
4011	30p	4048	60p	4518	90p
4013	45p	4049	50p	4520	110p
4015	85p	4050	50p	4527	165p
4016	48p	4052	80p	4528	100p
4017	80p	4060	120p	4532	125p
4018	90p	4066	63p	4543	170p
4020	110p	4068	25p	4583	80p
4022	100p	4069	25p	4585	115p
4023	25p	4070	25p		
4024	60p	4071	25p		

SKTS

Low Profile Texas

8 pin	9p	22pin	20p
14pin	11p	24pin	22p
16pin	12p	28pin	26p
18pin	16p	40pin	38p
20pin	18p		



LINEAR

		LM324	52p	MM57160	650p
		LM339	55p	NE531	140p
		LM348	100p	NE555	23p
741	18p	LM377	170p	NE556	60p
747	70p	LM378	230p	NE567	120p
748	40p	LM380	80p	RC4136	100p
7106	850p	LM381	140p	SN76477	230p
CA3046	70p	LM382	120p	TBA800	80p
CA3080	75p	LM386	90p	TBA810	110p
CA3130	100p	LM387	120p	TDA1022	630p
CA3140	60p	LM1458	40p	TL081	45p
LF347	170p	LM1830	180p	TL082	85p
LF351	45p	LM3900	60p	TL084	125p
LF353	90p	LM3909	72p	XR2206	390p
LF356	95p	LM3911	120p	ZN414	80p
LM301A	30p	LM3914	320p	ZN425E	475p
LM318	85p	LM3915	320p		

SWITCHES

TOGGLE

Standard	SPST	40p	DPDT	55p
Miniature	SPDT	80p	DPDT	90p
Subminiature	SPST	65p	DPDT	85p

SLIDE Standard DPDT 17p. Miniature 16p each.

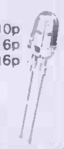
PUSH Push to make 16p. Push to break 22p.

OPTO

	0.125in.	0.2in.	
Red	TIL209	TIL220	10p
Green	TIL211	TIL221	16p
Yellow	TIL213	TIL223	16p
Clips	3p	3p	

DISPLAYS

DL704	0.3in	CC	130p
DL707	0.3in	CA	130p
FND500	0.5in	CA	100p



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		7472	35p	74126	60p
		7473	38p	74132	70p
7400	15p	7474	36p	74141	95p
7401	15p	7475	40p	74145	90p
7402	15p	7476	40p	74150	120p
7404	16p	7483	80p	74154	110p
7406	38p	7485	80p	74157	80p
7408	22p	7486	35p	74164	120p
7410	18p	7490	45p	74165	120p
7413	35p	7492	55p	74174	100p
7414	56p	7493	45p	74175	95p
7420	16p	7494	70p	74190	100p
7427	30p	7495	70p	74191	100p
7430	30p	7496	70p	74192	100p
7432	35p	74121	45p	74196	100p

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Bench PSU

Designed with the beginner in mind, this mains bench power supply unit combines high performance and quality and yet is simple to build.

TEST AND EXPERIMENTAL equipment remains perhaps one of the most popular project areas in electronic hobbyist magazines. Rightly so, of course — the home constructor would find it difficult to build and test his projects without test gear — and the most fundamental piece of equipment (bar a test meter) is arguably a power supply. The beginner naturally uses dry cells as a power supply for his first few projects, but eventually there comes a time when his requirements are for a voltage which is impossible to obtain with batteries (eg 20 V) or a higher current than batteries can supply (e.g. 1 amp).

Bear in mind that a good power supply unit is worth its weight in gold, consider this, you would only have to purchase 20 x 9 V cells at today's prices and the power supply would be paid for!

And so the scene is set! Enter from the wings to rapturous applause the HE PSU, a mains operated mains power supply with six switched output voltages (although you can adapt to a fully variable 1V5 to 20V supply if you wish). One simple, three terminal integrated circuit, (the LM317K) does all the hard work and it features a maximum output current of 1.5 amps, more than adequate for 99% of projects. The IC is called a voltage regulator and this particular variety has been around for three or four years now, that must say something for its quality and reliability in these days of rapidly changing technology. The alternative is a voltage regulator, using relatively expensive discrete transistors. However, of necessity these discrete component voltage regulators are complicated if they are to be as efficient as their IC counterparts. Because of this, there are more things to go wrong (as we all know, the well-known 'Murphy's Law' states what can go wrong — will!)

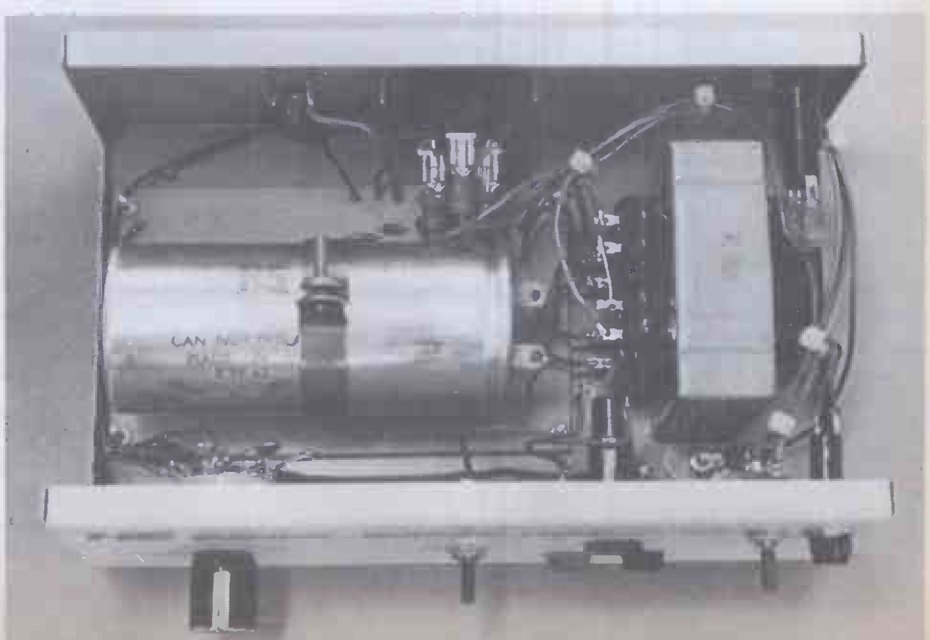
Given that all connections are correct, the HE PSU is virtually indestructible. Even a direct short circuit on the output will do no damage an internal current limiter keeps things in order. In this way, of course, there is less likelihood of a circuit under test being damaged if, say, it has a short circuit due to a solder bridge between tracks. A simple dry cell battery would continue to pass current at its highest rate until removed, by which time damage may have been done. The LM 317K continually monitors its own output current and if it is too high it "folds back" ie it switches the O/P current off. When the short circuit is removed or repaired the regulator automatically switches the current back on.

Construction

Care must be taken with the mains part of the circuitry ie everything up to and including the mains transformer T1 (the left hand side of the circuit diagram of figure 1. To aid clarity and safety we are giving two connection diagrams, one for the mains side of the supply and one for the relatively safe low voltage side. These are figures 3 and 4 respectively.

The first constructional step is the marking and drilling of the case. Ideally, a mild steel case should be used, in order to reduce electrical interference with other equipment which may be positioned close to the power supply. Mount the transformer on the base, leaving enough room for the PCB, bearing in mind the size of the capacitor C1. Bolt the fuse holders, mains on/off and DC on/off switches, mains neon (with integral resistor), output sockets and IC1 to the case, leaving only the six-way rotary switch and the PCB out.

Insert a grommet in the cable hole, push through the mains cable so that enough cable is inside the case to complete all of the mains side wiring (figure 3). We have shown all wires to be loose in the figure but when wiring up your supply, form all wires around the edge and keep them together using cable grips, lacing cord or ordinary string — whatever you have at hand. Fasten the cable as it comes through the case wall using a bolt-on cable clip or



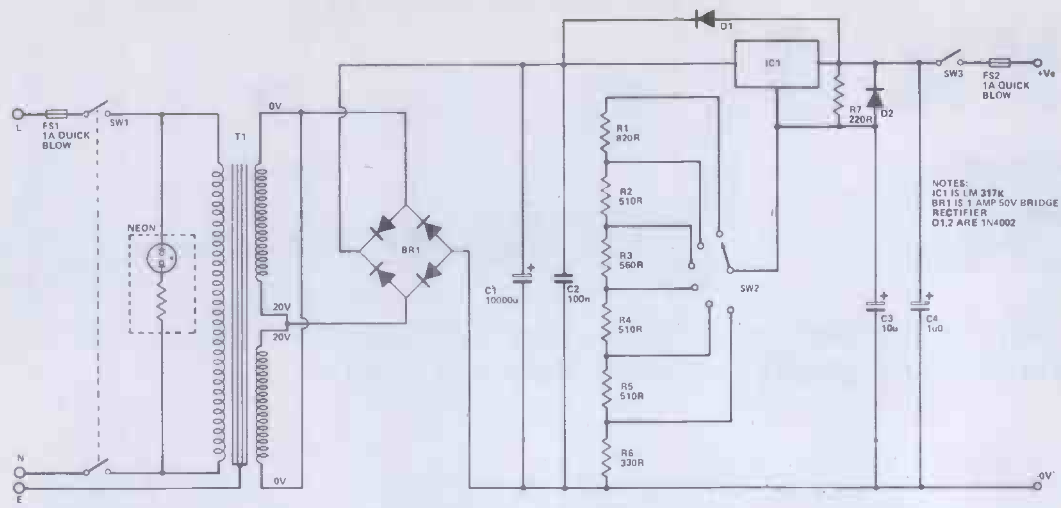


Figure 1. The HE Bench PSU circuit diagram. There's not a lot in it, but what is there does the job well.

How it Works

Transformer T1 provides the necessary step-down function from 240 V AC to 20 V AC which the rest of the circuit requires. It also isolates the low voltage side from the high-voltage (mains) side ie there is no *electrical* connection from mains to low voltage output.

The 20 V AC obtained at the transformer secondary is rectified by bridge rectifier BR1 to DC. Filter capacitor C1 "smooths out the bumps" providing a fairly level input voltage of about 28 V DC to the voltage regulator IC1.

The output voltage of IC1 is given by the formula $V_{OUT} = 1V25\ (1 + R2/R1)$.

where R2 and R1 are as in figure X

By fixing the value of R1 at 220R then R2 can be calculated from the above formula to be

$$R2 = 220\left(\frac{V_{OUT}}{1V25} - 1\right)$$

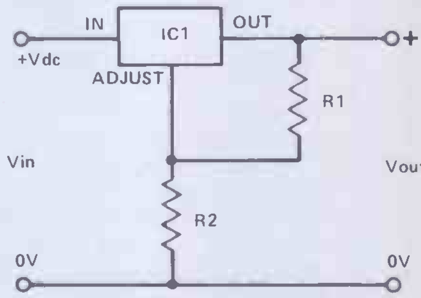
Simply by inserting whatever value of V_{OUT} we require into the formula, we obtain the necessary value of R2.

$$\text{eg } R2 = 220\left(\frac{3}{1V25} - 1\right) = 308R$$

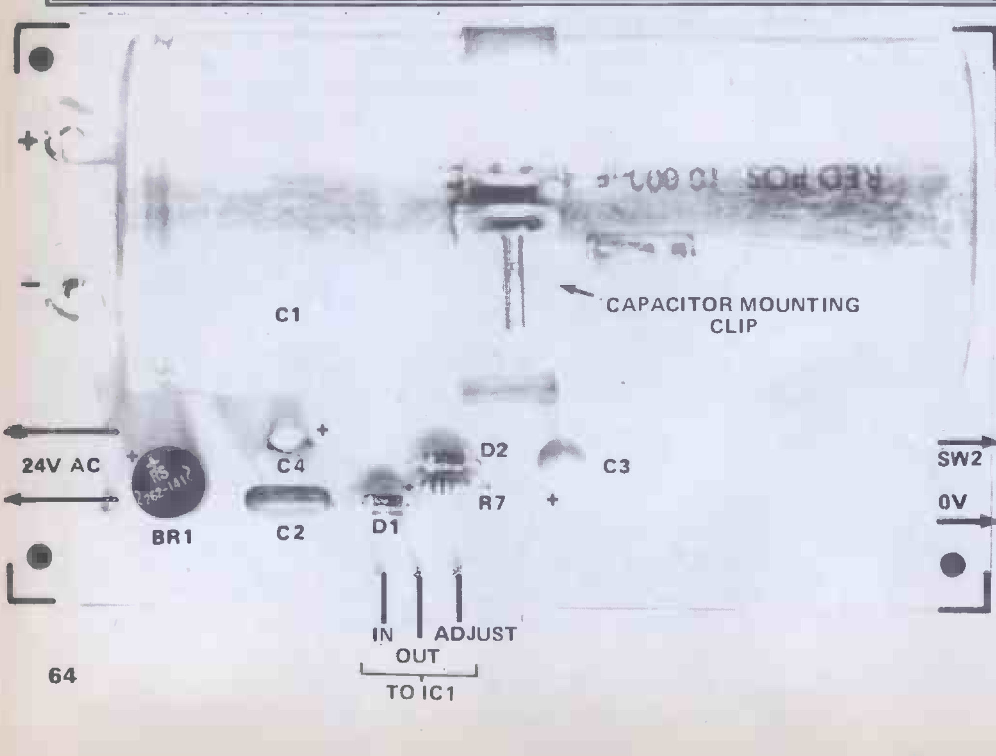
The nearest preferred value is 330R, therefore the output voltage is slightly over 3 volts DC. This resistor corresponds to R6 in the circuit of the HE PSU and position 1 of the rotary switch SW2. By combining R6 with R5 in series and by turning SW2 to position 2, an overall resistance of

$$330 + 510 = 840R$$

is obtained giving a voltage of 6 VDC. Similarly the remainder of the voltage steps ie 9 V, 12 V, 15 V and 20 V are obtained by adding further resistors into circuit by means of SW2.



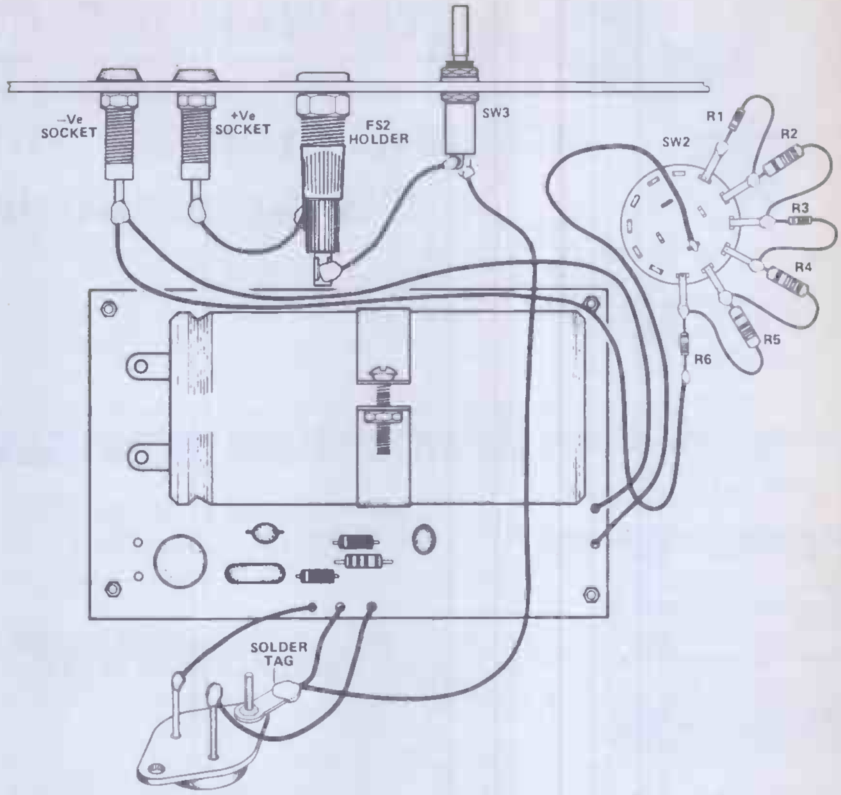
The resistor chain and SW2 could be replaced by a potentiometer to give a continuously variable output voltage but an expensive panel meter will then be required, to allow reading of the voltage. Switched resistors give a sufficient range of voltages and obviously keep the cost down considerably.



similar, this prevents the cable from being pulled out. Alternatively, you could use a plug and socket connector assembly as we did (see photographs).

We advise the use of rubber sleeving to cover the joints where a mains lead joins external hardware eg a switch or a fuse holder. This can help safeguard against electric shock hazards. You can test your mains wiring at this point if you have a meter. Measure the output voltage of the transformer when switched on. It should be about 25-30 V AC under no-load conditions.

Figure 2. Overlay details of the printed circuit board. It is important that capacitor C1 is polarised correctly.



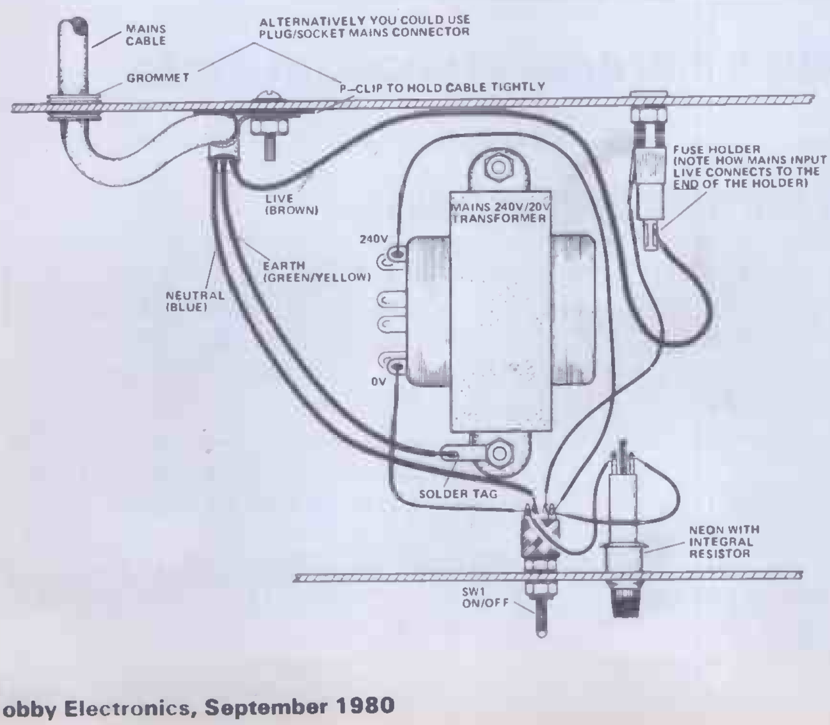
Once the mains voltage side has been wired in, the PCB can be completed. Mount C1 on the board using a capacitor clip and solder the tags to the board making sure it is polarized correctly ie the tag close to the red dot or positive marking on the capacitor goes to the positive connection on the PCB. Then SW2 (the rotary switch and resistors) can be mounted. Note how the resistors are mounted on SW2 and make sure you get them in the correct order. You won't do any damage if they are in the wrong order but the output voltages will not be correct.

Next, wire up the PCB, the two switches and the output sockets as in the connection diagram, again taking all leads neatly around the outside of the case and tying them together. Finally, wire in IC1 to the PCB.

At this stage, the PSU is complete and should work first time. Measure the DC output using a meter and check that all the settings are correct. If you possess a 25 V or a 30 V panel meter, an alternative suggestion is to insert a 4K7 linear potentiometer in the front panel instead of the SW2-resistor combination, with the meter across the output and use it to give a reading of the now fully variable output voltage. **HE**

Figure 3 (above) shows connection details of the mains circuitry. Care is needed as mains voltage can be dangerous.

Figure 4. The low voltage side of the Bench PSU project.



Buylines

A rough approximation of the cost of components for this project comes to around £15. This does not, of course, include the case or the PCB.

IC1 should be obtainable from the main National Semiconductor distributor (Marshalls) or the usual mail order companies.

C1 may be a problem. If you experience difficulty then it is possible to use a lower value capacitor eg 2200uF or 4700uF but the working voltage of 40 V must be maintained.

Parts List

RESISTORS (All ¼W, 5%)

R1	820R
R2,4,5	510R
R3	560R
R6	330R
R7	220R

CAPACITORS

C1	10,000u 40 V electrolytic, single ended
C2	100n polyester
C3	10u 35 V tantalum

SEMICONDUCTORS

IC1	LM317K voltage regulator
BR1	1A, 50 V bridge rectifier
D1,2	1N4002 diode

MISCELLANEOUS

SW1	Double-pole, double-throw toggle switch
SW2	6-way rotary switch
SW3	Single-pole, double throw toggle switch
FS1,2	Panel mounting fuse-holders and 1 Amp quick-blow fuses.
Neon	Panel-mounting with integral resistor
T1	20 V, 20 VA mains transformer

Grommet, cable clip, knob, 2 x 4mm O/P sockets, case to suit, mounting clip for C1.

CB Breaker One Four

Send any news, comments or information you may have to: Breaker One Four, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

Rick Maybury reports from the Trafalgar Square Rally plus a run-down of the suggested frequencies for Open Channel.

THE STORY SO FAR: The UBA and several other 'user groups' are still pushing for legalisation on 27MHz, they're pretty determined as we saw at the Trafalgar Square rally, but more of that later.

NATCOLCIBAR (National Committee for the Legalisation of CB Radio), comprising CBA, GLC, (Greater London Council) (Citizens Band Association), manufacturers and CB Clubs up and down the country are pushing for 41 to 49 MHZ, (405 line TV frequencies).

Meanwhile Her Majesty's Government, in the shape of the Home Office are almost certainly going for 900 MHz, a strange choice, best summed up by Richard Town of NATCOLCIBAR who said at the last meeting of the technical sub-committee:

"900 MHz acts like light and you can't see round corners".

Trafalgar Square

So there you have it, two campaigns and one government standpoint, all this came to a dramatic head at the Trafalgar Square rally on July the 6th.

The rally was organised by NATCOLCIBAR as the finalé to a six month campaign of demonstrations, petitions and meetings up and down the country. In retrospect this campaign has done more to highlight the absurdities of British law and bring the campaign to the attention of the public than any previous campaign.

The rally was designed to bring these achievements to the attention of the media and the government, and to thank the hard-working campaigners who have done so much. Approximately 5,000 people also thought it was worth turning up. Proceedings got underway around noon, the programme was laid down well in advance. We heard from Ivan Francis of REACT, (see last month's BOF). MPs Austin Mitchell, John Butcher and Patrick Wall gave a rousing speech apiece, liberally punctuated with: "Whadda ya want" and returned equally enthusiastically from the throng with a loud "CB".

All went fairly well until members of the UBA (United Breakers Association) were denied access (rightly or wrongly we'll never know) to the microphone. From then on events took a nasty turn for the worse. Things got completely out of hand and physical violence was threatened to members of the platform (MPs included) on at least two occasions.

Trafalgar Square — full to capacity.

Lucky!!

One thing became abundantly clear at that meeting; whether you want CB on 27 MHz, VHF or UHF all you will get is two tin cans and a piece of string if the various groups can't get together and thrash out a common policy. Threatening violence and forming multitudes of splinter groups is counter-productive. Everyone should consider themselves extremely lucky the media were

Austin Mitchell, John Butcher, Patrick Wall, Richard Town, Theo Yard and Hobby Electronics!

kind enough to ignore the in-fighting, it could have put back the campaign five years.

The Choices

For those of you still confused by the various suggestions here is a run-down of the proposed frequencies with some notes on advantages and disadvantages.

27 MHz This is the traditional CB frequency currently used by over 20 countries worldwide.

Advantages: Equipment cheaply and freely available, range good, technology well established.

Disadvantages: Massive interference problems both locally-Radio Control, (Soon to be allocated another frequency on 35 MHz) Radio Paging, TV etc Long distance 'Skip' from overseas. Quality is generally poor but acceptable.

41-49 MHz
A VHF system, used in the states for low power walkie-talkie equipment and some radio modelling.

Advantages: Equipment cheaply and freely available, range good, (within certain limits of power output), technology well established, quality can be excellent.

Disadvantages: Only one really, these frequencies are at present the 'property' of 405 line TV transmissions by the BBC and IBA. Note — TVs for 405 lines haven't been made for around 15 years.

230 MHz The original 'New frequency' proposed by the CBA some years ago.

Advantages: Virtually interference free, a good opportunity for British manufacturers as no mass production facilities exist for equipment on these frequencies.

Disadvantages: A non-starter really, the band is the province of the MOD (Ministry of Defence), who, although they probably don't use it, are nonetheless reluctant to hand it over.

900 MHz The most likely frequency to be legalised for 'Open Channel'.

Advantages: Interference free, another opportunity for British Industry, possibility of other EEC countries adopting this frequency.

Disadvantages: Reliable studies show range could be under a half mile in urban environments (power output is not significant at these frequencies as it follows the inverse square law). RF absorbtion by concrete and foilage is high. Some evidence to suggest that cataracts in the eye can be aggravated by high frequency RF though we would not consider this a major drawback until these studies are confirmed. No equipment available in any quantity.

Your Opinion?

Coming down to case histories it's clear that there are only two viable frequencies, namely 27 MHz and 41-49 MHz. We estimate there are something like 150,000 illegal CB rigs in the country, problems do exist with radio modellers but they are soon to be allocated another frequency. TVI can be cured very easily at the manufacturing stage, adding pence to the cost of TVs and rigs. Radio pagers can be upset, although 27 MHz pagers are somewhat old fashioned these days, very few new systems are being installed operating on these frequencies. On the whole the illegal CB network exists without any real inconvenience to the general public and can be said to be successful within its limitations.

41-49 MHz is our favourite. Equipment exists, it has been used in the States for some time now, the problems, such as they are, are well known and have been largely dealt with. In this country something like half a million 405 line TVs are being served by powerful transmitters on this frequency. The old 405 line transmitters were switched off in Ireland some time ago, complaints were few and no-one really missed it. One authority now suggests that the cost of running and maintaining these transmitters is greater than the cost of replacing all the sets that still operate on this frequency that would seem to be a logical answer.

We would like to see CB, Open Channel, call it what you will on or around 41-49 MHz, actually we would only need around one megahertz, what do you think?

Club Corner

No shortage of clubs this month but first a couple of points regarding our previous lists.

We've managed to get the name of the chairman of the CBRAG wrong on a couple of occasions, despite frantic letters from the gentleman concerned. So sorry to Bill Gittings who is most definitely the chairman and promise we won't do it again. Lastly we're sorry to hear that Keith Townsend has resigned from the MCBRC, all correspondence should now be addressed to the new chairman whose address appears below.

BIG FOUR CLUB
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40 Brunswick Square,
Hove BN3 1EF,
East Sussex.

WYE FOREST BREAKERS
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19 Chowson Pleck,
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Charing,
Ashford,
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MCBRC
Chairman: R. Hopkins
85 Allens Lane,
Pelsall,
Walsall,
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NORTH BIRMINGHAM CB CLUB
Secretary: Bob Barber,
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Chairman: Steve Cairns,
Room 101,
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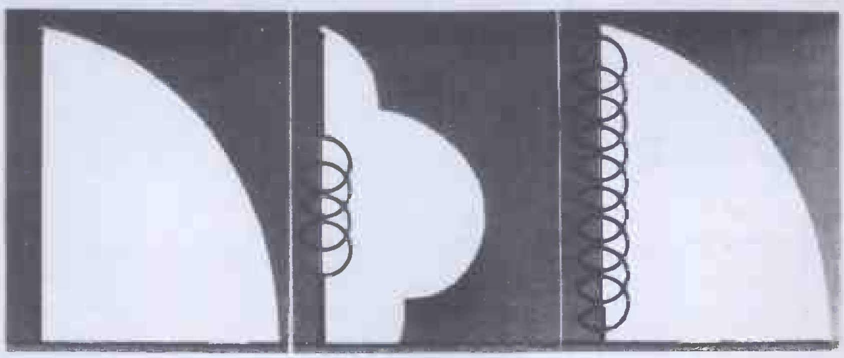

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The telephone number for the Northern Ireland CB Information Centre is 0232 58291, sorry to Margaret McCulloch for the confusion.

National Directory

We promised to bring you details of the National Directory this month; unfortunately production problems look like holding it up for a couple of weeks. (Have you any idea how much work is involved in sorting 15,000 names alphabetically?) The publication date is still mid September so no worries on that score. Cover price has also be decided but we're sure we'll know by next month — watch this space.

The Trafalgar Square Rally promoted a lot of comment, much of it unprintable, we think the best and most

CB VIP

BERNIE MURRAY

Firstly, a few points about myself. I am 40 years old. Among my hobbies are photography, rifle shooting, tape-sponding, radio controlled model making, and of course, campaigning for the legislation of Citizens Band Radio.

I was first introduced to CB in West Germany 10 years ago whilst on a camping holiday. We found the little walkie-talkies very useful for keeping contact if one of us strayed too far from base. Whilst in Germany, I helped form two CB clubs and one in Luxembourg. Of course, CB proved invaluable in driving across Europe (sometimes my navigation isn't too good). I have actually assisted in the saving of three lives thanks to CB. Two French people trapped in an overturned car, and a lorry driver in Germany stranded in the snow having gone off the road.

In 1976, myself and a few similarly minded people decided to form a campaign, hence UKCBC. We campaign for the legislation of CB on any frequency and any power but do not condone the use of illegal equipment. A lot of hard work and dedication has gone into the campaign, and we have at last had a statement from Mr. Whitelaw saying that the Government agrees in principle to CB radio. We have asked our members to send letters to Mr. Whitelaw to show just how much public support there is throughout the British Isles, and, hopefully you, the readers of Hobby Electronics, will assist us and do your bit even if you do not belong to any CB clubs or campaigns.

We here at UKCBC have to date produced 10,000 letters which have been sent out to our members for signature and forwarding to Mr. Whitelaw. We have collected over 5,000 signatures for the GLC petition which was duly handed in, and about 30,000 signatures on a nationwide petition, with the help of other CB clubs. These are yet to be handed in, and we hope to do this after the publication of the Green Paper.

Before closing I would like to publicly thank the following people:- Mr. Patrick Wall, MP, and all the members of his Parliamentary Committee, Mr. Theo Yard, Chairman of the National Steering Committee, Richard Town, John Sanderson of UKCBC Yorkshire, and his helpers, Les Carroll of CB North East, Steve Bishop from UKCBC Doncaster, Chuck & Trixie of UKCBC North Wales, Ray Withers and Paul Thompson from Birmingham, Bill Gittins, Chairman of CBRAG without whose help the Lewisham CB Road Show would not have got off the ground, and the loyal and dedicated few, including very patient wives, who have helped in the running of UKCBC and without whose help we couldn't keep going.

Final thanks go to Hobby Electronics for allowing me space in their excellent publication.

Austin Mitchell MP addresses the crowd.

constructive criticism came from Theo Yard, chairman of NATCOLCIBAR. Here are his views.

Sir,

The policy of the National Committee is to press for the legalisation of CB in this country. The Government will decide frequency, and although the Committee has an opinion on this matter, our philosophy has consistently been that any CB is better than no CB at all.

We are well aware that CB could be legalised immediately on the FCC 27MHz system, and would provide a service. Indeed, if that was the only option, I, and the members of my Committee would be delighted. However, that is not the case, and it is worth stating why we do not press for this to be done.

The Government has on three occasions publicly stated that it will not licence 27MH2 therefore, it seems stupid to antagonise the very people who will ultimately make the political decision, particularly as we now know that we are pushing at an open door. Secondly, imagine if you will, 40 telephone lines stretched across London, to which upwards of a million people can attach telephones at random. What then would be the chance of any coherent conversation, for that is what the implementation of 27MHz in its present form would mean in London alone, without extending this simplistic argument to the rest of the country.

There is undoubtedly, a very strong lobby against CB in this country, composed in the main of vested interest and political motivation, which takes comfort in the rift between those who are working for CB and those who are repeatedly putting back the clock by demanding no system unless it be on 27MHz. The arrogant, self-opinionated, and totally negative attitude of these people was forcibly demonstrated in Trafalgar Square by their attempts to break up a successful demonstration and to insult the Members of Parliament present, who have done so much for the British CB movement. If a test were to be made of responsibility before handing over air-waves to these sort of people, there will never be legal CB in Britain.

After the many years of work, let us not wreck the chances of a successful outcome by allowing this handful of egoists to lead us into a blind alley. The choice of frequency is for Government, and Government alone. Our task is to close ranks, and demand the implementation of the "Agreement in Principle" by the 1st January 1981. And yes, if it should be on 27MHz we would welcome it.

Theo Yard Chairman, National Committee for the Legalisation of Citizens' Band Radio

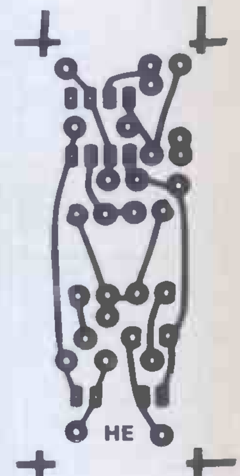
Our last item comes from Bernie Murray, our CBVIP this month. He and Bill Gittings (CBRAG) went over to Frankfurt last month on the invitation from an American and German CB Club (run by the United States Airforce. The event was a CB jamboree, used to raise funds for underpriviledged children. Whilst over there the UKCBC and CBRAG were affiliated to the club and they even received a trophy for being the most distant delegates. Part of the fund-raising was a 'Temporary Jail' event, people are put in jail by the organisers. To get out you have to pay a small fine. Apparently both Bernie and Bill went to jail three times each. No comment!

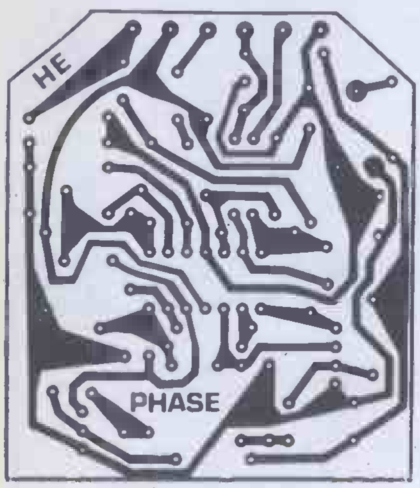
Stay lucky, see you next month. **HE**

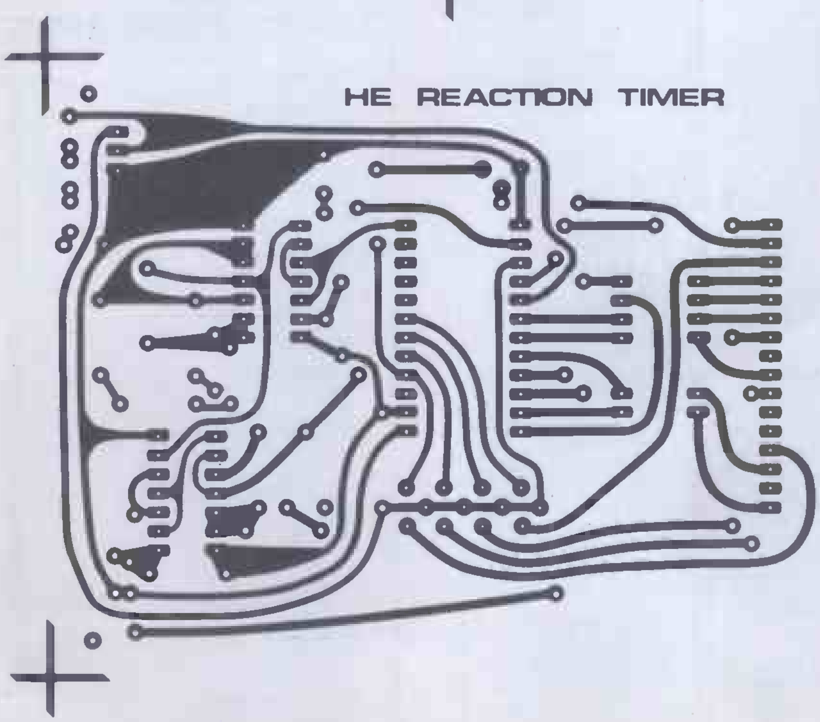
PCB Foil Patterns

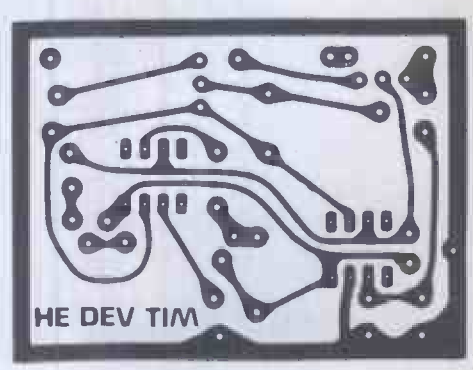
For the benefit of our confused readers who have been rushing around, frantically turning over pages, trying to find the foil patterns for the projects they are wanting to build — here they are!

We have collected all the track layouts or foil patterns (call them what you will) together on one page to make things easier.









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