FREE GADGETS, GAMES & KITS SUPPLEMENT INSIDE

Hobby Electronics

December '81

ISSN 0142-6192

Better value at only 60p

For A Down-To-Earth Approach To Electronics

•Easy-to-build Guitar Equaliser •Drum Synthesiser for under £30
•Headphone amp for guitar practice-peacefully! •Organ Pedalboard

Make Sweet Music With Our DIY Projects

Car Electronics- a complete takeover?

Special HE report brings you the facts

See Inside! See Inside! See Inside!

DECEMBER 1981
Vol 3 No 14

Hobby Electronics

Editor: Hugh Davies
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Esmé Dansiger

PROJECTS

FEATURES

NEWS & INFORMATION

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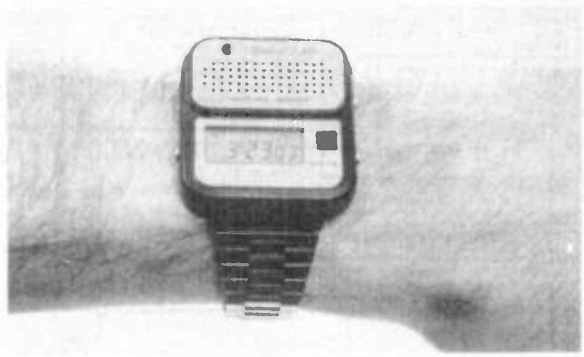
CAUGHT IN THE ACT: we found these two building our Drum Synthesiser project *(you can't beat it — see page 18)* in the HE Workshop while we were at lunch.
Son: "You've soldered that component in upside down Dad!"
Father: "Never mind son, I'm in a hurry — the Editor will be back soon!"



SPECIAL OFFER of the month: *Talking* Digital Watch. Not only will it tell you the time digitally but it will announce it at the press of a button and on the hour

DISSATISFIED with the tone of your acoustic or electric guitar? Just connect your pickup to our Guitar Graphic Equaliser (see easy-to-build project *with kit offer* on page 10) and balance-up the sound to your taste

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ELECTROLYTIC CAPACITORS: (Values are in µF) 500V: 10 52p; 47 78p; 63V: 0.47, 1.0, 1.5, 2.2, 3.3 8p; 4.7 9p; 6.8, 10 10p; 15, 22, 12p; 33 15p; 47 12p; 100, 19p; 1000 70p. 50V: 47 12p; 68 20p; 220 24p; 470 32p; 2200 90p. 40V: 4.7, 15, 22 9p; 3300, 90p; 4700, 120p; 25V: 1.5, 6.8, 10, 22 8p; 33 9p; 47 8p; 100 11p; 150 12p; 220, 15p; 330 22p; 470 25p; 680, 1000, 34p; 2200, 50p; 3300, 76p; 4700 92p; 16V: 40, 47, 100 9p; 125, 12p; 220 13p; 470, 20p; 680 34p; 1000 27p; 1500, 31p; 2200 36p; 3300 74p; 4700 79p.

TAG-END TYPE: 450V: 100µF 65p; 70V: 4700, 245p; 64V: 3300 198p; 2200 139p; 50V: 3300 154p; 2200 110p; 40V: 4700 180p; 25V: 10,000 320p; 15,000 345p.

POLYESTER CAPACITORS: Axial Lead Type 400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2 82p.
160V: 10nF, 12n, 39n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n, 38p; 1µF 42p; 1µ5 45p; 2µ2 48p; 4µ7 58p.
1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n, 100n 42p.

SIEMENS Pcb Type Miniature poly. Capacitors
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 12n, 15n 7p; 18n, 22n, 27n, 33n, 39n, 47n 8p; 39n, 56n, 68n 10p; 82n, 100n 10p.
100V: 100n, 120n 10p; 150n, 180n 11p; 220n, 270n 14p; 330n, 390n 20p; 470n, 560n 26p; 680n 30p; 1uF 34p; 2u2 50p.

POLYESTER RADIAL LEAD CAPACITORS: 250V 10n, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1u 23p; 1u5 40p; 2u2 46p.

FEED-THROUGH CAPACITORS 1000pF/450V 8p

TANTALUM BEAD CAPACITORS 35V: 0.1µF, 0.22, 0.33 15p; 0.47, 0.68, 1.0, 1.5 16p; 2.2, 3.3 16p; 4.7, 6.8 22p; 10 28p; 16V: 2.2, 3.3 16p; 4.7, 6.8, 10 18p; 15, 36p; 22 30p; 33, 47 40p; 100 75p; 10V: 15, 22, 26p; 33, 47 35p; 100 55p; 6V: 100 42p.

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & Lin. 500Ω, 1KΩ & 2KΩ (Linear only) Single Gang 29p; 5KΩ-2MΩ Single Gang Log & Lin. 29p; 5KΩ-2MΩ Single Gang D/P Switch 78p; 5KΩ-2MΩ Double Gang 89p.

MYLAR FILM CAPACITORS 100V: 1nF, 2, 4, 4nF, 10 6p; 15nF, 22n, 30n, 40n, 47n 7p; 56n, 100n, 200n 9p; 50V: 470nF 12p.

SLIDER POTENTIOMETERS 0-25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 110p
Self Stick Graduated Bezel 40p

CERAMIC CAPACITORS 50V: Range: 0-5pF to 10nF 4p. 15nF; 22nF; 33nF; 47nF 5p. 100nF/30V 7p. 200nF/6V 8p.

PRESET POTENTIOMETERS
0.1W 50Ω-5MΩ Miniature Vertical & Horizontal 7p
0-25W 100Ω-3-3MΩ horiz. larger 10p
0-25W 200Ω-4-7MΩ vert. 10p
Cermet. Precision, multiturn, 0.75W ¾in 100Ω-100KΩ 89p

SILVER MICA (Values in pF) 2, 3.3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF 15p each; 200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 21p each; 1000, 1200, 1800, 2200 30p each; 3300, 4700pF 60p each.

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

	RANGE	VAL	1-99	100+
¼W	2.2Ω 4M7	E24	2p	1p
½W	2.2Ω 4M7	E12	2p	1p
1W	2.2Ω 1MΩ	E12	5p	4p
2% Metal Film	10Ω-1MΩ		6p	4p
1% Metal Film 0.5W	51Ω-1M		8p	6p

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

POLYSTYRENE CAPACITORS 10pF to 1nF 8p; 1.5nF to 12nF 10p

MINIATURE TYPE TRIMMERS 2-6pF, 2-10pF 22p; 2-25pF, 5-56pF 30p; 10-88pF 35p

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

SPECIAL OFFER

	1+	50+
741 8 pin	14p	12p
NE555	16p	14p
2114L-450n/300n	99p	90p
2114L-200n	130p	115p
2532 or 2732	525p	499p
2708 or 2716	230p	199p
4027	240p	215p
4116-200n	85p	70p
4334-3	325p	298p
7805-5V	45p	36p

75 SERIES

75108	350
75150	140
75154	150
75188	65
75189	65
75322	185
75450	75
75451	70
75452	70
75454	225
75491	89
75492	95

NEW LOW PRICES
Computer & Linear ICs, Texas TTL74, 74LS, Motorola CMOS.
ALL PRIME PRODUCT

DIODES

AA119	15
BA100	15
BY100	24
BY126	12
BY127	12
CR033	250
OA9	40
OA47	12
OA70	12
OA79	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

BRIDGE RECTIFIERS

(plastic case)	p
1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	350
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V 1.3W 15p each

TRIACS

3A 200V	54
3A400V	56
8A100V	60
8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	135
16A100V	103
16A400V	105
16A800V	220
25A500V	220
25A800V	295
T2800D	120

Thyristors

5A/40V	32
5A400V	40
5A600V	48
8A300V	60
8A600V	78
12A100V	78
12A400V	95
12A800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	38
2N5064	38
2N4444	130

DIAC

ST2 25

NOISE

Z5J 196p

VARICAPS

BA102	60
BB105B	40
BB106	40
MVAM2	165
MVAM115	158

COMPUTER ICs

1702	200
1802CP	760
2101-2	260
2112-2	260
2114-450n	260
2114L-300n	99
2118-3 250n	250
2147	[illegible]
2532-450n	525
2708	200
2716-5V	280
2732-450n	455
4027	240
4116 200n	80
4118-250	460
4164-200n	790
4315 Cmos	790
4334-3 CMOS 2114-3	325
4864-3	[illegible]
5101-450	116
6116-3 16K	800
6502CPU	450
6503	850
6504	396
6505	796
6520PIA	310
6522VIA	456
6530	1360
6532RRIOT	796
6545CRTC	1450
6551ACIA	[illegible]
6582PC	376
6800	[illegible]
6802	560
6803	1350
6804	100
6805	670
6808	520
6809	1220
6810	175
6820	176
6821	176
6840	1460
6843	878
6845	850
6847	860
6850	176
6852	256
6875	550
8080A	450
8085A	550
8116	[illegible]
8123	125
81LS95	115
81LS96	115
81LS97	116
8202	£26
8212	170
8214	425
8216	170
8224	250
8228	250
8251	400
8253	799
8255	399
8257	800
8T26A	136
8T27	150
8T28A	135
8T31	350
8T95N	135
8T97N	135
AM26LS31C	125
AM26LS32A	125
AY-3-1015	395
AY-5-1013	350
AY-5-2376	700
FD1771	£18
IM6402	380
MC1488	62
MC1489	62
MC14411	895
MC14412	800
MM1702A	250
MM5 280D	695
RO-3-2513L	775
RO-3-2513U	600
SFF96364E	800
SFC71301	820
TMS2716 3V	875
TMS4027	240
TMS4035	00
TMS6011	365
ULN2003	100
UPD80 C35C	£11
Z80CPU 2.5	390
Z80ACPU 4M	550
Z80DMA	999
Z80P10	380
Z80AP10	400
Z80CTC	380
Z80ACTC	400
Z80S10-1	£18
Z80AS10	£23
Z80Dart	726
Z80Adart	775

LINEAR ICs

555CMOS	80
702	75
709 14 pin	40
709C 8 pin	35
741 8 pin	14
747C 14 pin	70
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-0212	675
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-3-1270	840
AY-3-8500	390
AY-3-8910	620
AY-3-8912	625
AY-5-1224A	235
AY-5-1230	450
AY-5-1317A	630
AS-5-3500	350
AY-5-4007D	450
AY-5-8100	775
CA3011	110
CA3012	175
CA3014	167
CA3018	68
CA3019	70
CA3020	188
CA3023	191
CA3028A	90
CA3035	236
CA3036	115
CA3043	275
CA3045	365
CA3046	70
CA3048	214
CA3059	195
CA3075	213
CA3080E	65
CA3081	190
CA3085	95
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	90
CA3140	48
CA3160	95
CA3161	135
CA3162E	450
CA3189	285
ICL7106	750
ICL7107	975
ICL8038CC	300
ICL8211A	150
ICM7204	550
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7217A	790
ICM7224	785
ICM7555	80
LA4032	295
LC7130	495
LF351	48
LF355	85
LF356	90
LM10	395
LM301AP	26
LM308T	95
LM311	70
LM318N	200
LM319	236
LM324A	50
LM339	64
LM348	64
LM349	115
LM358	50
LM377	156
LM379	416
LM380	75
LM381N	145
LM382	125
LM384	140
LM386	90
LM387	120
LM389	95
LM393	150
LM725CN	325
LM733	75
LM1458	46
LM2917	195
LM3900	44
LM3909N	70
LM3911	125
LM3914	210
LM3915	220
LM3916	220
LM13600	125
LS7220	280
M252AA	625
M253AA	1150
MC663	50
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1445	150
MC1458	40
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC1710	79
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	89
MC3405	150
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM5387A	475
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	210
NE544	185
NE555	16
NE556	55
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	156
NE567V	150
NE570	450
NE571	420
RC4136D	69
S566B	245
SAB3209	425
SAB3210	275
SAB3271	485
SAS560	150
SAS570	150
SG3402	295
SL490	350
SN76003N	240
SN76013	250
SN76018	140
SN76023	170
SN76023ND	240
SN76033N	210
SN76115N	215
SN76131	125
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TA7205A	225
TAA611	125
TAA621AX1	250
TAA661A	155
TAA700	250
TAA900	00
TAD100	159
TBA120S	70
TBA540Q	220
TBA550Q	330
TBA641-A12	275
BX or BX11	250
TBA651	190
TBA800	80
TBA810	95
TBA820	70
TBA920Q	260
TBA950	300
TBA990Q	270
TCA220	360
TCA270Q	250
TCA940	00
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA1034	350
TDA1490	290
TDA2002	326
TDA2020	320
TDA2030	320
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	30
TL072CP	50
TL074CN	100
TL081CP	25
TL082CP	45
TL083CP	75
TL084CN	96
UAA1003-3	935
UAA170	170
UAA180	170
UAA2240	196
ULN2003	86
ULN2004	150
ULN2238	100
XR2206	350
XR2207	375
XR2216	675
XR2240	195
XR2266	750
ZN414	88
ZN419E	190
ZN423E	195
ZN424E	130
ZN425E	350
ZN426E	325
ZN427E	625
ZN428E	478
ZN429E	210
ZN1034E	200

TRANSISTORS

AC125	35	BC212	10	BF224A	25	MPSA56	30	VN88AF	94	2N3441/2	140	2SC1678	140
AC126/7	25	BC212L	10	BF244B	29	MPSU02	58	ZTX107/8	11	2N3663	15	2SC1923	50
AC128	20	BC213	10	BF245	30	MPSU05	55	ZTX109	12	2N3702/3	10	2SC1945	225
AC141/2	30	BC213L	10	BF256A	35	MPSU06	55	ZTX212	28	2N3704/5	10	2SC1953	90
AC176	25	BC214	10	BF256B	45	MPSU52	65	ZTX300	13	2N3706/7	10	2SC1957	90
AC187	25	BC214L	10	BF257/8	32	MPSU55	60	ZTX301	16	2N3708/9	10	2SC1969	198
AC188	30	BC237/8	14	BF259	35	MQSU56	60	ZTX302	16	2N3710/11	10	2SC2028	85
ACY17/18	70	BC307B	14	BF274	42	MPU131	52	ZTX303	25	2N3713	140	2SC2029	180
ACY19/20	75	BC308	16	BF336/7	40	OC26	170	ZTX304	17	2N3771	170	2SC2078	155
ACY21/22	75	BC327/8	15	BF451	35	OC28/35	130	ZTX314	25	2N3772	195	2SC2091	85
ACY28	75	BC337/8	15	BF594/5	30	OC36/41	120	ZTX326	30	2N3773	270	2SC2314	85
ACY39/41	85	BC441/61	34	BFR39/40	23	OC42/44	120	ZTX341	30	2N3819	22	2SC2166	185
AD142	120	BC477	40	BFR41/79	23	OC45/70	40	ZTX500	14	2N3820	45	2SC1679	190
AD149	79	BC516/7	40	BFR80/81	25	OC71/72	40	ZTX501/2	15	2N3822/3	65	2SD234	74
AD161	42	BC547/8	14	BFR98	105	OC74/75	50	ZTX503	18	2N3824	65	2SK45	90
AD162	42	BC549C	14	BFX29	28	OC76/77	50	ZTX504	25	2N3866	58	3N128	112
AF115/6	60	BC556/7	15	BFX81	45	OC81/82	40	ZTX531	25	2N3879	150	3N140	112
AF117/8	60	BC558/9	15	BFX84	26	OC83/84	40	ZTX550	25	2N3903/4	18	40311	60
AF124/26	70	BCY30	68	BFX85/6	28	OC140	110	2N697	23	2N3905	15	40313	130
AF139	40	BCY34	85	BFX87/8	28	OC170/71	85	2N698	40	2N3906	17	40315	60
AF178	75	BCY35	50	BFY18	50	OC200	85	2N699	48	2N4037	40	40316	95
AF186	70	BCY39/40	85	BFY50/1	23	TIP29	34	2N706A	19	2N4041	40	40317/20	60
AF239	78	BCY42/43	14	BFY52	23	TIP29A	36	2N708	19	2N4058	10	40323	60
ASZ21	125	BCY45	50	BFY53	32	TIP29B	56	2N918	35	2N4061/2	10	40324	100
BC107	10	BCY58/59	35	BFY55/6	32	TIP29C	60	2N1131/2	24	2N4064	115	40326/7	70
BC107B	12	BCY70/71	16	BFY64	35	TIP30	47	2N1302	45	2N4220	70	40347	90
BC108	10	BCY72	20	BFY71	20	TIP30A	48	2N1303	60	2N4234/6	48	40348	120
BC108B	12	BCY78	24	BFY81	120	TIP30B	50	2N1304/5	60	2N4264	24	40360	40
BC108C	12	BD112	125	BRY39	40	TIP30C	58	2N1306/7	65	2N4286	15	40361/2	50
BC109	10	BD124	115	BSX20	20	TIP31A	45	2N1308	68	2N4289	18	40408	70
BC109B	12	BD131/32	48	BSX26/29	34	TIP31B	48	2N1613	30	2N4314	68	40411	285
BC109C	12	BD133	60	BSX78	45	TIP31C	55	2N1670	150	2N4400	18	40467A	130
BC114/5	22	BD135	45	BSY26	30	TIP32A	48	2N1671B	160	2N4427	80	40468	85
BC117/8	24	BD136/37	40	BSY95A	25	TIP32C	60	2N2160	295	2N4859	78	40594	105
BC119	38	BD138/39	40	BU105	170	TIP33A	65	2N2217	45	2N4871	55	40603	110
BC137/9	40	BD140	40	BU205	190	TIP33C	78	2N2218A	45	2N4898	135	40636	175
BC140	30	BD144/45	198	BU206	200	TIP34A	74	2N2219A	28	2N4901	175	40673	95
BC142/3	30	BD158	55	BU208	200	TIP34C	88	2N2220A	26	2N4921	55		
BC147	9	BD205/6	110	E421	250	TIP35A	160	2N2221A	26	2N4922	60		
BC147B	10	BD222	85	MD8001	250	TIP35C	185	2N2222A	25	2N5102	145		
BC148	9	BD245	45	MJ490	90	TIP36A	170	2N2297	45	2N5135/6	20		
BC148B	10	BD378	70	MJ491	175	TIP36C	199	2N2303	45	2N5138	18		
BC149	9	BD434	55	MJ2955	90	TIP41A	56	2N2368	25	2N5172	18		
BC149C	10	BD517	75	MJE170	150	TIP41B	80	2N2369A	18	2N5179	40		
BC153/4	27	BD695A	85	MJE180	150	TIP42A	60	2N2476	50	2N5180	45		
BC157/8	10	BD696A	85	MJE340	54	TIP42B	75	2N2483/4	27	2N5190/1	75		
BC159	11	BDY56	180	MJE370	100	TIP120	90	2N2492	50	2N5305/8	24		
BC160	45	BDY60	160	MJE371	100	TIP121/2	99	2N2497	63	2N5457/8	30		
BC167A	10	BDY61	160	MJ490	90	TIP141/2	120	2N2646	45	2N5459	35		
BC168C	10	BF115	35	MJE520	65	TIP147	120	2N2784	55	2N5485	36		
BC169C	10	BF154/8	15	MJE521	95	TIP2955	60	2N2904/5	28	2N5777	45		
BC170	15	BF167	29	MJE2955	99	TIP3055	60	2N2906/7	26	2N5879	190		
BC171/2	11	BF173	27	MJE3055	70	TIS43	32	2N2907A	26	2N6027	32		
BC177/8	20	BF177	25	MPF102	66	TIS44/5	45	2N2926G	10	2N6388	150		
BC179	20	BF178	30	MPF103	36	TIS46	45	2N3011	28	2SA715	60		
BC182/3	10	BF179	35	MPF104	36	TIS59/74	50	2N3020	45	2SC495	70		
BC184	10	BF180/2	38	MPF105	36	TIS90/91	30	2N3053	26	2SC496	70		
BC182L	10	BF184/5	38	MPF106	40	UC734	65	2N3054	58	2SC1096	82		
BC183L	10	BF194/5	12	MPSA05	22	VK1010	80	2N3055	48	2SC1173	125		
BC184L	10	BF196/7	12	MPSA06	25	VN10KM	46	2N3108	45	2SC1306	150		
BC181	20	BF198/9	16	MPSA12	32	VN46AF	78	2N3252	46	2SC1307	220		
BC186/7	30	BF200	30	MPSA55	30	VN66AF	85	2N3302	30	2SC1449	85		

TTL 74 (TEXAS)

7400	11	7401	11	74120	75
		7402	11	74121	30
		7403	14	74122	45
		7404	14	74123	50
		7405	18	74125	42
		7406	28	74126	40
		7407	28	74128	42
		7408	18	74132	48
		7409	18	74136	35
		7410	14	74141	70
		7411	20	74142	190
		7412	20	74143	250
		7413	24	74144	250
		7414	32	74145	70
		7416	25	74147	99
		7417	25	74148	75
		7420	16	74150	80
		7421	20	74151	45
		7422	20	74153	45
		7423	22	74154	75
		7425	28	74155	75
		7426	30	74156	75
		7427	27	74157	45
		7428	28	74159	99
		7430	16	74160	60
		7432	26	74161	60
		7433	27	74162	62
		7437	27	74163	64
		7438	27	74164	64
		7440	17	74165	62
		7441	68	74166	65
		7442	38	74167	185
		7443	90	74170	168
		7444	90	74172	290
		7445	65	74173	65
		7446	55	74174	72
		7447	50	74175	72
		7448	50	74176	55
		7450	16	74177	75
		7451	16	74178	96
		7453	16	74179	68
		7454	16	74180	65
		7460	16	74181	140
		7470	36	74182	75
		7472	30	74184	99
		7473	30	74185	99
		7474	25	74188	290
		7475	40	74190	70
		7476	30	74191	70
		7480	48	74192	70
		7481	120	74193	65
		7482	70	74194	75
		7483	50	74195	65
		7484	80	74196	65
		7485	95	74197	65
		7486	26	74198	99
		7489	205	74199	99
		7490	28	74221	80
		7491	45	74246	150
		7492	30	74247	150
		7493	30	74248	150
		7494	34	74249	150
		7495	50	74251	80
		7496	45	74259	196
		7497	120	74265	65
		74100	85	74273	195
		74104	54	74276	150
		74105	55	74278	160
		74107	32	74279	90
		74109	35	74283	90
		74110	40	74284	199
		74111	55	74285	199
		74112	170	74290	105
		74116	88	74293	125
		74118	80	74297	236
		74119	90	74298	100

74361	196
74365	66
74366	56
74367	55
74368	55
74390	99
74393	99
74490	120

74L (TEXAS)

74L00	68
74L30	50
74L47	380
74L75	145
74L85	349
74L121	165
74L123	325

74S (TEXAS)

74S00	60
S04	73
S132	138
S138	240
S158	240
S188	210
S189	158
S194	360
S195	795
S201	00
S225	00
S241	540
S262	850
S287	325
S288	210
S289	00
S301	00
S470	325
S471	620
S472	1150
S475	825
S571	620

74LS (TEXAS)

LS00	12	LS47	40	LS248	65
LS01	13	LS48	80	LS249	68
LS02	14	LS49	60	LS251	40
LS03	14	LS51	15	LS253	40
LS04	15	LS54	15	LS257	48
LS05	15	LS55	30	LS258	40
LS06	15	LS63	150	LS259	85
LS08	15	LS73	25	LS261	195
LS09	15	LS74	25	LS266	25
LS10	15	LS75	28	LS273	90
LS11	15	LS76	20	LS275	290
LS12	15	LS78	24	LS279	88
LS13	30	LS83	56	LS280	250
LS14	40	LS85	70	LS283	45
LS15	15	LS86	38	LS290	57
LS20	15	LS90	35	LS293	46
LS21	15	LS91	80	LS295	215
LS22	15	LS92	36	LS298	130
LS26	18	LS93	36	LS299	420
LS27	15	LS95	46	LS300	175
LS28	20	LS96	120	LS302	175
LS30	18	LS107	43	LS320	270
LS32	15	LS109	30	LS323	270
LS33	16	LS112	30	LS324	200
LS37	18	LS113	40	LS325	320
LS38	18	LS114	35	LS326	330
LS40	18	LS122	44	LS327	315
LS42	35	LS123	55	LS347	150
		LS124	105	LS348	190
		LS125	30	LS352	185
		LS126	30	LS353	185
		LS132	45	LS365	37
		LS133	35	LS366	37
		LS136	28	LS367	37
		LS138	35	LS368	90
		LS139	38	LS373	75
		LS145	75	LS374	75
		LS147	199	LS375	48
		LS148	99	LS377	90
		LS151	39	LS378	89
		LS153	39	LS379	85
		LS155	39	LS383	70
		LS156	39	LS384	250
		LS157	35	LS385	378
		LS158	36	LS386	28
		LS160	41	LS390	62
		LS161	41	LS393	60
		LS162	41	LS395	199
		LS163	41	LS396	190
		LS164	48	LS398	275
		LS165	145	LS399	220
		LS166	85	LS445	140
		LS170	170	LS447	195
		LS173	72	LS471	620
		LS174	72	LS490	245
		LS175	58	LS541	135
		LS181	130	LS571	620
		LS183	275	LS640	225
		LS190	58	LS641	225
		LS191	58	LS645	210
		LS192	58	LS668	175
		LS193	65	LS669	150
		LS194	40	LS670	175
		LS195	40	LS673	550
		LS196	58	LS674	750
		LS197	85		
		LS200	345		
		LS202	345		
		LS221	80		
		LS240	96		
		LS241	96		
		LS242	85		
		LS243	85		
		LS244	80		
		LS245	118		
		LS247	40		

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT 1/2A	13p

PUSHBUTTON 6A
with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4 way 70p; 6 way 85p; 8 way 90p; 10 way 145p. (SPDT) 4 way 190p.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way 45p

ROTARY: Mains DP 250V 4 Amp on/off 56p

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only 90p

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 way 56p
Mains DP 4A Switch to fit 45p
Spacers 4p. Screen 6p

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

DIL PLUGS

14pin	44p
16pin	49p
24pin	88p
40pin	250p

Ribbon Cable ft

10 way	20p
20 way	40p

JUMPER LEADS (Ribbon Cable Assembly)
Single ended DIP Jumpers 24 inches 14 pin 145p; 16 pin 165p; 24 pin 240p; 40 pin 385p.

Double ended DIP Jumpers

Length	14 pin	16 pin	24 pin	40 pin
6in	185p	205p	300p	485p
12in	195p	215p	315p	490p
24in	215p	235p	350p	540p
36in	230p	250p	375p	595p

AMPHENOL PLUGS IEEE 575p Centronics llel 857p

VEROBOARD 0.1in

	clad	plain
2½ x 3¾"	73p	52p
2½ x 5"	83p	–
3¾ x 3¾"	83p	–
3¾ x 5"	95p	79p
3¾ x 17"	326p	211p
4¾ x 17"	426p	–
Pkt. of 100 pins	50p	
Spot face cutter	118p	
Pin insertion tool	162p	

VO Board	150p
DIP Board	330p
Vero Strip	144p

PROTO-DECs

Veroblock	375p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	785p
Superstrip SS2	998p

VERO WIRING PEN + Spool 310p
Spare Spool 75p
Combs 6p

DALO ETCH RESIST PEN
+ Spare tip 90p

FERRIC CHLORIDE
1 lb bag Anhydrous 195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz 395p pr

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided	S.R.B.P. 9.5" x 8.5"
6" x 6"	90p	110p	95p
6" x 12"	150p	195p	

DIL SOCKETS (TEXAS)

	Low Prof.	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	22p	60p
22pin	25p	70p
24pin	25p	70p
28pin	28p	90p
36pin	–	109p
40pin	30p	99p

EDGE CONNECTORS:
(Double type)

	.1	.156
2x10 way	–	120p
2x15 way	–	135p
2x18 way	140p	145p
2x22 way	180p	165p
2x25 way	180p	175p
2x30 way	199p	–
2x36 way	235p	–
2x40 way	285p	–
2x43 way	280p	–

D CONNECTORS (Cannon type)

Pins	Plugs	Sockets	Covers
9way	95p	125p	145p
15way	135p	198p	150p
25way	170p	250p	130p
37way	290p	398p	185p

Soldercon Pins
100 pins 70p
500 pins 325p

PLUGS & SOCKETS

JACK	Plug	Socket	In-line
2.5mm (plastic)	8p	–	10p
Metal	15p	8p	16p
3.5mm (plastic)	10p	15p	12p
Metal	18p	10p	18p
1/4in Mono			
Plastic	15p	20p	15p
Metal	36p	14p	30p
1/4in Stereo			
Plastic	22p	24p	22p
Metal	36p	20p	39p
DIN			
2 pin	8p	6p	14p
3 pin	13p	10p	15p
4 pin	18p	12p	15p
5 pin	13p	12p	15p
BANANA			
1mm	9p	9p	–
2mm	13p	13p	–
3mm (wander)	11p	11p	–
4mm	13p	14p	–
CO-AXIAL (TV)			
Plastic	10p	18p	8p
Metal	19p	20p	40p

UHF Connectors (50Ω-CB)
plug PL259 40p; Reducer 14p;
Socket SO239 Round Chassis 40p
Socket SO239 Square Panel....... 38p

BULGIN OCTAL 250V-6A/pin
Plug P551 199p; Socket 68p

IEC 3 pin 250V/6A

Plug, chassis mounting	40p
Socket, free hanging	70p
Socket, with 2 metre lead	150p

ZERO INSERTION FORCE DIL SOCKETS 24 way 650p
28 way 820p; 40 way 975p

PANEL METERS

FSD
60x46x35mm
0-50µA
0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
445p each

CRYSTALS

100KHz	290
200KHz	370
455KHz	383
1MHz	300
1.008M	395
1.28MHz	392
1.6MHz	323
1.8MHz	323
1.8432MHz	300
2MHz	305
2.4576MHz	300
3.2768M	240
3.57954M	150
3.6864MHz	300
4.000MHz	200
4.032	290
4.19430M	200
4.433619	120
5.0MHz	240
5.185M	300
5.24288M	390
6.0MHz	240
6.144MHz	240
6.5536MHz	200
MHz	200
7.168MHz	290
7.680M	200
8.0MHz	200
8.08333M	382
8.867237M	240
9.375M	323
10.0MHz	240
10.7MHz	270
12MHz	290
14.31818M	320
16.0MHz	275
18MHz	240
18.432M	240
19.968MHz	300
20.0 MHz	323
26.0 MHz	383
26.69 MHz	290
27.145MHz	240
27.648M	323
38.6667M	290
48.0MHz	270
100.00MHz	323
116.0MHz	300

RELAYS

REED, Encapsulated, Single Pole, 5W Normally Open, 200mA, 50V DC.

RL12	700Ω 6V to 9V	120p
RL13	1KΩ 9V to 12V	120p
RL14	1K7Ω 12V to 18V	120p
RL15	3KΩ 18V to 30V	135p

Single Pole, Change Over

RL16	1KΩ 4V to 10V	295p
RL17	1KΩ 9V to 12V	295p

Double Pole, Normally Open

RL18	350Ω 9V to 12V	200p

Miniature, enclosed, PCB mount. Our RL6 series.
S.P.C.O.
RL6-91 170Ω coil, 7V5 to 12V DC; 380V/6A AC; 1300VA/50W 210p
D.P.C.D.
43Ω coil, 4V2-7V DC; 250V AC; 5A; 1100VA/150W 218p
RL6-111 170Ω coil, 8V-14V; 250V AC 5A 220p
RL6-114 740Ω coil, 17V5-29V 250V 5A AC. 222p

CONTINENTAL Cradle Type Relays. Miniature Plug-in relays. 110V DC; 12V AC. 2A/DC; 2.5A AC 30W/100VA.
2 pole c/over 185Ω; 6V-18V. RL201 180p
2 pole c/over 13V to 35V; 700Ω; RL202 180p
4 pole c/over 9V to 18V; 185Ω. RL211 220p
High Power "Heavy Duty" PCB Mounting, Cradle type.
S.P.C.D. Power Gain 1:8000 380V AC/16A; 3.5K VA. 8 to 19V; 190Ω 295p

PIEZO TRANSDUCERS
Type PB-2720 75p

BUZZERS, miniature, solid-state 6V; 9V & 12V 70p

LOUDSPEAKERS
Miniature, 0.3W; 8Ω. 2in, 2¼in, 2½in, 3in 80p
2½in 40Ω, 64Ω or 80Ω 80p

WANDER MIKE
The new Radio microphone that transforms your FM radio into a cordless PA System. Just tune-in your radio on to 90MHz, turn on the Wander Mike and you have instant high quality sound reproduction. PA System. Has a range of 100 feet +. Also supplied is a 5-metre cable with jack plug, should you wish to use it as a standard microphone. Ideal for singers, musicians, conferences, lectures, discos, clubs etc.
ONLY £39.50

SPEAKING CLOCK
Complete Kit of parts available for this clock Only £37.50

TRANSFORMERS: Prim. 240V

6-0-6V; 9-0-9V; 12-0-12V 100mA 98p
pcb mounting, Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A 200p
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A 270p
Standard Split Bobbin type:

6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A 220p
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A 275p (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A 320p (60p p&p).
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A 400p (60p p&p).
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A 920p (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

	+ve		–ve	
1A TO3 metal case				
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		–
18V	7818	145p		–
1A TO220 Plastic Casing				
5V	7805	46p	7905	56p
12V	7812	50p	7912	55p
15V	7815	50p	7915	56p
18V	7818	50p	7918	56p
24V	7824	50p		
100mA TO92 Plastic Casing				
5V	78L05	30p	79L05	80p
6V	78L62	30p		–
8V	78L82	30p		–
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	80p

CA3085	95p
LM304H	170p
LM309KP	99p
LM300H	170p
LM305H	140p
LM309K	135p
LM317K	350p
LM317H	280p
LM323K	550p
LM325N	240p
LM326N	240p
LM327	270p
LM723	35p
TAA550	50p
TBA625B	75p
TDA1412	150p
78HO5 + 5V/5A	550p
78HG +5V to +25V 5A	650p
79HG-2.25V to 24V 5A	800p

25way 'D' CONNECTOR
Jumper Lead Cable Assembly

18" long, Single End, Male	520p
18" long, Single End, Female	525p
36" long, Double Ended, M/M	1020p
36" long, Double Ended, F/F	1010p
36" long, Double Ended, M/F	1000p

ANTEX SOLDERING IRON
C-15W 420p; CX17W 430p.
CCN-15W 440p; CX25W 445p.
Spare tips, assorted sizes 50p
Spare Elements 210p
Iron stand with sponge 160p

SOLDER (Multicore)
18SWG
Size 5 Dispenser 75p
Size 12 Reel 360p
22SWG
PC115 Dispenser 100p
Size 10 Reel 360p

CMOS

4000	14	4073	20	4536	295
4001	14	4075	20	4538	115
4002	14	4076	60	4539	115
4006	66	4077	26	4541	140
4007	18	4078	26	4543	135
4008	62	4081	26	4544	150
4009	35	4082	21	4549	395
4010	40	4085	65	4553	299
4011	15	4086	70	4554	190
4012	18	4089	140	4555	50
4013	34	4093	43	4556	55
4014	75	4094	168	4557	320
4015	66	4095	90	4558	120
4016	32	4096	90	4559	395
4017	48	4097	320	4560	180
4018	68	4098	88	4561	104
4019	42	4099	95	4562	495
4020	61	4160	95	4566	175
4021	70	4161	99	4568	250
4022	66	4162	99	4569	175
4023	20	4163	99	4572	36
4024	45	4174	99	4580	460
4025	19	4175	105	4581	250
4026	130	4194	105	4582	99
4027	38	4408	790	4583	99
4028	58	4409	790	4584	48
4029	77	4410	725	4685	99
4030	50	4411	695	4597	330
4031	170	4412	800	4598	290
4032	125	4415	480	4599	595
4033	165	4419	280	40097	88
4034	195	4422	770	40100	215
4035	95	4433	770	40101	130
4036	275	4435	850	40102	180
4037	115	4440	999	40103	175
4038	110	4450	350	40104	95
4039	290	4451	350	40105	115
4040	59	4490	350	40106	75
4041	78	4500	675	40107	60
4042	60	4501	28	40108	450
4043	70	4502	90	40109	100
4044	65	4503	50	40110	300
4045	170	4504	105	40114	240
4046	75	4506	65		
4047	75	4507	40		
4048	55	4508	265		
4049	30	4510	68		
4050	30	4511	68		
4051	78	4512	75		
4052	78	4513	199		
4053	78	4514	195		
4054	125	4515	198		
4055	125	4516	75		
4056	120	4517	415		
4057	1915	4518	42		
4059	480	4519	29		
4060	90	4520	78		
4061	1225	4521	200		
4062	995	4522	125		
4063	99	4526	95		
4066	36	4527	115		
4067	399	4528	80		
4068	22	4529	150		
4069	20	4530	90		
4070	26	4531	130		
4071	20	4532	110		
4072	20	4534	500		

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TIL211 Grn.	17
TIL212 Yel.	18
TIL220 .2" Red	14
.2" Green, Yellow or Amber	18
0.2" Bi colour Red/Green	65p
Green/Yellow	65p
0.2" Tri colour Red/Green/Yellow	85p
Square LEDs, Red, Green, Yellow	30
LD271 Infra Red	46
SFH205 Detector	91
TIL32 Infra Red	58
TIL78 Detector	60
BARGRAPH, Red 10 segments	225
LS40C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45

ISOLATORS

IL74	55
TIL111/2/4	90

7 Segment Displays

TIL307	675
TIL312 .3" CA	105
TIL313 .3" CC	106
TIL321 .5" CA	116
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
DL747 .6" CA	180
.8" Orange CA	250
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ±1 Red CA	150
.3" ±1 Green CA	150
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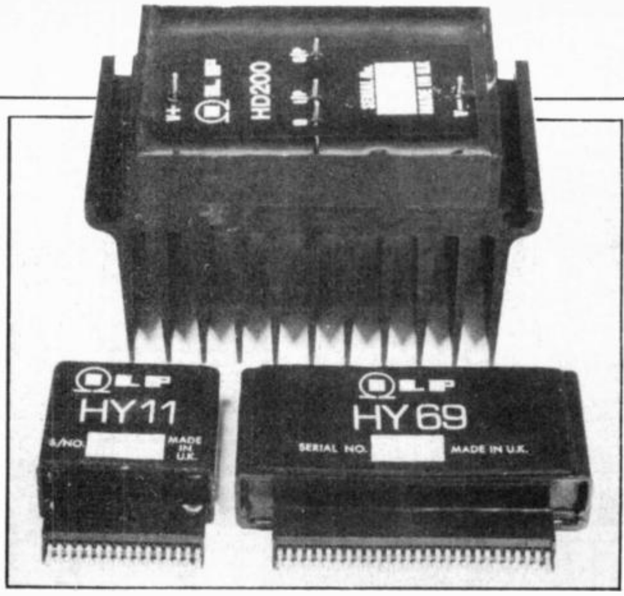


Editorial

I will be leaving HE (and Argus Specialist Publications) at the end of October, after holding HE's 'reins' since September last year.

From the January 1982 issue (due out early in December 1981) Ron Keeley will take over as HE's Editor. Ron's name should be familiar to regular readers, as the author of our *Synthesiser Secrets* series (the third part is on page 29 of this issue).

His face may be familiar too — we persuaded him to hold the HE Electronic Ignition module for the cover picture of the August '81 issue. (Next to him, incidentally, is Adrian Boxall from our photographic department.)

Ron left his native Australia in 1980 and has been working in the UK as a freelance journalist. He is a professional musician and has a background in electronics.

Thanks to everyone who has helped me put HE together over the last few months, and best wishes to all our readers, in the UK and overseas.

Hugh Davies

Hugh Davies MISTC, G3VCU

Sounds New

A RANGE OF new modular products for home hi-fi and disco/guitar amplifier constructors has been announced by ILP Electronics of Canterbury.

The company is already well known as a designer and manufacturer of encapsulated audio amplifiers, pre-amplifiers and power supplies, and the new modules increase its range to almost 50 modules.

Many of the new modules are suited to disco and guitar amplifier equipment including: mono mixers, stereo mixers, high-power MOSFET amplifiers and stereo headphone drive modules.

ILP Electronics Ltd, Roper Close, Canterbury, CT2 7EP (tel 0227 54778).

Make Friends With A Microprocessor

DOES THE WORD 'microprocessor' send a cold shiver down your spine? Does it describe a faceless technological monster that threatens mankind's existence? Or is it just a black plastic gadget, not much bigger than a 50p piece, that you can buy for around £10?

In *Introducing Microprocessors* (Keith Dickson Publishing Limited, £4.50), Ian Sinclair removes the mystery from microprocessors without going into deep technological explanations.

Definitely a good way to get to grips with these devices before moving on to a practical microprocessor-based computer system (and there's nothing like hands-on experience to help with understanding computers).

News For Radio Control Enthusiasts

THE ANNOUNCEMENT of the date (2nd November) for the start of the Government's legal CB service has done little to reassure the Radio Control fraternity.

Members of this fraternity are only too well aware that the numbers of users of illegal CB equipment are such that the chances of regaining the use of 27 MHz are negligible. The resulting overcrowding on the new 35 MHz allocation, and the frustration of boat and car enthusiasts, who have no realistic alternative to 27 MHz, means that the pressure is now being applied to the Home Office for it to make a further RC frequency allocation.

The CEPT recommends frequencies in the 40, 53 and 72 MHz wavebands, in addition to 27 and 35 MHz for RC applications: it is likely that a claim for one or more of these allocations is imminent.

Pete Christy

Faster Teletext . . . And a First For Scotland

TWO DEVELOPMENTS in ORACLE, the ITV teletext service, took place in October. The first wes a halving of the average access time to pages, from 30 to 15 seconds. The second was of national significance: Scotland was given the world's first *regional* teletext service.

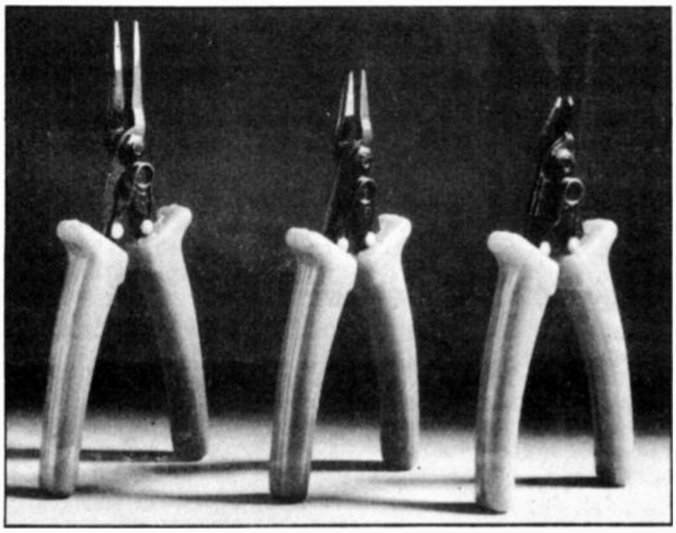
Both developments stemmed from one change in the method used to transmit the teletext pages. In the past, ORACLE's page information was carried on two 'spare' TV lines out of the nominal 625. (These lines are not normally visible but if the picture height is badly adjusted on your TV receiver you can see them flickering away at the top of the picture. This flickering is the page information, transmitted in digital form.)

Now four lines have been allocated to the service, with one of four magazines of page information allocated to each line.

On Scottish Television (STV), from 12 October 1981, three of the lines are allocated to national magazines while the fourth is allocated totally to regional information (such as local weather, sports, events and so on).

According to the ITV, ORACLE will become 'completely regionalised' by 1984/5.

For a comment from the competition, HE spoke to Graham Clayton, Duty Editor of CEEFAX (the BBC's teletext service). He said that the BBC had simply 'slashed access time' (that is, reduced it by half). Although the BBC had originally planned to start its first regional service in Manchester this year, cuts in spending have prevented this from being implemented. The BBC still hopes to operate regional services as soon as funds are available.



Cushion-grip Comfort For Hobbyists

TELE-PRODUCTION TOOLS Limited has placed emphasis on comfort with the set of tools it is offering to hobbyists.

The set comprises:

- fine-nosed pliers, jaw length 40 mm from pivot
- fine-nosed pliers, jaw length 28 mm from pivot
- flush-cutting micro-shear, with cutting head angled at 45° for ease of use on printed circuit boards

Each tool is fitted with what are described as: 'softly sprung cushion-grip handles' that are claimed to reduce fatigue in use.

You can either buy all three for £10 or buy them individually at £3.75 each. (These prices include postage, packing and VAT.)

Tele-Production Tools Limited, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW (tel 0702 352719).

UOSAT Launches. OK!

THE UNIVERSITY OF SURREY'S satellite, UOSAT, Britain's first educational spacecraft intended for use by engineers, radio amateurs and schools (see HE August '81, pages 56-57) was successfully launched, by NASA, at 12.27 pm British Summer Time on Tuesday 6th October.

Separation from the Delta 2310 launch rocket was at 13.30 pm as the spacecraft entered orbit. Lift-off was from the Western Test Range, Vandenburg, California.

The latest news we've heard is that all functions of UOSAT are performing well and that the spacecraft is transmitting telemetry data as planned on 145.825 MHz. The signal is strong and transmissions can be picked up using a standard amateur narrow-band FM receiver with a crossed dipole aerial.

Calling All Home Computer Owners

THE BBC has planned what it describes as a unique experiment. It will take place on the Tomorrow's World programme on Thursday 3rd December, on BBC-1, and home computer owners throughout Britain are invited to take part.

During the programme, a complete *program* (notice the difference in spelling!) will be broadcast, in audio form, consisting of a burst of bleeps from the Beeb and lasting about 15 seconds. Viewers will be able to record the program on an audio cassette machine with its microphone placed close to the loudspeaker of the TV receiver. Once recorded, it should be possible to run the program through a computer (probably propped on top of the TV).

If the experiment works, data which started in the Tomorrow's World studio in London will be in thousands of homes throughout Britain — in a few seconds. (The implications of this are exciting — and frightening — 1984 is only two years away!)

Full details will be given in the Radio Times. According to the BBC, 'Viewers with unusual, but sensible applications are invited to contact Trevor Taylor at 'Tomorrow's World', Kensington House, Richmond Way, London W14 0AX'.

Projects To Build ... For Disabled People

THE WORK of ACTIVE, a charitable association which aims to help disabled people to lead more active and independent lives by sharing ideas on one-off aids and modifications, was described in *Electronic Aids For The Disabled* (HE July '81, pp 15-19). ACTIVE has recently started publishing a series of Worksheets covering a wide range of play, leisure and communication aids for severely disabled children and adults.

The Worksheets are segregated into categories according to the skills and facilities required. Main groups are Craft Techniques (group C), Electrics/Electronics (group E), Metalwork (group M) and Woodwork (group W). Degrees of constructional skill required are indicated by the number of asterisks after each group (for example, an E* project is easier to make than an E*** project).

Constructional details are given for aids ranging from simple 'kitchen table' woodwork to electronic, woodwork or metalwork designs which are best tackled, unless you have the ability, at an evening class or as a project by local technical college students.

HE readers might be interested in the electrical or electronic projects. Group E* projects contain no transistors or ICs but include some details of construction. Group E** projects are likely to include these devices and some details of construction or Veroboard layout. Group E*** is similar to E** but designs are generally more complex and no constructional details are likely to be given.

Examples of electrical/electronic projects are: *Wee-D Mk.5* (E*), a unit devised to establish incontinence pattern and assist in training, and *Mandeville Clown* (E*** M** W*), a toy originally designed for severely handicapped children. It provides a combination of light and sound rewards when a separate switch is pressed.

Prices of Worksheets range from 20p to £1.60: a catalogue giving details of all projects is available from: ACTIVE, The Toy Libraries Association, Seabrook House, Wyllyotts Manor, Darkes Lane, Potters Bar, Herts EN6 2HL (tel 0707 44571).

19 81

Technology For The Handicapped Child

THE COURSE, Technology for the Handicapped Child, was held at Castle Priory College, Wallingford, Oxfordshire during October.

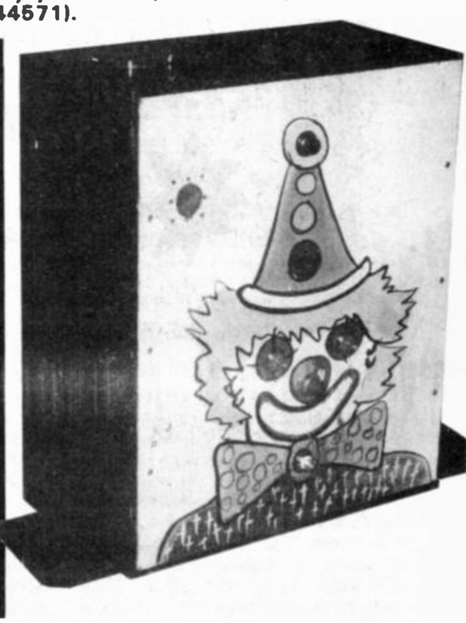
This week-long residential course has been a regular event over the last few years and has as one of its main aims the dissemination of information on the latest advances in technology, and how these advances can benefit handicapped children.

HE attended the 'micro course' — Microcomputers for Disabled People — on Saturday 10 October. Apart from learning some fascinating details of how micros are used to aid the disabled at home, in their education and at work we had the chance to try out some of the latest computer equipment.

The course is organised by Roger Jefcoate, who was the subject of our *Electronic Aids For The Disabled* feature in the July '81 issue and who helped judge our IYDP Project Design Competition (see page 46 of this issue for details of winners). It is likely that next year's course, due to be held in November 1982, will be of interest to HE readers. When HE spoke to Rosemary Mc Closkey, Tutor and Organiser, she said that there will be a greater emphasis on computer systems throughout the week, and for this reason there will not be a special day dedicated to the subject.

Those interested in attending can either opt for the full week or select individual days when subjects of particular interest will be covered.

Further details from: Miss Rosemary McCloskey, Castle Priory College, Thames Street, Wallingford, Oxfordshire OX10 0HE (tel 0491 37551).



NEXT MONTH IN HE — NEXT MONTH IN HE — NEXT MONTH IN HE

Just a month to wait for the January '82 issue — out December 11th

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An ingenious yet simple design which encourages burglars to buzz off. We'd describe it as a psychological deterrent.

Switch-tuned Radio

A very neat project, this one. it's a sensitive radio, with built-in loudspeaker, that gives you the stations of your choice at the touch of a button.

Volume Expander

Enables you to take your amplifier to new heights (and depths). An invaluable aid to audio enthusiasts.

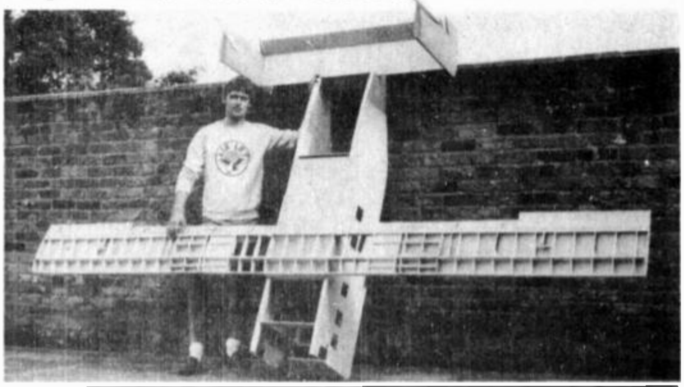
plus features galore

Hi-Fi System Feature — ***all you ever wanted to know about hi-fi (but the salesman wouldn't tell you)***

This feature is definitely a down-to-earth approach (where did that come from?) to choosing hi-fi systems. So before you depart with £££s of hard-earned cash take time to read this feature.

Large Scale Model Aircraft

Guest writer John Greenfield outlines some of the problems associated with large (and we do mean large) scale radio-controlled model 'planes. John also describes his experiences when he attempted to take two of his models to the Las Vegas Large Scale Championships last year.



Items mentioned here are those planned but unforeseen circumstances may affect the actual contents

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Model No	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D. 50Hz/7kHz 4:1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex. VAT
HY 30	15w/4-8Ω	0.015%	<0.006%	±18±20	76×68×40	240	£8.28	£7.29
HY 60	30w/4-8Ω	0.015%	<0.006%	±25±30	76×68×40	240	£9.58	£8.33
HY 120	60w/4-8Ω	0.01%	<0.006%	±35±40	120×78×40	410	£20.10	£17.48
HY 200	120w/4-8Ω	0.01%	<0.006%	±45±50	120×78×50	515	£24.39	£21.21
HY 400	240w/4Ω	0.01%	<0.006%	±45±50	120×78×100	1025	£36.60	£31.83

BIPOLAR Standard, without heatsinks

Model No	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D. 50Hz/7kHz 4:1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex. VAT
HY 120P	60w/4-8Ω	0.01%	<0.006%	±35±40	120×26×40	215	£17.83	£15.50
HY 200P	120w/4-8Ω	0.01%	<0.006%	±45±50	120×26×40	215	£21.23	£18.46
HY 400P	240w/4Ω	0.01%	<0.006%	±45±50	120×26×70	375	£32.58	£28.33

Protection: Load line, momentary short circuit (typically 10 sec). Slew rate 15V/μs Rise time: 5μs. S/N ratio 100db. Frequency response (-3dB):15Hz-50kHz. Input sensitivity 500mV rms. Input impedance 100kΩ. Damping factor (8Ω/100Hz)>400.

HEAVY DUTY with heatsinks

Model No	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D. 50Hz/7kHz 4:1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex. VAT
HD 120	60w/4-8Ω	0.01%	<0.006%	±35±40	120×78×50	515	£25.85	£22.48
HD 200	120w/4-8Ω	0.01%	<0.006%	±45±50	120×78×60	620	£31.49	£27.38
HD 400	240w/4Ω	0.01%	<0.006%	±45±50	120×78×100	1025	£44.42	£38.63

HEAVY DUTY without heatsinks

Model No	Output power Watts rms	DISTORTION T.H.D. Typ at 1kHz	DISTORTION I.M.D. 50Hz/7kHz 4:1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc. VAT	Price ex. VAT
HD 120P	60w/4-8Ω	0.01%	<0.006%	±35±40	120×26×50	265	£22.82	£19.84
HD 200P	120w/4-8Ω	0.01%	<0.006%	±45±50	120×26×50	265	£27.17	£23.63
HD 400P	240w/4Ω	0.01%	<0.006%	±45±50	120×26×70	375	£39.42	£34.28

Protection: Load line. PERMANENT SHORT CIRCUIT (ideal for disco/group use should evidence of short circuit not be immediately apparent). The Heavy Duty range can claim additional output power devices and complementary protection circuitry with performance specs as for standard types.

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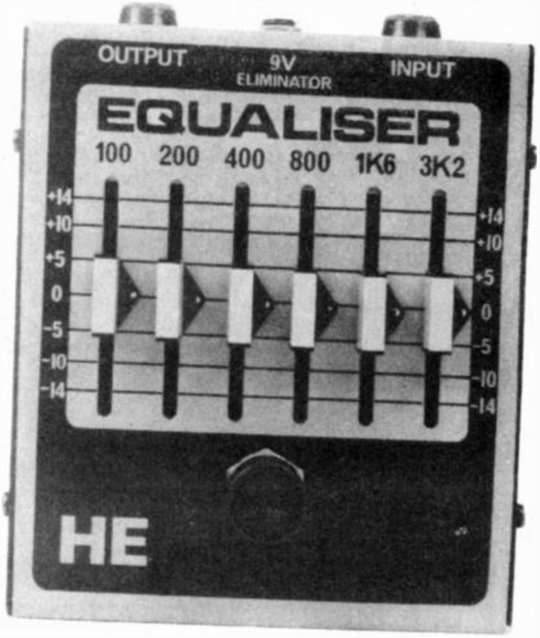


IMAGINE — YOU'RE ON stage playing to a packed house. You're just about to run your lead guitar break and you need just that little extra 'top', to give the solo the brightness you're after. With the HE Guitar Graphic Equaliser, it's easy. Simply adjust the control for the frequency you feel needs boosting (or cutting) and then you have it — a perfect guitar sound.

You couldn't ask for more really: the project is built in a strong metal case so even that flat-footed roadie can't damage it; it has a footswitch to enable you to cut in and out while playing; it has six controls which provide boost or cut at six centre frequencies. it's battery-powered (with an option for an external power supply); and it looks good!

Construction

Build up the main printed circuit board (PCB) first. Insert and solder the six links, followed by resistors and capacitors (making sure that the polarised capacitors are the right way round). **Figure 2** shows all component locations for this board.

Next insert the four ICs directly into the PCB making sure they are the correct way round and then solder them in.

Insert and solder the ¼" jack sockets and switch SW1. Connect a short length of wire to the large solder tag (the tag fits over the switch) and solder the other end of the wire into the board where shown.

Jack socket SK3 should be soldered directly into the board at this time, although as you can see in the view of the prototype board, we wired ours in.

Now fit the battery connector and leave this board aside.

The slider PCB should now be constructed. Insert and solder the five links as shown in **Fig. 3**.

Now insert the six slider potentiometers into position. Bend their solder tags over the edges of the board and solder them to the copper track.

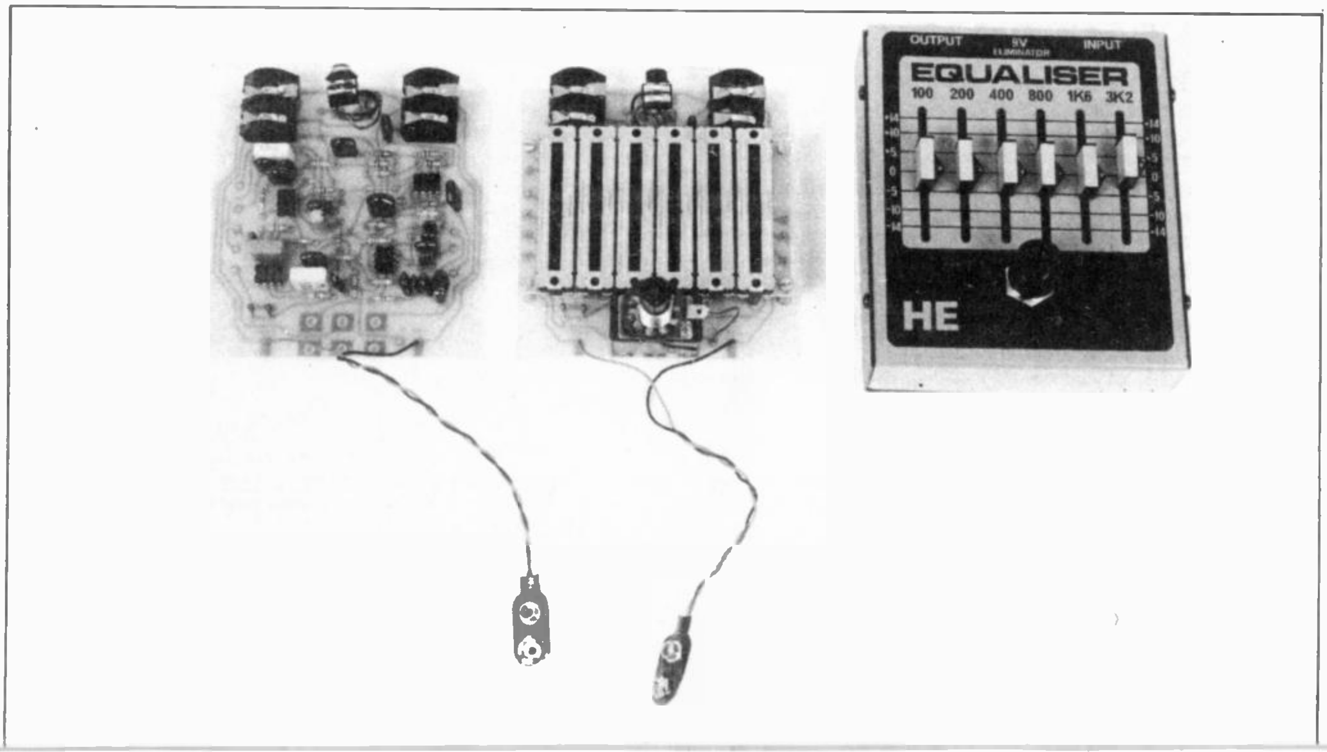
Using nuts, bolts and ½" spacers, mount the slider board above the main board.

Connect between the two boards, in eight places using single-strand tinned wire.

Insert the complete assembly of two boards into the case and fasten the three jack sockets and the footswitch with their corresponding nuts.

Push fit the slider knobs onto the slider spindles. Insert a battery. Finally, fit the case together and fasten with four self-tapping screws.

Below: Three stages in the build-up of the HE Guitar Graphic Equaliser. On the left is the main PCB. Centre is the main PCB with the slider PCB positioned over it and on the right is the finished project



Buylines

A full kit of parts, including PCBs, case and all hardware, has been produced by:

Sola Sound Ltd,
Unit 6,
LETO Works,
Offmead Road,
Edgware,
Middx.

The price of the kit is £29.50 including VAT and p&p.

Sola Sound can also supply assembled and tested equalisers at £34.50 including VAT and p&p. Cases alone are £6 including VAT and p&p.

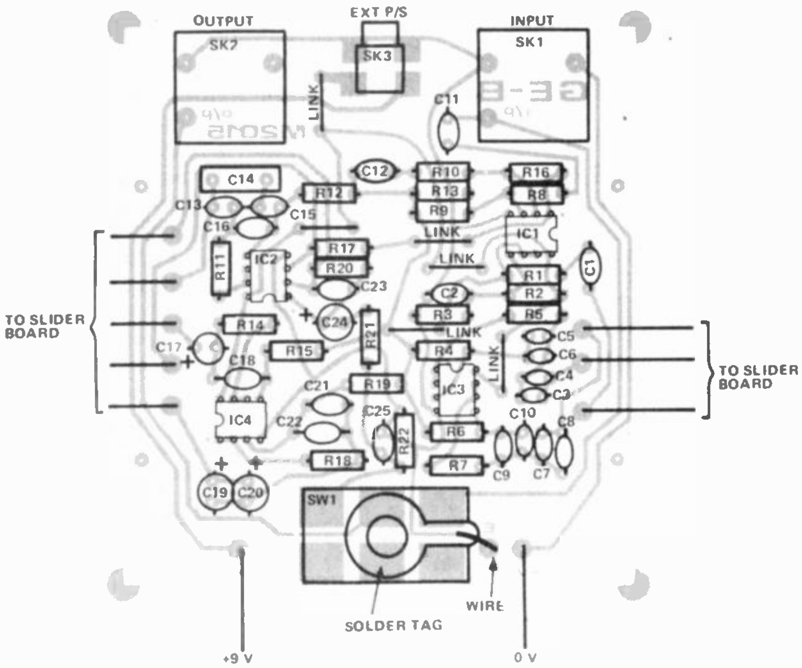


Figure 2. Component overlay of the main component PCB

Parts List

RESISTORS (All ¼W, 5%)

R1,10	680R
R2,3,9	470k
R4,6,12, 15,19	22k
R5,7,11, 14,18	470R
R8,13,16, 17,20,21, 22	10k

POTENTIOMETERS

RV1,2, 3,4,5,6	22k linear sliding potentiometers

CAPACITORS

C1,12,16, 21,23	68n mylar
C2,8	100n mylar
C3	10n mylar
C4,11	47n mylar
C5	3n3 mylar
C6,13	15n mylar
C7	22n mylar
C9	33n mylar
C10	4n7 mylar
C14,22	220n polycarbonate
C15	6n8 mylar
C17,19,20	470n, 16 V tantalum
C18	150n polycarbonate
C24	10u, 10 V electrolytic
C25	1n0 mylar

SEMICONDUCTORS

IC1-4	LM1458 dual operational amplifiers

MISCELLANEOUS

SK1,2	¼" jack sockets
SK3	3.5 mm jack socket
SW1	double-pole, double-throw footswitch

Battery + clip
Case to suit
Slider knobs

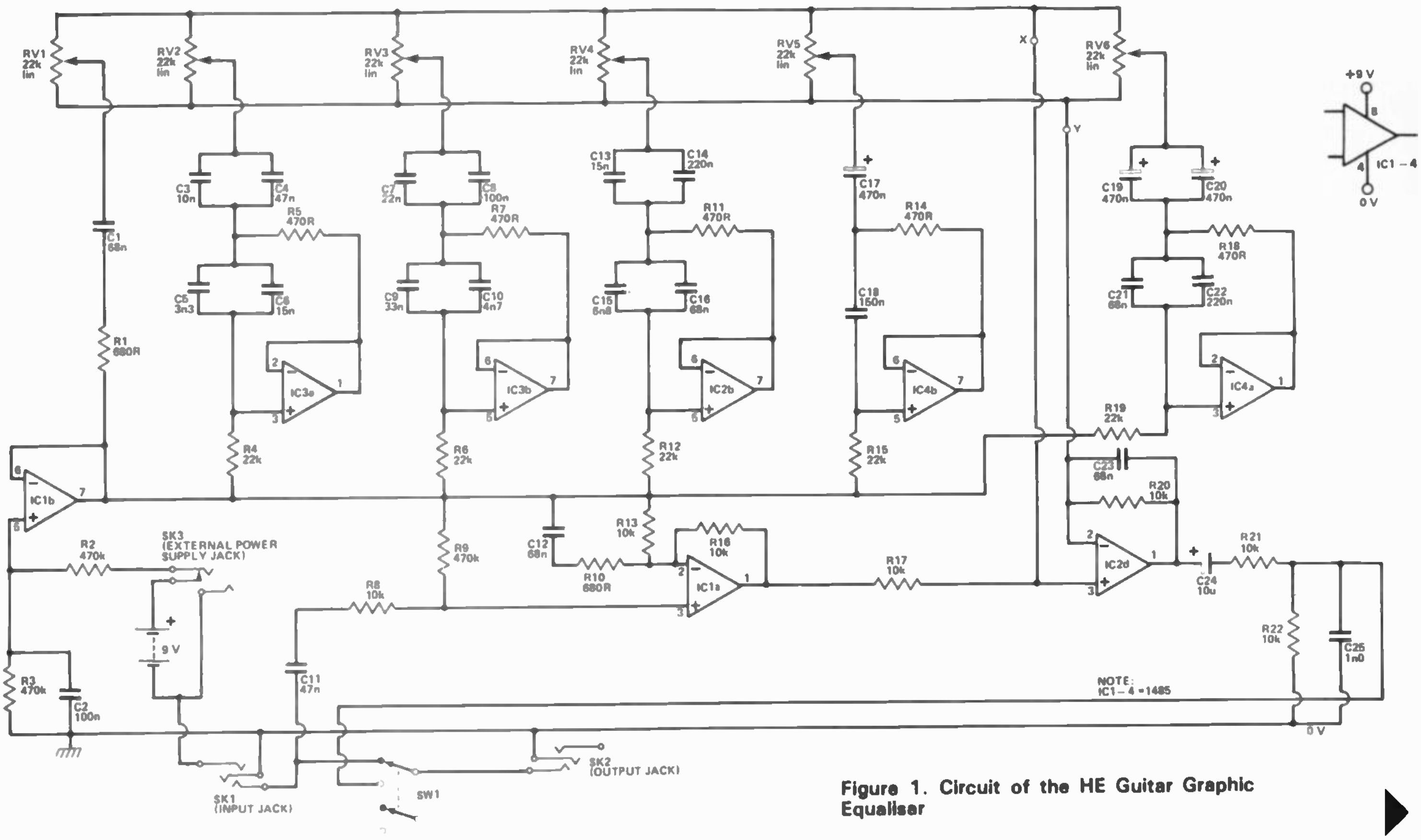
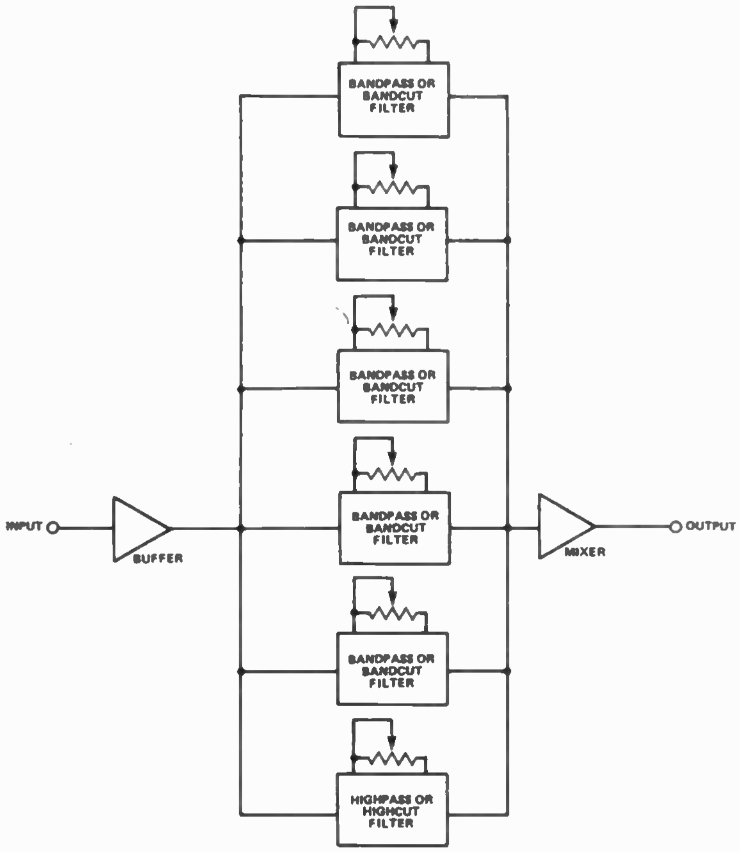


Figure 1. Circuit of the HE Guitar Graphic Equaliser

How It Works

The input guitar signal is buffered and then applied to a group of six filters. Five of these filters are bandpass/bandcut filters; ie, they can be adjusted to amplify or attenuate a single frequency range. The sixth filter is a highpass/lowpass filter; ie, all frequencies above a set 'corner' frequency can be amplified or attenuated together.

In this way a selection of amplified or attenuated frequency bands are combined together in the output mixer.

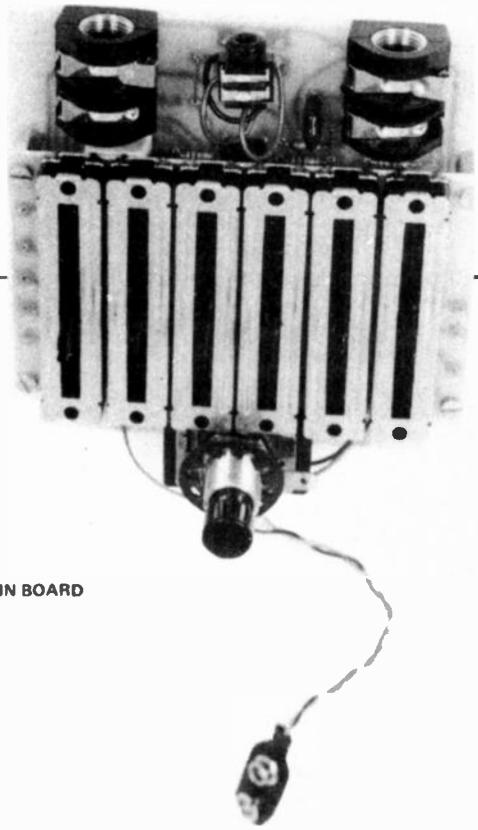


Because all integrated circuits are of the conventional 741-type operational amplifiers, they need a three-rail power supply (ie, + V, 0 V, − V). This is not possible from a 9 V battery alone, so an artificial mid-rail has to be formed electronically. Operational amplifier IC1b is a non-inverting buffer amplifier. Its input (the mid-point of potential divider R2 & 3) and therefore it's output too, is held at 4.5 V. Thus a three-rail power supply; 9 V, 4.5 V, and 0 V, results.

Operational amplifier IC1A forms the input buffer and IC2a forms the output mixer.

The remaining five operational amplifiers are used in the five bandpass/bandcut filter stages. Centre frequencies of these filters are defined mainly by the values of capacitors in the circuit. For example, capacitors C17 & 18 define a filter frequency of 200 Hz for IC4b.

A highpass/lowpass filter is formed in the same way as a 'treble' control in a standard hi-fi amplifier. Its corner frequency is defined by the value of C1.



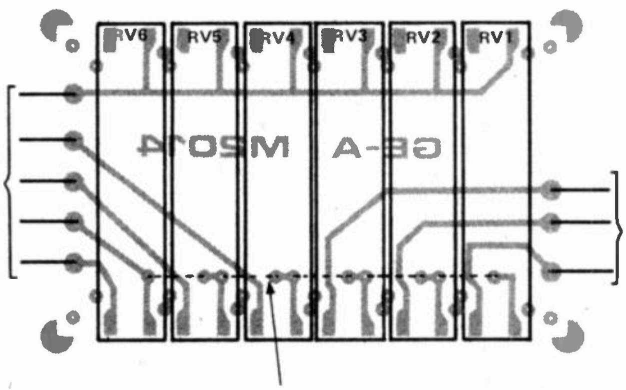


Figure 3. Component overlay of the slider PCB

HE

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AMAZING! COMPUTER GAMES PCBs FOR PEANUTS!!

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STARBIRD

Gives realistic engine sounds and flashing laser blasts — accelerating engine noise when module is pointed up, decelerating noise when pointed down. Press contact to see flash and hear blast of lasers shooting. PCB tested and working complete with speaker and batt clip. (needs PP3). PCB size 130 x 80mm. Only £2.95

COMPUTER BATTLESHIPS

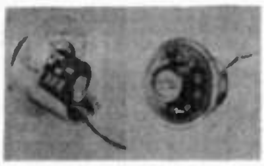
Probably one of the most popular electronic games on the market. Unfortunately the design makes it impractical to test the PCB as a working model, although it may well function perfectly. Instead we have tested the sound chip, and sell the board for its component value: SN76477 sound IC; TMS1000 u-processor; batt clips, R's, C's etc. Size 160 x 140mm. Only £1.50
Instruction book and circuit 30p extra

LOGIC 5

The object is to find the number held in the memory with as few entries as possible. PCB contains u-processor chip and 10 leds, and is linked to a membrane type keyboard. Overlay for keys and instruction provided. PCB sizes: 95 x 80 & 85 x 70mm. Supplied tested and working — PP3 required. Only £2.60

MICROVISION Cartridges

These are a small PCB with a micro-processor chip, designed to plug in to we don't have any consoles!! However, they can be used as an oscillator with 4 different freq. outputs simply by connecting a battery and speaker. Tested and working (as an osc) with pin out data. PCB size 72 x 60mm
ONLY 25p each!!



ELECTRO-DIAL

Electrical combination lock — for maximum security — pick proof. 1 million combinations!! Dial is turned to the right to one number, left to a second number, then right again to a third number. Only when this has been completed in the correct sequence will the electrical contacts close these can be used to operate a relay or solenoid. Overall dia. 65 x 60mm deep Only £9.95

OEVELOPMENT PACKS

These packs of brand new top quality components are designed to give the constructor a complete range so the right value is to hand whenever required. They also give a substantial saving over buying individual parts.

K001. 50V ceramic plate capacitors, 5%, 10 of each value 22pF to 1,000pF, total 210. £4.80.

K002 Extended range 22pF to 0.1. Values over 1000pF are of a greater tolerance. 10 of each value 22 27 33 39 47 56 68 82 100 120 150 180 220 270 330 390 470 560 680 820 1000 1500 2200 3300 4700 6800 .01 .015 .022 .033 .047 .1. **PRICE: £7.68**

K003 C280 or similar Polyester capacitors, 10 each of the following: .01, .015, .022, .033, .047, .068, .1, .15, .22, .33 and .47μF. **PRICE: £5.40.**

K004 Mylar capacitors. Small size, vertical mounting 100V. 10 each of the following: .001, .0012, .0015, .0018, .0022, .0027, .0033, .0039, .0047, .0056, .0068, 0082, .01. Total 130 capacitors. **PRICE: £4.70.**

K007 Electrolytic capacitors 25V working small physical size axial or radial leads. 10 each of the following: 1, 2.2, 4.7, 10, 22, 47, 100μF. Total 70 capacitors. **PRICE: £3.59**

K008 Extended range, as above, also including 220, 470 and 1000μF all at 25V. Total of 100 capacitors. **PRICE: £6.35.**

K021 CR25 resistors or similar, miniature 1/4 watt carbon film 5%, as used in nearly all projects. 10 of each value from 10 ohms to 1M, E12 series. Total 610 resistors. **PRICE: £5.95**

K041 Zener diodes 400mW 5%. 10 of each of all the values from 2V7 to 36V. Total 280 zenners. **PRICE: £15.95.**

K051 LEDs – pack of 60, comprising 10 each red, green and yellow 3mm and 5mm, together with clips. **PRICE: £8.95.**

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2200uF 100V cans 77 x 35mm dia. 75p; 10/£5.50.
220uF 10V axial 5p; 100 £2.30; 1000 £16.
400 + 100uF 275V 102 x 44mm dia. 75p; 10 £5.60.
200uF 350V, 100 + 100 + 50uF 300V can. 75 x 44mm dia. 40p; 10/£3; 100/£20.
100uF 25V axial 100/£3.

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110mm dia. x 40mm deep. 110/240V pri., sec. 18V 4A, 6.3V 1A, 240V 0.3A. Ideal for scopes, monitors, VDUs, etc. Special low price £7.95

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K524 Large variety of values/voltages, mostly cropped leads for PCB mntg. 1-1000uF, 10-63V. All new full spec. components, not chuck-outs!! 200 £4; 1,000 £17.50.

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7 seg displays available in 3 styles. Char. height 12.5mm.
Z650 2 digit on PCB with 16 way ribbon cable terminated in 16 DIL header plug, giving multiplexed output £1.20
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Data supplied.

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FNA5220 2 digit 1/2" 7-seg. display on PCB, CC. With data, £1.50
7-seg displays: FND360, 367, 501, all 50p; 530, 847, 850, all £1.50.
Regs. TO3 case: 7924 120p, 7885 100p, 7808 100p, 7912 100p, 78CB 230p. Others on B/L 13.
Op-Amps: uA4136 130p; uA776 145p; uA777 300p; uA318 245p.
Isolators: FCD831, IL15, TIL118, all 60p.
TIL311 Hexadecimal display with decoder, 0-9 and A-F. With data, £3.50.

COMPONENT PACKS

K503 150 wirewound resistors from 1W to 12W, with a good range of values £1.75
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K511 200 small value poly, mica, ceramic caps from a few pF to .02uF. Excellent variety £1.20
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Z521 Panel with 16236 (2N3442) on small heatsink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. 60p
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Z527 Reed relay panel – contains 2 x 6V reeds, 6 x 2S030 or 2S230, 6 x 400V rects + Rs 50p
Z529 Pack of ex-computer panels containing 74 series ICs. Lots of different gates and complex logic. All ICs are marked with type no. or code for which an identification sheet is supplied. 20 ICs £1; 100 ICs £4.
A504 Black case 50 x 50 x 78mm with octal base. PCB inside has 24V reed relay, 200V 7A SCR, 4 x 5A 200V rects, etc. 60p

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Z537 PCB 100 x 75mm containing a wealth of components:
2 x 12v DPCD min. relays, 2 x 47uf 16v tants, SC146E 10A 500v triac, C112d 8A 400v SCR, 556 timer, 10 x IN4001 diodes, 2N5061, 2 x 3mm leds 3 x 2N3704, also R's and C's.
Amazing value!! – If bought separately parts would cost around £8!! – Price for the panel just £2.00.

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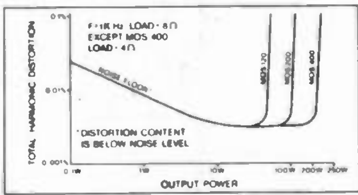

Load impedance, all models, 4 ohm — infinity
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MOSFET Ultra-Fi, with heatsinks

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MOS 120	60w/4-8Ω	<0.005%	<0.006%	±45±50	120 x 78 x 40	420	£29.76	£25.88
MOS 200	120w/4-8Ω	<0.005%	<0.006%	±55±60	120 x 78 x 80	850	£38.48	£33.46
MOS 400	240w/4Ω	<0.005%	<0.006%	±55±60	120 x 78 x 100	1025	£52.20	£45.39

MOSFET Ultra-Fi without heatsinks

MOS 120P	60w/4-8Ω	<0.005%	<0.006%	±45±50	120 x 26 x 40	215	£26.82	£23.32
MOS 200P	120w/4-8Ω	<0.005%	<0.006%	±55±60	120 x 26 x 80	420	£32.81	£28.53
MOS 400P	240w/4Ω	<0.005%	<0.006%	±55±60	120 x 26 x 100	525	£44.75	£38.91

Protection:
Able to cope with complex loads, without the need for very special protection circuitry (fuses will suffice).

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Slew rate 20Vμs. Rise time 3μs. S/N ratio 100db. Frequency response (–3dB) 15Hz-100kHz. Input sensitivity 500mVrms. Input impedance 100k. Damping factor (8Ω/100Hz)>400.

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Car Electronics

Steering Towards Micro Control

Some recent applications of integrated circuits and microprocessors in car electronics, and the possibilities of fully integrated microprocessor-controlled systems, are outlined by Bill Mitchell*, who also looks ahead a decade or so to the time when we could be driving 'hands off' on an automatic highway

THE APPLICATION OF ELECTRONICS in areas such as ignition, regulators, fuel injection, fuel consumption/economy computers, warning flashers and air conditioning is becoming a standard feature of many models of cars now coming off worldwide production lines. In fact, some systems are so well established that they can be purchased as individual items for installation by enthusiasts in older makes of vehicles.

However, these are all systems in isolation; that is, they are not 'integrated' as a total vehicle system (and it is doubtful if any of them could be) and for the average motorist this situation is likely to prevail for a number of years.

Fully integrated electronics in production cars would control not only those functions already mentioned but would also control engine management, anti-skid braking, continuous monitoring of tyre pressures, oil levels, coolant levels etc by means of non-contacting sensors, all through a central computer — or possibly a distributed computer system — and using a 'two wire' system to replace the conventional cable harness.

At present, such sophistication is only to be found in experimental, one-off vehicles, but work is progressing rapidly in the major car-producing nations, and possibly by 1983 we should see the first 'computerised' car in production. Indications are that the race to achieve this distinction will be between the Americans, the Japanese and, conceivably, the West Germans.

The ultimate, and this will be a decade or so away, is the computer-controlled car with built-in route guidance running on an automatic highway system.

Components Of Integration

Few of the electronic systems as we know them today will be capable of meeting all the requirements of a fully integrated and computerised system. First, they have not been designed for such operation. Second, the rapid advances in technology will undoubtedly render them obsolete over the next 12 to 24 months. Third, in certain areas two or more individual systems could well be integrated into single sub-systems. For example, over the last 15 years nearly four million vehicles in Europe have been equipped with electronic fuel injection systems. Couple this with electronic spark advance, which could become significant by 1983, and integration of the two is the next obvious and predictable step. Another example is the electronically-controlled carburettor. This could be with us by 1983 and its function is likely to be combined with electronic ignition or digital spark advance within a shared module.

Engine Management And Fuel Injection

Engine management systems, taking full advantage of all that the microprocessor has to offer, are now being designed into new vehicles by many of the world's major car manufacturers. Prominent in the UK in this field is Lucas Electrical whose system employs the technique of measuring the engine air consumption on a mass flow basis by using an improved and mechanically strengthened device working on the principle of hot-wire anemometry, a technique which is capable of operating in car environments.

The Lucas hot-wire air mass flow meter, as it is known, is accurate for all inlet air conditions but a special solenoid cold start/idle valve is incorporated to provide control of idle speed. This allows the engine idle speed to be set throughout the complete engine temperature range, irrespective of the power required to drive ancillary equipment such as the air-conditioning compressor and power steering pump. A microprocessor-based Electronic Control Unit (ECU) calculates the fuelling and ignition timing requirements for each operating condition of the engine, using data from the air mass flow meter and from sensors measuring coolant temperature, crankshaft position and speed (Fig. 1).

Each of the two crankshaft position sensors, which give information on engine speed and ignition timing, provides a pulse for each engine revolution and determines the sequence in which the ignition coils are energised, and hence the firing order of the engine. Under normal operating conditions the microprocessor calculates the timing advance by delaying the spark for a specified time from the preceding crankshaft transducer signal. It also calculates the required dwell time to ensure that sufficient energy is stored in the coil — two double-ended coils eliminate the need for a distributor. The sensors also provide the pulses that control the timing at very low engine speeds.

Engine intake air flow, water temperature, throttle position, battery voltage and engine speed are first converted into digital form, from which the microprocessor computes the fuel and spark timing required by the engine for minimum fuel consump-

*The author is Editor of Electrotechnology and the IEETE Bulletin, of the Institution of Electrical and Electronics Technician Engineers.

tion, low exhaust emissions and good driveability. The ECU also controls the fuel pump so that, with the engine stationary, the fuel pump is automatically switched off, thus preventing fuel spillage in the event of an accident.

An integral part of the overall system is electronic fuel injection, and the Lucas Electrical system uses a digital control unit incorporating LSI (large-scale integration) circuits and a 1024-bit ROM (read-only memory) which contains the fuel schedule for the engine. In addition to providing improved fuel economy, performance and driveability, the system also reduces exhaust emission to comply with legislation.

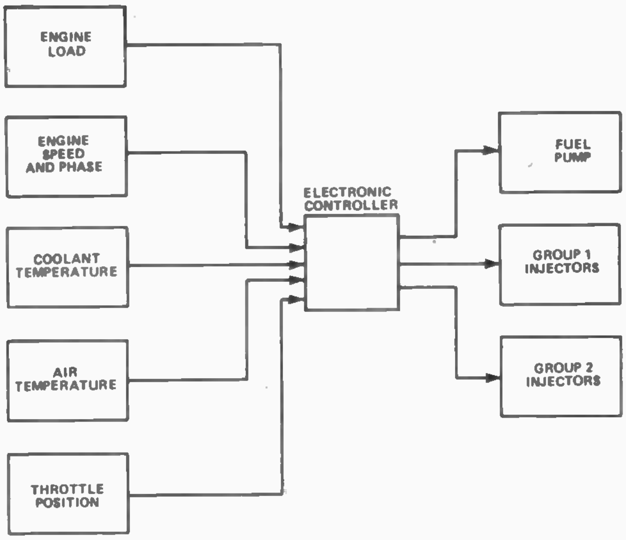


Figure 1. Input/output signals of Lucas Electrical's Electronic Control Unit

The processing of information within the control unit is shown in **Fig. 2**. Load input signal and engine speed (obtained from the ignition system) are each converted into a digital 'word' which is influenced by the interpolation mathematical function obtained from the fuel requirements of the engine. The modified numbers representing load and speed are then used to select the site in the memory which stores the fuel requirements for these particular conditions. The memory output number (fuel quantity) is fed into a number-to-time counter where it is stepped to zero by a fuel trim oscillator. Power circuits energise the solenoid injectors for the countdown period of the number-to-time counter, when fuel is delivered to the engine. Fuel enrichment under cold-start conditions is provided through a separate cold-start injector.

The circuit used to drive the injector solenoids is one of the most critical points of an electronic injection system, which normally uses a constant-current drive. It is present-day practice for discrete power devices to be used to drive the solenoids but the biggest problem here is that, to overcome initial stiction (friction or sticking), the injector coil and its driving circuit have to withstand a high current for the whole time that the solenoid is open. This high current is required despite the fact that, once the solenoid is activated, only a relatively small holding current is required to keep it open. The problem appears to have been overcome by SGS-ATES. This company has recently developed a new integrated circuit (type L 583) which, when the IC is coupled to a power stage, allows the generation of a two-level switching current waveform that guarantees the maximum efficiency of operation and very low response times. Its design is such that, during initial switch-on of the solenoid, the power Darlington transistor under its control provides the high current required to overcome solenoid stiction, and afterwards has its current reduced to a holding level.

Ignition Control

The wide range of electronic ignition systems currently used in cars, or available as DIY items, are generally of the inductive storage type, where energy is stored in the ignition coil primary winding, or the capacitor discharge type, where the energy is stored in a capacitor. Either of these may or may not use some form of triggering to replace the contact breaker, and this triggering could be either optical or magnetic in operation.

A more recent form of breakerless electronic ignition that is gaining in popularity, and which would appear to lend itself well to integrated circuit or microprocessor control, is that which uses a Hall-effect sensor. With this technique, named after E.H. Hall who first discovered the effect in metals in 1879, if a current is allowed to flow through a plate of semiconductor material from one edge to the opposite edge in the presence of a magnetic field across the faces of the plate, a voltage is produced across the other two opposite edges of the material. (See *Technical Terms*, HE September '81, page 23.) If the magnetic field is constant the Hall voltage is proportional to the current, and if the current is held constant the Hall voltage is proportional to the magnetic field.

In practice, a typical Hall-effect ignition sensor comprises a fixed Hall-effect semiconductor, through which a fixed current is passed, and a fixed magnet, separated by an air gap. A slotted metal vane is then passed between them which has the effect of switching on and off the magnetic field to the semiconductor, so producing ignition pulse voltages and thus eliminating the need for contact breaker points. Variations of this have been, and are being, developed along with associated discriminatory circuitry to overcome the effects of temperature variations which can occur.

Typical of the integrated ciruit controllers that have been designed to control the dwell angle in a Hall-effect ignition system is the Siemens TLF1492 (**Fig. 2**). With this the charging time of the ignition coil is controlled so that the primary current will reach its permissible maximum value just at the moment of ignition. Because high-performance ignition coils are used, the ideal ignition energy is available during any driving state and, at the same time, the average power dissipation of the ignition circuit will be minimised.

Another integrated circuit is the SGS-ATES L482, intended for use in breakerless ignition systems using Hall-effect sensors and high-energy coils to provide regulated current in the coil with low power dissipation. It is also particularly suitable for use as a dwell controller and driving stage in more complex ignition systems which use microprocessor circuits. Full current, overvoltage, reverse battery and thermal protection circuits are incorporated in the device.

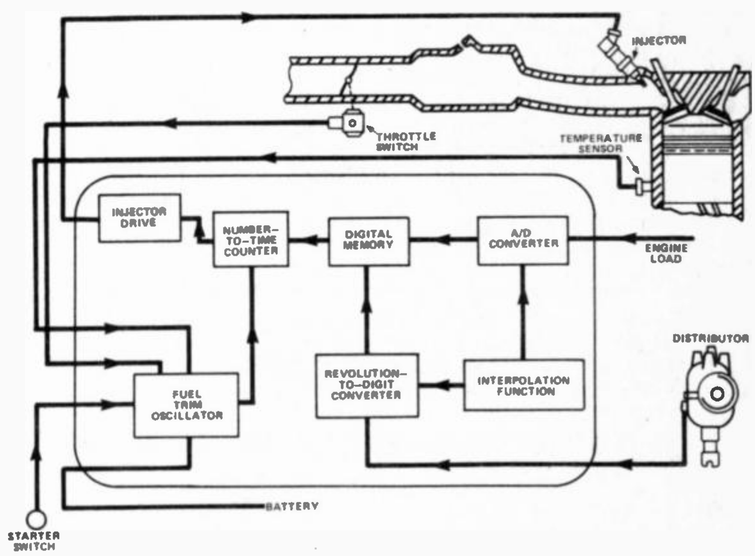


Figure 2. Signal processing with Lucas Electrical's Electronic Control Unit

Anti-skid Braking Control

Control of braking during skid conditions will be an important feature of road vehicles in the near future and a number of systems are being developed worldwide. Typical is a system announced by Robert Bosch GmbH of West Germany. It has developed a microprocessor-based anti-skid control system which is designed to maintain vehicle stability and steerability during emergency braking on any road surface.

The system depends on the fact that, with the brakes ap-

■ Feature

plied, only a rolling wheel provides the necessary lateral (sideways) support at optimum deceleration. A locked wheel cannot transmit lateral forces, so a car with locked wheels loses steering control and stability. Hence the reason for the manual 'pumping' of the brakes when stopping on wet, icy or snow-covered roads.

To prevent the wheels from locking, the Bosch anti-skid brake control system senses continuously whether or not there is a tendency for any of the wheels to lock. The wheel-sensor signals are processed by a set of AMI Microsystems microcomputers, and these form part of an electronic control unit which activates the hydraulic brake unit, modulating the brake pressure by means of electromagnetic valves. Such action simulates the manual pumping of a brake system but at a much higher rate, and also modulates the pressure in the wheel brake cylinders individually to obtain optimum stability and deceleration.

Three custom-designed microcomputers are used in the total system. One monitors the sensors on the right front wheel and drive shaft: another monitors the left front wheel and drive shaft. The third functions as a safety monitor to ensure that the system is functioning correctly. If a system malfunction occurs, the monitor circuit returns the brakes to normal operation and flashes a warning on a dashboard indicator.

This system is currently being offered as an option on a number of European vehicles, but no American car manufacturer has yet incorporated the system.

Wheel speed and vehicle speed reference in this system are derived from transducer sensors, while some schools of thought suggest that an optimum system should be based on knowledge of the true vehicle speed relative to the ground. One method of obtaining this speed is to use the principle of Doppler radar, and Philips Research Laboratories at Redhill has developed an experimental system in which a continuous wave in the microwave frequency band (X band) is beamed from the vehicle onto the road surface at a specific angle. The forward motion of the vehicle causes a Doppler frequency shift proportional to speed in the returned (reflected) signal from the road surface. After mixing with a sample of transmitter signal, this low Doppler frequency beat is amplified, frequency band limited and counted electronically to give a speed reference which can be used by a microprocessor-based anti-skid system.

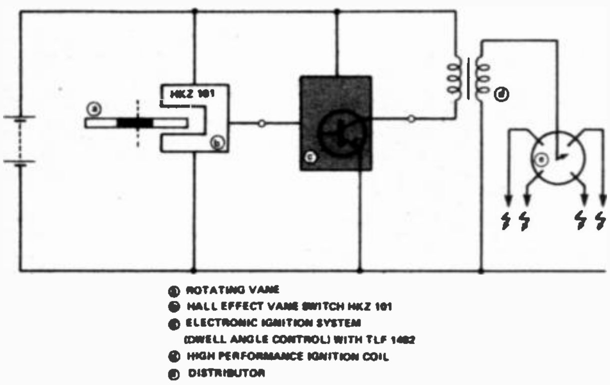


Figure 3. Siemens' integrated ignition controller used with a Hall-effect ignition system

Integration Of Instrumentation

The concept of integration is now being applied to the car dashboard layout where, by the use of optoelectronics, the entire instrumentation can be built into one panel. Of the various types of displays available and under development, the two which are most suitable are direct current electroluminescence (DCEL) and vacuum fluorescence (VF), both of which have the advantage that they emit light. The colour of the light produced is a function of the phosphor used, and hence the displays require no other means of illumination, unlike liquid crystal displays (LCDs) which require back lighting. A number of countries, including the UK, have been experimenting with both types of displays for some years — Smiths Industries Ltd, for example, demonstrated a practical installation based on DCEL as far back as 1978 (Fig. 4) — but at present neither has emerged as the dominant technology, although VF does appear to hold favour in the USA and Japan.

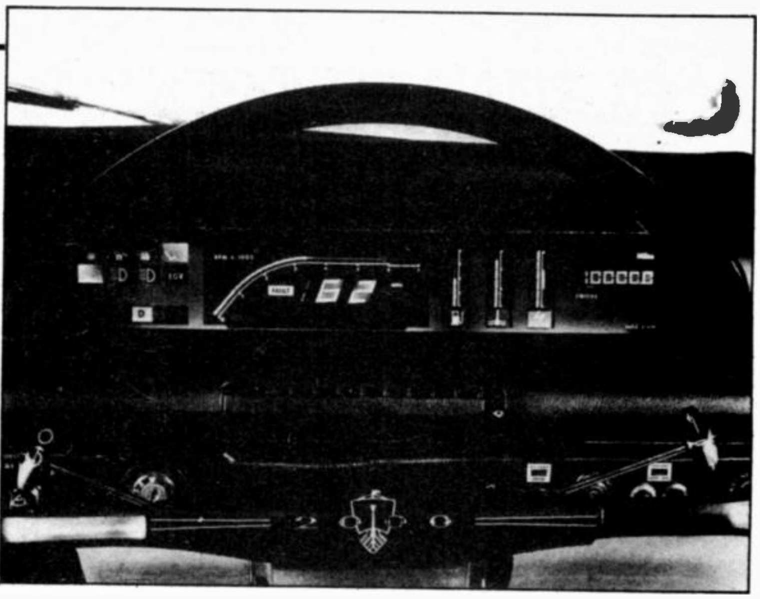


Figure 4. Smiths Industries' DC electroluminescence display system installed in a prototype vehicle

In construction, the DCEL display consists of a glass plate, the reverse side (the side furthest from the viewer) of which is coated with a thin film of conductive material (usually indium oxide or tin oxide), the desired character pattern being produced by a photo-resist and etching process. This is followed by a coating of phosphor and a thin coating of aluminium or silver which forms the negative electrode. A protective cover is then fitted and the assembly is gas filled. Application of voltage between the negative electrode and the conductive pattern on the glass plate (the positive electrode) causes the phosphor to glow in the shape of the etched pattern. A dot matrix pattern enables a range of characters to be presented from one display.

With the VF display, a thin aluminium film (the negative electrode) is deposited onto the glass plate and a pattern is etched in a similar way as that used in the manufacture of the DCEL display. Next comes a layer of insulation (usually screen printed) with spaces left for the positive connections, and this is followed by a further layer of aluminium used as a base for the deposited phosphor. The assembly is then covered and hermetically sealed. As with DCEL a dot matrix pattern enables a range of characters to be presented from one display. The subtle difference compared with DCEL is that the illuminated characters appear at the back of the assembly while with DCEL they appear on the reverse of the front glass plate. However, both assemblies are so slim that this difference is not apparent.

The predominant colour with DCEL is yellow so that a multicoloured display would require the use of optical filters to give the desired effect, although development of phosphors emitting different colours is proceeding. With VF displays a limited range of colours is already available, although some filtering may still be necessary.

Apart from the major benefit of both types being self-illuminating, their big advantage is the slimness of the final assembly. For example, a typical instrument panel using DCEL would measure 360 mm x 60 mm with a total thickness of only 12 mm, and would contain 35 parts and process steps. Compare this with a conventional electromechanical instrument panel presenting the same amount of information which would measure 400 mm x 120 mm with a total thickness of 60 mm and containing 430 parts.

Another important aspect to consider is that the ready availability of membrane switch panels now enables a complete system, comprising displays, indicators and switches, to be integrated into one slim-line instrument module. (See *Technical Terms*, HE October '81, pp 27-28.)

Continued Next Month

Bill Mitchell continues *Car Electronics* in next months' HE. He looks at methods of obtaining stabilised power supplies in vehicles and outlines other parts of the vehicle to be brought under electronic control. He also considers the dilemma facing vehicle manufacturers: total integration of control or separate control systems. The article concludes with a description of automatic highways.

HE

DRUM SYNTHESISER

A drum synthesiser to build yourself, for under £30 — an exceptional project at an exceptionally low price

NOT ONLY CAN this project imitate the sounds of various types of drum, it will also produce other sounds not entirely typical of natural percussion instruments, but which can still be used for rhythm-keeping purposes. Perhaps the commonest sound recognisable as such is the 'beeoom-beeoom' sound featured on certain pop records. The range of available noises and sounds is very wide and with a bit of practice any 'player' will be able to obtain many interesting electronic rhythm accompaniments.

The project is simple to build and is constructed using a printed circuit board (PCB). Two integrated circuits along with only a handful of semiconductors and passive components form the circuit.

An integral crystal microphone acts as the pickup for the project, but an external microphone can be used instead, and a headphone monitoring socket allows the player to set up the synthesiser using headphones so that fellow musicians are not disturbed.

Construction

Insert and solder all resistors and the single link into the PCB. **Figure 2** shows the PCB overlay.

Next, insert and solder all capacitors into place, making sure all electrolytic capacitors are the correct way round, followed by the three transistors and the diodes.

It's a good idea to use circuit board pins where all off-board connections are to be made (shown in Fig.2) so insert and solder them into place now.

Integrated circuits IC1 & 2 can be soldered directly into the PCB, but as they are fairly expensive devices, we advise you use IC sockets. The sockets should be soldered in and then the ICs pushed into place. Check that these ICs to their correct places.

Next, mark and drill the case for all controls and sockets and fasten them to their correct places.

Following the connection details in Fig.2 wire up your project. Use thin multi-stranded wire for this job and tie the PCB to front panel leads together with cable ties, to give a neat finish.

Operation

Before you turn on your project, set all front panel variable controls — decay, LFO (low frequency oscillator), rate, sweep and pitch — to mid-position. Set switch SW2 to 'INT' position and SW1 to VCO (voltage controlled oscillator) position.

Plug in your headphones and insert your ears between them!

Now, switch on the project by turning the gain control clockwise — the synthesiser should produce an audio frequency whine. Set the gain control so that everytime you tap on the side of the project's case the whine is reproduced.

Now, start experimenting with each control until you get 'the hang' of your project.

Buylines

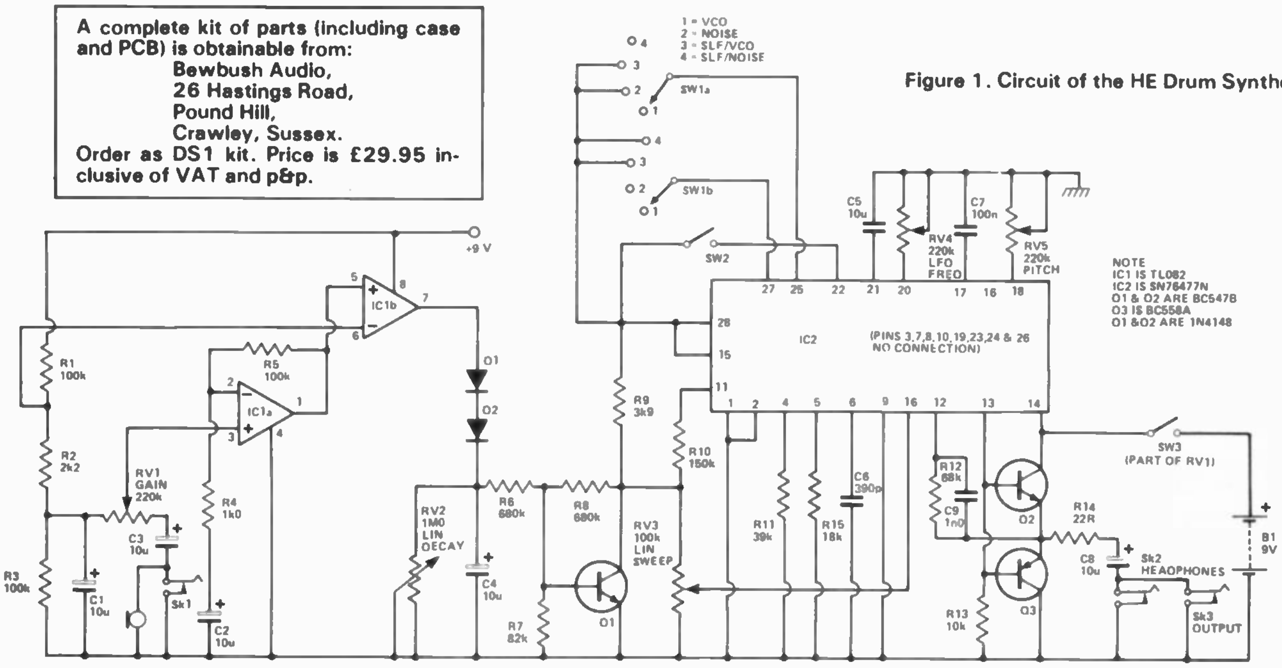
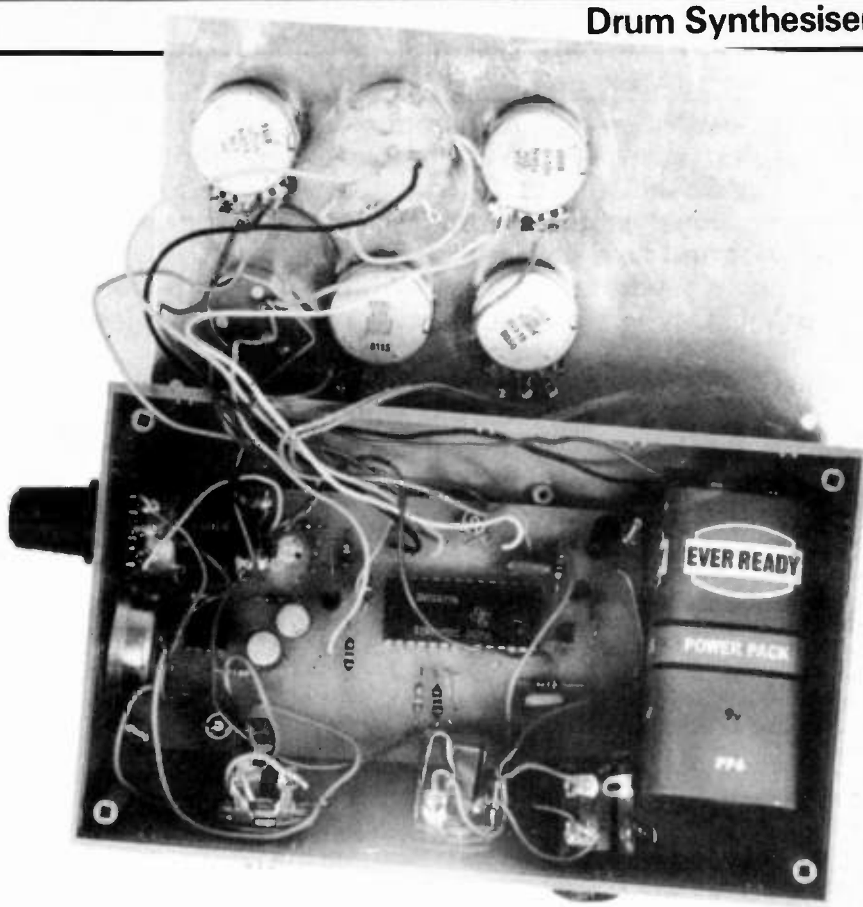


Figure 1. Circuit of the HE Drum Synthesiser

Parts List

RESISTORS (All ¼ W, 5%)	
R1,3,5	100k
R2	2k2
R4	1k0
R6,8	680k
R7	82k
R9	3k9
R10	150k
R11	39k
R12	68k
R13	10k
R14	22R
R15	18k
POTENTIOMETERS	
RV1	220k linear potentiometer + double-pole, double-throw switch
RV2	1M0 linear potentiometer
RV3	100k linear potentiometer
RV4,5	220k linear potentiometer
CAPACITORS	
C1,2,3,4, 5,8	10u, 16 V printed circuit mounting electrolytic
C6	390p ceramic
C7	100n polyester
C9	1n0 polystyrene
SEMICONDUCTORS	
IC1	TL082 dual operational amplifier
IC2	SN76477N complex sound generator
Q1,2	BC547B NPN transistor
Q3	BC558A PNP transistor
D1,2	1N4148 diode
MISCELLANEOUS	
SW1	three-pole, four-way rotary switch
SW2	single-pole, single-throw rotary switch
Case to suit	
JK1,3	mono ¼" jack socket
JK2	stereo ¼" jack socket
Knobs to suit	
Crystal insert	
PP6 sized battery + clip	



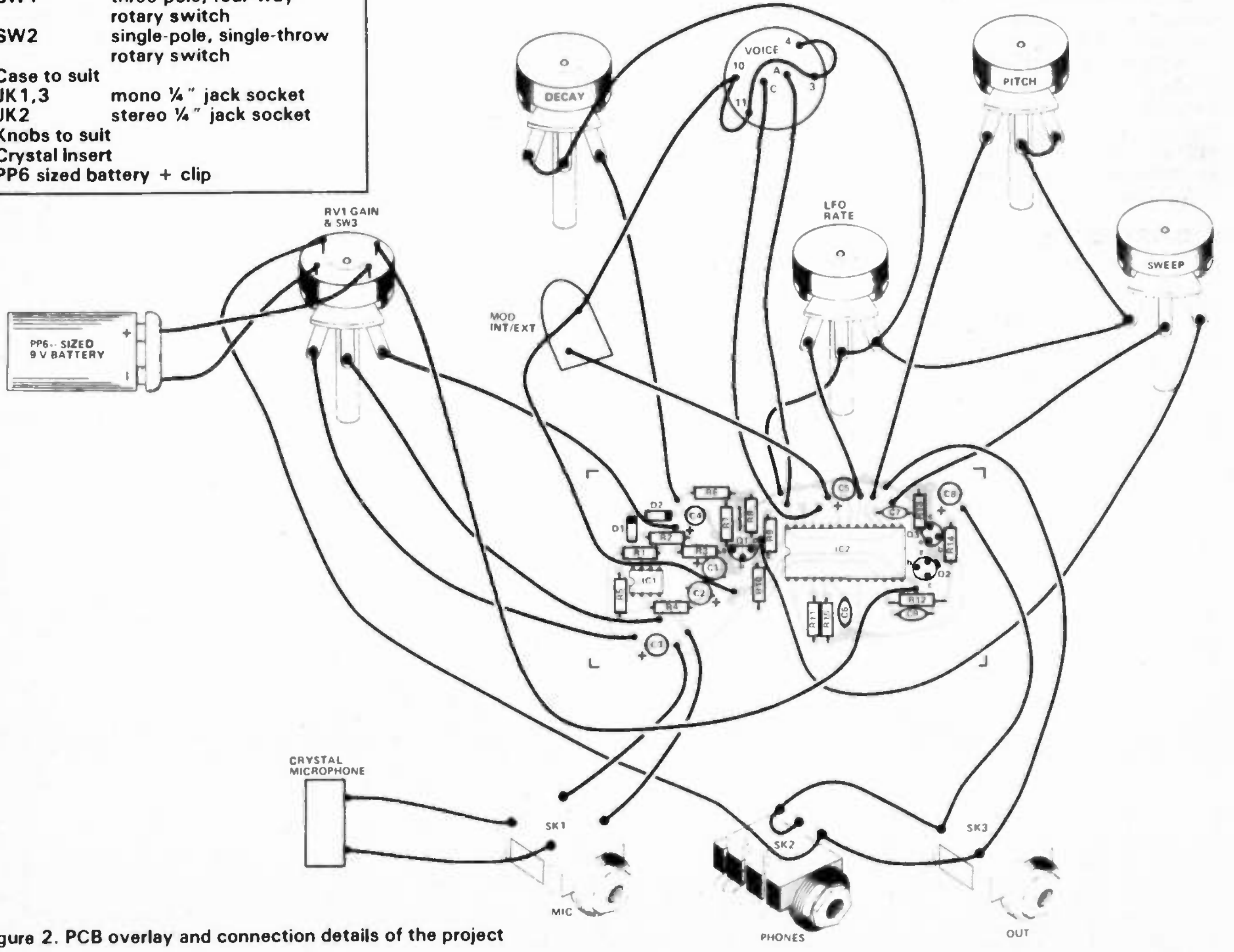


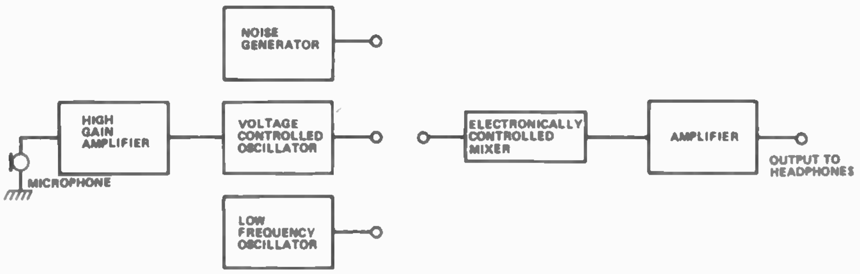
Figure 2. PCB overlay and connection details of the project

How It Works

Sound, picked up by the microphone as the project's case is tapped, is amplified and then used to control a voltage controlled oscillator (VCO). The frequency of the oscillator output signal is thus proportional to the gain of the amplifier and how hard the project is struck.

A noise generator produces white noise when required and an LFO (low frequency oscillator) generates a low frequency (2-20 Hz) sinewave.

An electronically controlled mixer accepts a combination of one or more of the three sound generators. The output of the mixer is then amplified and fed to the headphones.



The heart of the drum synthesiser is integrated circuit IC2. This device (an SN76477) is complex. It contains: the VCO; a VCA; the noise generator; the LFO; the mixer; and a 5 V regulator. The latter is important because the output of the chip depends on the logic levels on 'mixer select' pins 25, 26 and 27. The 'voice' of the synthesiser is determined by connecting these pins, via SW1, to the output of the regulator.

The LFO is used to modulate both the VCO and the noise generator. This is switched 'IN' or 'OUT' by means of SW2.

Transistors Q2 & 3 are used as a complementary output amplifier stage, to allow headphone monitoring of the project's output. The actual output amplitude is variable over a large range by controlling the current from pin 11.

Before the circuit is triggered, Q1 is switched off, and no current flows from pin 11 — so the output signal amplitude is zero. However, when triggered, the collector voltage of Q1 drops to 0 V and the output amplitude is at maximum. As the trigger voltage decays so does the output signal (because Q1's collector voltage increases and reduces the pin 11 current).

Input trigger signals, from either an external microphone or the internal pickup, are applied to the input of IC1a via RV1. Most types of microphone can be used to trigger the circuit. Operational amplifier IC1b is configured as a comparator. When its inverting input is at a more positive voltage than its non-inverting input, the output is at a low state. However, as soon as the voltage on the non-inverting input goes higher than the inverting input voltage, the output switches to a high voltage.

This comparator action rapidly charges capacitor C4 on every trigger pulse from the pickup. Potentiometer RV2 controls the discharge rate of the capacitor, hence the duration of the sound. **HE**

Your Letters

The Editor answers a selection of your letters

THIS IS THE last opportunity I'll have to answer some of your letters on this page and so I've tried to fit in a few more than usual.

There's nothing like a controversial start to an article, and so I'll begin with this letter from D.L. Gillan, which was passed to me by Clever Dick.

Dear Sir,
Re your 'HE reader offer' in the Oct. issue. I was seriously considering purchasing the SK6220 when, purely by chance whilst browsing through one of your rival mags Everyday Electronics (one I seldom lift from the shelf), I came across an ad for the SK6110 and SK6220 with price tags of £59.95 and £42.95 respectively. OK you're not a charitable organisation, your offer prices show that only too well. Also your prices are lower than the recommended retail but if Audio Electronics can make a profit at the above-mentioned prices why con readers? No doubt you will have a plausible answer. If so I would very much like to hear it.
Obviously you cannot print this but if you could I don't want a binder — a buckshee SK6110 or 6220 will do instead.
D.L. Gillan
Clydebank

Yours is the second letter I have received about our Special Offer Digital Multitesters. Just after the October issue went to press I too saw the advertisement you mention and was equally surprised: when we made arrangements with our supplier, West Hyde Developments Limited, the prices represented a special offer to our readers. I discussed the matter with Chris Long, product manager at West Hyde. According to Chris, when products such as the HE Digital Multitesters travel half-way across the world it is possible for them to reach the British market-place by several different routes and to be sold at several different prices. The important point he made was that West Hyde has been trading with the Japanese exporter of these instruments for many years and is in a position to offer a full service back-up. For instance, in the unlikely event of a serious manufacturing defect occurring in either model, West Hyde will replace the defective instrument with a brand new one. (Both models, by the way, carry a 12-month guarantee.) Our Special Offer prices may be above those of the other company but we can at least offer the back-up of West Hyde, a company which often advertises in HE and whose products we often recommend for use in our projects.

Dear Sir,
In a recent experiment I discovered that by connecting an electromagnet to the loudspeaker output of my tape recorder and holding it near the loudspeaker of a small radio, the radio would reproduce the output of the tape recorder. The volume control on the radio was set at its minimum to prevent 'interference' from radio stations, but otherwise didn't affect the output.
The coil wasn't driving the loudspeaker directly because removal of the radio's battery stopped it working. Can you please tell me what was happening?
Colin Price
St Andrews, Fife, Scotland

I believe I have an explanation for the phenomenon that you describe. When you connect an electromagnet to the loudspeaker output of your tape recorder the electromagnet will produce, over a distance of perhaps a few inches, an audio-frequency electromagnetic field. You say that when the volume control of the radio is set to minimum it does not affect the output: this indicates that it is the amplifier section, not the radio frequency section, of your radio that is picking up the 'signal' from the electromagnet. I suspect that the component in the radio that is responsible for the effect is a transformer in an early stage of the amplifier. Thus a transformer action is taking place: the electromagnet is the 'primary' and the transformer in your receiver is the 'secondary'. (A better explanation of this action is given in this month's Into Electronic Components on page 52.)

Dear Sir,
I have just completed the HE Electronic Organ. I would like to say that the quality of sound is very good.
I have been getting the "Hobby Electronics" since the first issue and of course intend to keep on taking it.
I am 67 years of age and have only started electronics since I retired.
Would like to thank you for the help your very good magazine has given me.
I wonder if any of your readers have any ideas on a cabinet for the organ?
A.P. Chislett
Guiseley, Leeds

I was pleased to hear of your success with the HE Electronic Organ — we have the HE Organ Pedalboard, which is complementary with the Organ project, in this issue.

I spoke to Trevor Hawkins, designer of both projects, recently and he told me that the first project has proved to be very popular, judging from the response to his kit offer. He has also had to give some personal assistance to some readers to get their projects working — for instance he even made a visit to one reader's home in Birmingham. With such a complicated project (by HE's standards) it is easy to make an odd mistake or two with component values or interwiring.

I thought it was worth including this next letter, as a follow-up to M.L. Peake's letter under YL in the October '81 issue, page 55.

Dear Sir,
In Hobby Electronics dated Oct, a letter suggests the use of the sound operated trigger circuit to operate the power winder on a camera.
I have been experimenting with circuits for power winders and motor drives for the past two years and, while I have not used a Chinon winder, I have had two different drives fail while using circuits where they were triggered by thyristors, so I feel that your readers should be warned that while the circuits work in the short term, I would not recommend their use.
I think the trouble occurs since the winder is controlled by electrical timing circuits, the action being started by a pulse from a microswitch connected to the shutter release, which is used to trigger a thyristor in the winder timing circuit. Unfortunately the thyristor in the external circuit does not produce a pulse but latches the power on until the voltage drops across the remote control socket, which can be several seconds.
In the two winders which failed, it appeared that the circuits of the winders would not take the overload caused by the power being latched on while the winder was in a single shot mode, and as the modern ideas of repair are to remove and replace an entire printed circuit if faulty, the repair bill is usually about £20 to £30.
I now have a golden rule when combining external circuits with cameras:

ALWAYS USE COMPONENTS WHICH ISOLATE THE POWER SOURCES OF THE EXTERNAL CIRCUIT FROM THAT OF THE CAMERA ETC, AND TRY TO IDENTIFY WHAT TYPE OF PULSE THE DESIGNER HAD PLANNED THE CIRCUITS OF THE CAMERA TO WORK WITH.

I also would make the comment that, with the sound operated trigger, the delay in the time of the mirror rise, before the shutter opens, would spoil its purpose for action shots.
It may also interest you to know that, although it has been extremely common in the past to use the thyristor in circuits to trigger electronic flash

guns, the new breed of dedicated flash guns are in electrical contact with the camera circuit (to give viewfinder information or to stop the shutter/flash working if the shutter speed is wrong). I personally prefer to use the opto-coupled thyristor RS 308-001 to keep the camera circuits protected, as far as possible, from any component failure in the triggering circuit.
D.C. Kent
Aylesbury, Bucks

Dear Sir,
I am a regular reader of the Hobby Electronics: some time ago I asked if you would put an article in the Hobby Electronics about oscilloscopes. The only one you did was not much use to me. Like a lot of others it is a hobby with me and I have several books on scopes, but they all take it for granted that one knows all about scopes and how to use them, I don't.

That is where the trouble starts: how do you use the scope for voltages? How do you use the probe and where do you use the probe? How do you use the scope on a radio to find faults etc?

If you could put in an article covering these points, over a few months, I am sure there would be others like me that would be most grateful. There are others like me that are too old to go to night school to learn. I rely on Hobby Electronics to teach me. My scope is the 456.

I thank you for any help you can provide.
K. Hall
Potters Green, Coventry

I have passed your letter on to Ron Keeley, HE's incoming Editor: I'm sure he'll give your suggestion serious consideration.

Dear Sir,
Could you please include more projects concerning motorcycles in either this mag or ETI. If so may I suggest various alarms, electronic ignition or possibly a helmet intercom?

Great mag, keep up the standards.
Mark Heywood
Breightmet, Bolton

More worthwhile suggestions — I'll pass these on too.

Dear Sir,
I was very interested in your multimeter offer in the October issue of "Hobby Electronics". However, on reading the "fine print" (specifications) I was disappointed.

My great misapprehension concerns the frequency response of the digital multimeters. With an upper limit of 500 Hz, I think that their use is limited when trying to make measurements across the audio bandwidth, even say at 1 kHz, a popular test frequency. This is puzzling as I have noticed that, in general, digital multimeters have a very limited response when compared to their analogue counterparts, even the cheaper ones.

I understand that the limited frequency response is due to the low slew-rate/frequency response of the op amps used for the precision rectifiers. If this is so, could the performance of these digital multimeters be improved by using an IC like the Harris HA5195 (200 V/us slew-rate, 150 MHz gain-bandwidth)? Your answer will be appreciated.

On another subject, couldn't the electronic combination lock, shown on page 21 of the same issue, be opened by depressing all the buttons together?
Norman King
Finsbury Park, London N4

The main part of the circuit that influences the frequency response of a digital meter is the RMS to DC converter. Individual integrated circuits that perform this function are expensive and, one that provides a reasonably high frequency response would add appreciably to the overall price of the instrument.

I can put your mind at rest on the second point. The Electronic Combination Lock *will not* operate if all the buttons are pressed together. Only the correct sequence of buttons, pressed within a reasonable period, will result in the solenoid being activated.

Dear Sir,
I am hoping to construct the Audio Mixer featured in your June '81 issue of HE. As my knowledge of electronics is very limited and extends only to being able to follow circuit diagrams for constructional purposes I wonder if you would be kind enough to send me details of a suitable transistor to use as Q1 in the circuit, as I am unable to find any reference to it in the article.
Mike Floyd
Kings Lynn, Norfolk

PS. Thanks for such a super mag.

We published the Audio Mixer as a Quick Project in the June '81 issue, on page 58. The type number for Q1 *was* given in the article: it is a BC109. You'll find the number tucked in as a note to the circuit given in **Fig. 1**.

Dear Sir,
Can you please help me. How can I convert a 1 mA meter to a 1 V FSD meter?
Timothy Chapman
Fareham, Hants

The conversion is very simple but you omitted to supply one small piece of information; that is, the electrical resistance of the meter movement. Normally this will be very small, and shouldn't have any great effect on the accuracy of your readings, so let's assume it is zero ohms.

Full-scale deflection of the meter will occur when 1 mA is passed through it. Therefore, with a voltage V of 1 V and a current I of 1 mA, from Ohm's law, the value of resistor R required *in series* with the meter will be given by:

$$R = V/I,$$

or

$$R = 1\ V / 0.001\ A, = 1k.$$

If your meter is calibrated in tenths of a milliamp, then each division can be read as one tenth of a volt.

Dear Mr Davies,
I think your magazine is really excellent but *please would you test the equipment you have on "SPECIAL OFFERS". I bought the recommended Multimeter you have on offer but when it arrived the meter had faults so I returned it. When the next meter arrived I was disappointed to find the same sticky needle and fluctuating accuracy again. These faults must be in the design because I cannot blame the Post Office again, so I have sent it back again and asked for a refund.*

I bet you wouldn't print this letter so I will keep my mouth shut for a binder.

Good mag otherwise.
Paul Turnbull
Lossiemouth, Morayshire

I wish that you'd bet me £10 that I wouldn't print your letter! Seriously, though, I was sorry to hear about such extreme problems: it sounds like you've just been unlucky, as we're unaware of any design defect with the HE Multitester. Before I leave HE, I'll set a one-time-only precedent: I'll send you a binder for your troubles.

Finally, a letter from Norway:

Dear Editor,
Please answer the two short questions to follow.

1) Has HE published the second half of the "Heart Beat Monitor" project as promised? If so, when?
2) Could you please tell me where I could obtain two valves, type 6V6 or 6L6, or any equivalent?

Thanks for the info and keep up the good mag.
C.R. Dimmock
HEFAN, Norway

First, I find that address very suspicious.

Second, we never did get round to publishing the 'second half' of the Heart Beat Monitor project. The design has been in progress but it is difficult to say at present when you will see it. (We may even publish a revised design, which will incorporate the facility for direct monitoring of pulse rate.)

Third, try RST Valve Mail Order Company, Climax House, 159 Fallsbrook Road, London SW16 6ED, for the valves. I understand from RST that the 6V6 (GT version) costs £1.60 and the 6L6 (GC version) costs £2.50. Postage charge to Norway (both valves sent together) is 72p.

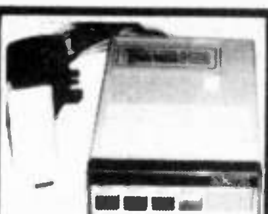
And with that I'll say farewell to all HE's readers. Thanks for all your letters — I'm only sorry that I couldn't manage to answer all of them. As I mentioned above, Ron Keeley will be taking my place — he will be sitting in front of this typewriter from November. **HE**

32 TUNES DOORCHIME/BURGLAR ALARM

This doorchime is powered from 9V d.c. source, and has battery back-up facility. It has an automatic tune advance facility and single or dual play options at 3 selectable speeds. A built-in burglar alarm circuit allows construction of a NORMALLY CLOSED alarm system, two bell pushes can be connected, each playing different tunes.

£9.95 + 95p P&P

POST OFFICE APPROVED TELEPHONE ANSWERING SYSTEM WITH REMOTE CONTROL



You will never miss that important phone call with this machine. You can call your number from any telephone and with the remote control bleeper check to see if any calls have been recorded. You can then erase or retain the messages. It comes complete with microphone, cassette, remote control bleeper and adaptor. We are offering this system at a very low introductory price. Elsewhere it is being sold for £149.

£119.95 + £2.90 P&P

ANALOGUE/DIGITAL LCD WATCH

with dual time, musical alarm, count down timer, chronograph and 12/24 hr selectable display mode.

This Analogue/Digital watch has no mechanical hands. Integral Liquid Crystal display shows time in analogue and digital form. The other features include:

* 2nd time zone
* Analogue display showing normal time
* 24 hour musical alarm
* Selectable 12/24 hr display mode
* Count down timer
* 1/100th sec Chronograph with lcd time
* Digital display shows hours, mins, secs, or hours, mins, date and day of the week
* Back light
* Alarm test function

We are offering all this at a very low price:

Model 1 with simulated leather strap

£17.95 + 75p p&p

Model 2 with stainless steel bracelet

£19.95 + 75p p&p

SANYO

Battery operated mini shaver. Ideal for use while on holiday. Uses one HP7 battery.

£4.95 + 75p P&P

DUAL TIME COUNTDOWN ALARM CHRONO

This superb watch has all the features one would ever need. It has selectable 12/24-hr. display count-down timer/alarm dual-time zone, chronograph with lap time facility. 24-hr. alarm with 5 min. snooze facility, back light fully adjustable stainless steel bracelet and we are offering it at our incredibly low price.

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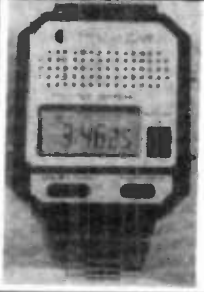
TALKING WATCH



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Famous Names

Campbell-Swinton ranks as one of the most remarkable pioneers of modern TV. Over 70 years ago he had a vision of an *electronic* TV system

RECOGNISE THE NAME? You should, because Campbell-Swinton was the true inventor of one of the spectacular uses of electronics, television. You thought someone else invented television? Read on — legends are not always the same as reality.

A.A. Campbell-Swinton, born in 1863, was almost the archetype of the Victorian engineer. At the age of 19 he was apprenticed to Armstrong's Engineering Works at Elswick-on-Tyne, and this apprenticeship lasted five years. During this time his interest in electricity and the topics which would form the foundation of the new engineering technology of electronics grew and matured. At the end of his apprenticeship, he left Armstrong's to become an independent contractor and consultant, a way of life which allowed him to experiment and innovate to the full.

By the end of the 19th century, Campbell-Swinton was a very respected figure in engineering. Typical of the time, he had introduced innovations in more than one field of engineering. In 1896, he had taken the first X-ray photograph, and had quite certainly laid the foundations for the method of diagnosis we now call radiography. By contrast, he had also acted as a consultant to Parsons in the development of the steam turbine, which was to revolutionise shipping and lay the foundations for Whittle's later work on gas turbines.

Vision Of Electronic TV System

By the turn of the century, he was a member of most of the engineering institutions, and his interests were turning to the idea of television. Now it's important to realise at what stage television had got to then. The idea of mechanical scanning had been put forward by Nipkow and others in the 1870's: these were the systems which Baird was to adopt. Campbell-Swinton was more influenced by Braun (inventor of the cathode ray tube) and Rosing, who believed that a completely electronic system was possible.

Campbell-Swinton set himself the task of designing such a system, using cathode ray tubes both at the camera and at the receiver. It's difficult nowadays to imagine what an enormous task he had set himself. To start with, no-one had ever built a working mechanical TV system, let alone an electronic one. Radio itself was in its infancy — Marconi had only just shown that signals could be transmitted across the Atlantic. The cathode-ray tube was a laboratory toy which could not be produced in any quantity. Despite all these difficulties, though, there is little doubt that Campbell-Swinton thoroughly understood the problems and saw how they were to be solved. His patent of 1908 and his speech to the Röntgen Society in 1911 are classics of our time — perfect descriptions of the television system which would later be developed by Schoenberg, McGee and Blumlein in Britain, and by Zworykin's team in the USA around 1936.

Touch Of Genius

Before we look at the patent, one question remains. Why did he choose the Röntgen Society to reveal his scheme to? The answer is reasonably simple — it was the most appropriate of the professional societies to which he belonged. At that time, the IEE (Insitution of Electrical Engineers) was completely rooted in power engineering, and paid little attention to radio or telegraphy, the other engineering institutes were virtually unaffected by the new technology and only the Röntgen Sociey of which Campbell-Swinton was a founder seemed appropriate. The Röntgen Society, named after the discoverers of X-rays, took an interest in radiation, photography and image formation, and in radio. To this day, developments in some aspects of electronics are reported in the Journal of the Röntgen Society before they appear in other journals. Certainly in 1911, this was the place to reveal a stunning new idea. Stunning? Take a look at the wording which Campbell-Swinton used. It's the language of 1911, not so very different from the language you'll find in some present-day patent applications, and it's the first description of television as we know it:

> **'. . . two beams of cathode rays, one at the transmitter and one at the receiver, synchronously deflected by the varying fields of two electromagnets placed at right angles to one another and energised by two alternating electric currents at widely different frequencies, so that the moving extremities of the two beams are caused to sweep synchronously over the whole of the required surfaces within 1/10 of a second, necessary to take advantage of visual persistence.'**

These are the words of a genius. He must have realised that only the principle of the cathode ray tube could permit scanning of a picture at a rate which would give good definition. The unanimous rejection of Baird's 30-line system in favour of Schoenberg's 405-line system (in 1936) proved how right Campbell-Swinton was. He also realised the importance of synchronisation, that signals which were being transmitted at the start of a scan at the transmitter should arrive at the receiver at an identical part of the scan. No-one else before this date seems to have understood how important synchronisation would be in any sort of television system, but Campbell-Swinton's patent makes it clear that he had completely thought this out, making life much easier for future workers in this field of research.

He also had a good understanding of the principles of scanning. Scanning up till then had meant using the Nipkow disc, a crude mechanical system which was difficult to synchronise. Campbell-Swinton seems once again to have understood thoroughly the idea of using two timebases running at very different speeds (see *How A TV Receiver Works* in this month's issue). He also seems quite clear about how these timebases were to be applied to the cathode ray tubes, using deflection coils (electromagnets) set at right angles to one another. Finally, he had learned from the movies, in their infancy, that a picture will seem continuous provided that its repetition rate is more than about 10 pictures per second.

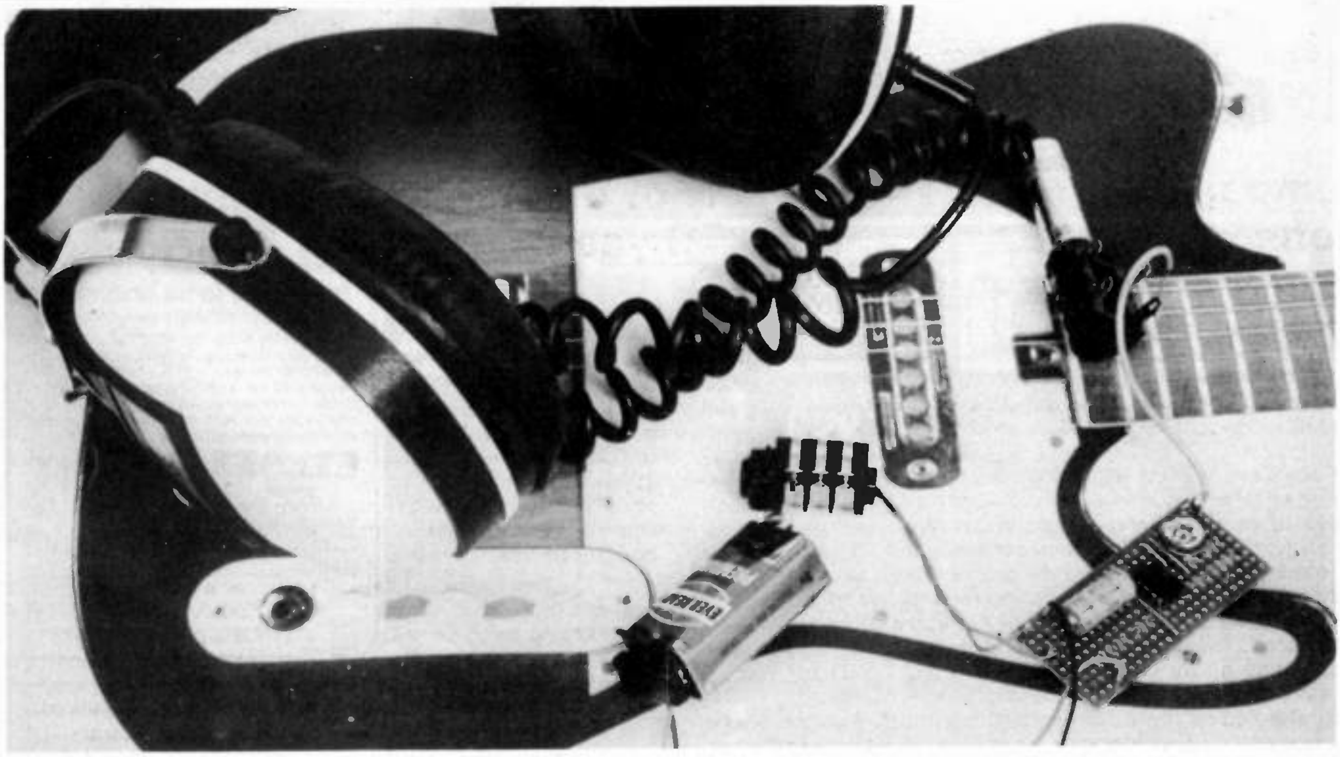
Ahead Of His Time

As so often happens, however, Campbell-Swinton was years ahead of his time. His patent was valid, his ideas were correct but the technology simply wasn't there. Like Leonardo da Vinci's helicopter, the Campbell-Swinton TV system couldn't be manufactured, and in 1911 there simply was no urgency about it. The urgency came later. Techniques using cathode-ray tubes were as essential to radar as to TV and even in the thirties, when the idea of defending Britain was one which drew ridicule from many well-known political figures, some just recently retired, there was keen interest in cathode ray tubes, scanning techniques and wideband radio transmissions. These advances enabled Campbell-Swinton's ideas to be put into practice at last, culminating in the television service which we now take for granted.

No one man invented television, but from the names which include Rosing, Zworykin, Schoenberg and many others, that of Campbell-Swinton must be ranked as the most far-sighted of all the pioneers.

HE

QUICK PROJECT:



Guitar Headphone Amp

This Quick Project couldn't be simpler — only three components are used to make a super practice amplifier for an electric guitar

At long last — now you don't need a 100 watt amplifier and a ginormous speaker stack to practise your electric guitar. Now, with a pair of 'phones, you can play your guitar in private without annoying others.

A standard pair of stereo (or mono) headphones should be plugged into the output socket of the project and your guitar lead plugs into the input socket. Preset resistor RV1 adjusts the basic volume, but once set to match your guitar it needn't be readjusted because the guitar's volume and tone controls cater for any required variation.

Integrated circuit IC1 is an LM386 — an audio power amplifier IC which has its gain internally set to 20. Thus a guitar signal input of, say, 100 mV will produce an output from the amplifier of 2 V. The IC is capable of driving any load of 4R or more, so most headphones can be used with this project.

Construction is easy; make the five track breaks where shown in *Fig. 2*, using a cutting tool or a small (about ⅛'') hand-held drill bit. Press the cutting edge of the tool against the hole in question and twist the tool clockwise until the copper track breaks in a clean circle. Make sure no copper swarf from the track bridges across to adjacent tracks, forming a short circuit.

Now insert all components as shown and wire up your project. Finally, connect a battery and play away.

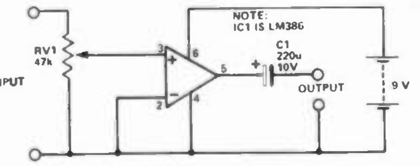


Figure 1. Circuit of the HE Guitar Headphone Amplifier

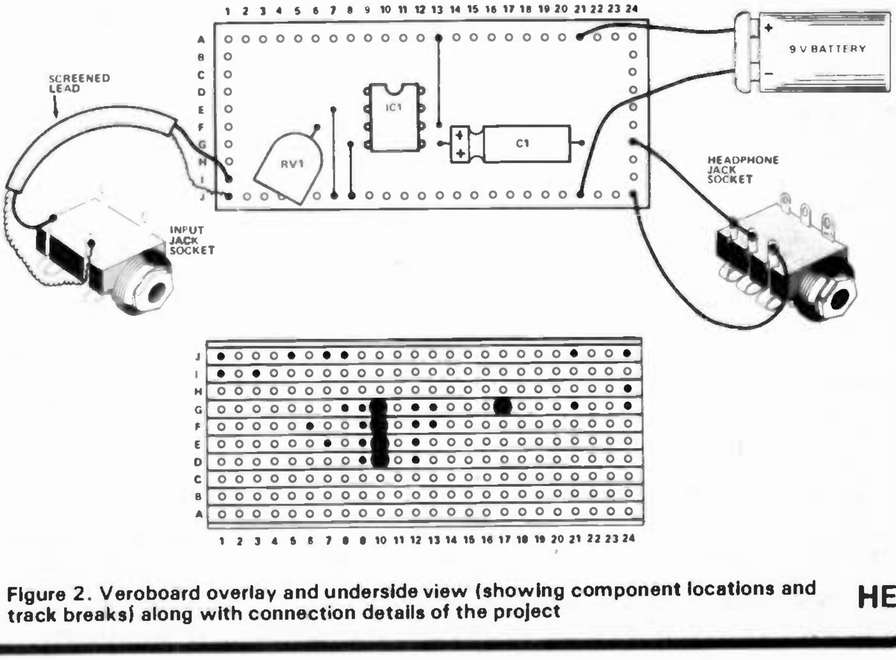


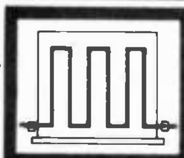
Figure 2. Veroboard overlay and underside view (showing component locations and track breaks) along with connection details of the project

HE

FIVE NEW BOOKS

in the Newnes constructors projects series

Each book contains a collection of constructional projects, giving details of how the circuit works, how it may be assembled and how setting-up and trouble-shooting problems may be solved. The skilful use of colour in the text helps to clarify operation and circuit board layouts are suggested. Shopping lists of components are drawn up for each project. Each book measures 216 x 135mm and has 96 pages.



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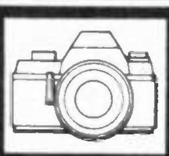

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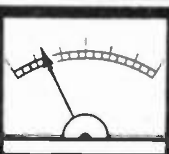

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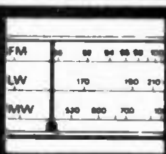

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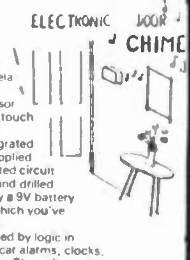

Fed up with your old doorbell? This KIT should cheer you up! Our latest kit gives you a pleasing three-note harmonically related tone sequence (NOT a microprocessor controlled buzz) at a touch of a button.

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It may also be switched by logic in such applications as car alarms, clocks, toys, PA systems, etc. The unit produces a 150mW output and draws less than 1uA from a PP3 battery, when the tone ceases. Supplied complete with circuit and assembly instructions.

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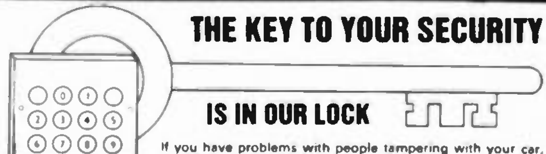

If you have problems with people tampering with your car, electrical and electronic equipment, or if you are just in a habit of forgetting your door keys, we have just the kit for you.

Our ELECTRONIC LOCK KIT includes a 10-way keyboard and a special IC which provides a 750mA output to drive a solenoid or relay (not supplied) when four keys are depressed in the correct sequence. This gives over 5,000 possible combinations! The sequence is pre-wired and may be easily changed by means of a small plug and socket. A "SAVE" function is also available enabling the open code to be stored (especially useful in a car when it is left in a garage for servicing as the open code need not be disclosed). Size: 7 x 6 x 3 cms. Power consumption is 40uA at 5V. to 15V. d.c.

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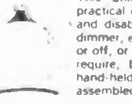
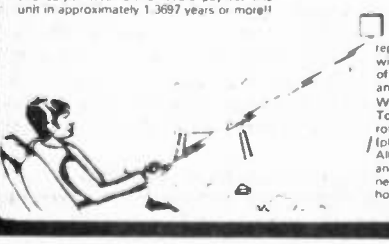
than getting up to switch lights on when it gets dark. Our Lamp Dimmer Kit with INFRA-RED REMOTE CONTROL will enable you to switch the lights on or off, and set the brightness, at a push of a button without leaving your armchair, water bed, etc. Not only will you save time but it has also been estimated that the savings in shoe leather and carpet wear alone would pay for this unit in approximately 1.3697 years or more!!



This unit has, of course, considerable practical uses, especially for the old, infirm and disabled. It works like a conventional dimmer, enabling you to switch the lights on or off, or to dim to whatever brightness you require, by touch or remotely using the hand-held infra-red transmitter. When assembled, it fits into a plaster depth box to replace your conventional switch or dimmer with no rewiring and will control up to 300w of lighting. TDR300K Dimmer Kit £14.30, and MK6 Transmitter Kit £4.20



We also still sell our highly-popular TD300K Touch Dimmer Kit at £7.00 and the LD300K rotary-controlled Dimmer Kit at only £3.50 (plus V.A.T. to above prices).

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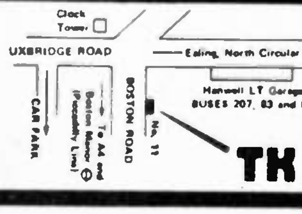

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Synthesiser Secrets

In Part 3 of this occasional series, on the electronics of music synthesisers, Ron Keeley talks about sound generators, the voltage controlled oscillators (VCOs)

THERE ARE MANY different techniques for building voltage controlled oscillators. These days, of course, you can buy a single integrated circuit which may contain two, three or more complete VCO circuits but for the moment we're going back to the Dark Ages, when circuits were built up from individual components . . .

The first thing to realise about VCOs for music synthesisers is that they don't (generally) produce sinewaves. Musically interesting sounds are much more complicated, and sinewaves are simply boring. A practical VCO must produce a wave shape rich in harmonics, one that can be selectively filtered to generate a replica of traditional musical sound — or a completely new one.

The best wave shapes for this purpose are square, triangle and sawtooth waveforms. Often one or two of these can be generated simultaneously, and any other required shape can be produced by special conversion circuits. Even sinewaves (which do have their uses in, for example, modulating other oscillators, filters etc, or for making bell, chime and synthesised drum sounds) can be produced by squarewave-to-sinewave converters.

In fact voltage controlled square/triangle wave oscillators are relatively easy to make — much simpler than voltage controlled sine oscillators. A simple squarewave VCO is shown in Fig. 2. It is based on the even simpler circuit in Fig. 1, an astable multivibrator that uses two CMOS inverters, a resistor and a capacitor.

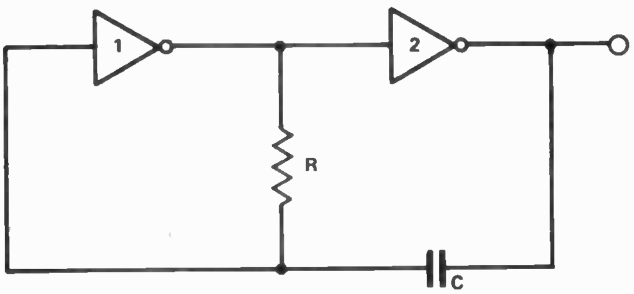


Figure 1. Simple CMOS astable multivibrator

The operation of this circuit depends on the fact that the output of a CMOS inverter will switch from high to low — or vice versa — when the input voltage crosses a certain threshold level called the transfer voltage, Vtr, which is usually about half the supply voltage.

If we assume that the output of the second inverter is low, its input, and therefore the output of the first inverter must be high which, in this example, is the full postive supply voltage +V. The capacitor therefore begins to charge up, through R, to the supply voltage. When it reaches about half +V, though, the output of the first inverter will switch low, taking the output of the second inverter high. The full supply voltage will appear on top of the capacitor and will be coupled through to the input of the first inverter, providing positive feedback (this input was already going high as C charged up) and forcing inverter 1 to rapidly switch states.

Now the capacitor begins to discharge through R into the low output of the first inverter, until the voltage at the junction of R and C once again crosses the threshold level Vtr, but this time in the opposite direction. This causes its output to go high, taking the second output low and restoring the original conditions: this whole cycle then will repeat indefinitely.

The period of oscillation of this simple circuit is approximately 1.4 RC, and this corresponds to a frequency f, where:

$$f = \frac{1}{1.4\,RC}.$$

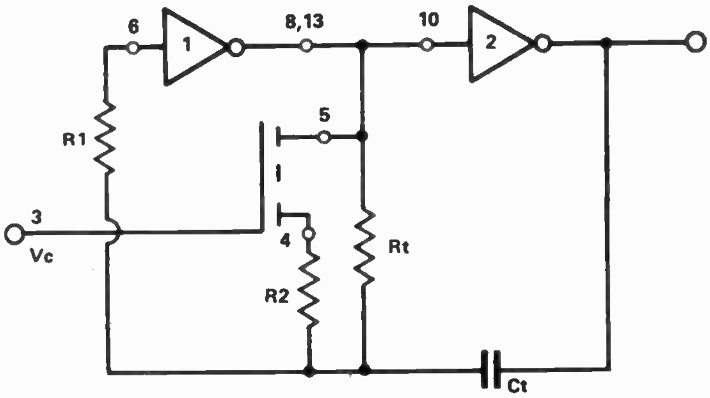


Figure 2. Voltage controlled oscillator using CMOS inverters and a CMOS field-effect transistor. Pin numbers relate to the 4007 integrated circuit. Supply connections are not shown

Obviously the frequency can be varied by altering either R or C. The circuit in Fig. 2 does this by using a CMOS field effect transistor (FET) as a variable voltage-controlled resistor in the timing network RC. When the gate voltage Vc is zero, the source-to-drain resistance of the FET is about 1000MR — virtually an open circuit — and the oscillator frequency will be very low. As Vc is taken positive, though, the FET resistance drops towards a minimum value of about 1k when Vc is equal to +V and the frequency of oscillation will be high. Thus by simply varying the control voltage Vc we are able to control the frequency of the oscillator.

The minimum frequency is set by the parallel combination of Rt and the FET resistance: the maximum frequency is determined by the series combination of R2 and the FET.

This circuit is rather basic and, while it will work, it will not work particularly well. Many refinements are necessary to turn it into a VCO suitable for use in a synthesiser. One such refinement is the inclusion of R1, which makes the oscillator less susceptible to fluctuations in frequency caused by fluctuations in the supply voltage. The same circuit is shown, more conventionally, in **Fig. 3**. Comparing the pin numbers, you can see that they are practically identical, with the addition of a pair of BC108s (or similar audio-frequency transistors) in the final circuit to drive an 8 ohm speaker.

Next month we'll look at another simple VCO scheme, based on two simple circuit elements, an integrator and a Schmitt trigger.

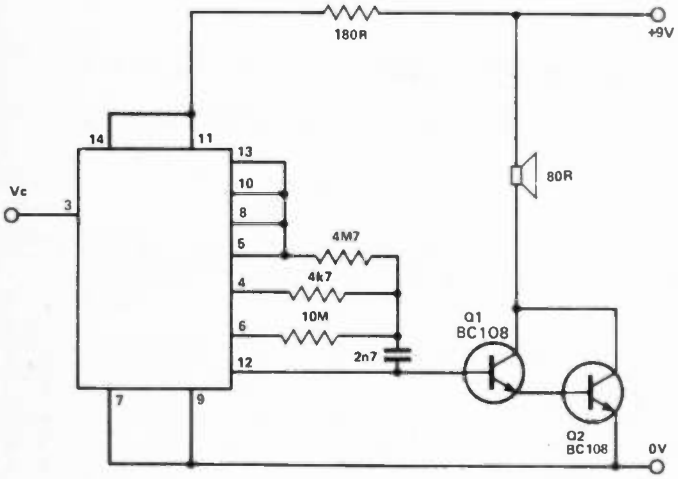
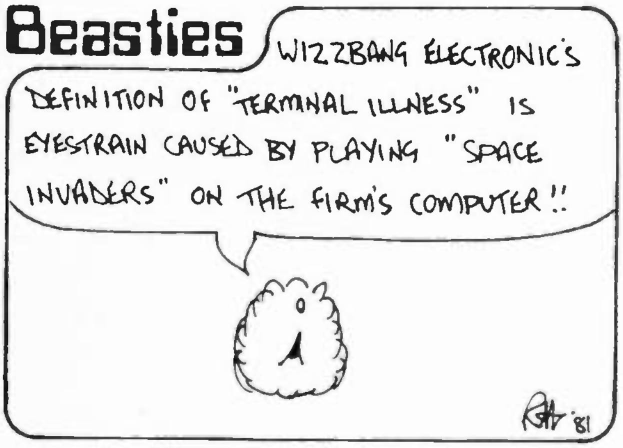
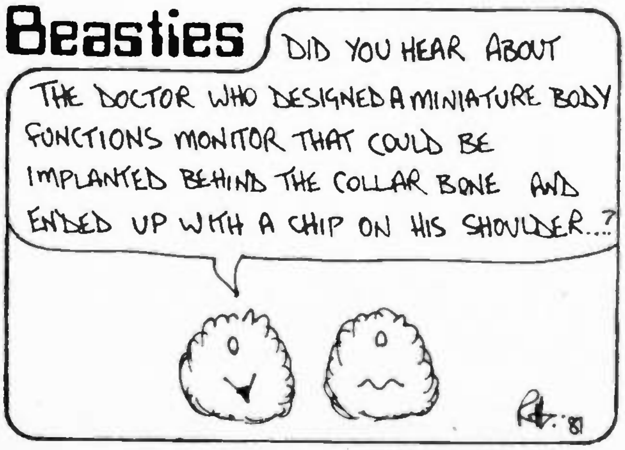


Figure 3. Complete circuit of a VCO based on the 4007

HE





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2. Overall compression (sustain)
3. H.F. compression for bass overdrive
4. Overall expansion for sustained overdrive
5. Mid frequency expansion
6. H.F. expansion for H.F. accentuation.

All (except overall overdrive) have variable effects control. Guitar Note Expander Kit £16.47, less case £11.25.

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A mix control allows the modulated signal to be mixed with the straight through signal. Ideal for outer space, voice and music effects. Just connect a signal source and a power amplifier and speaker.
Sound Bender Kit £20.76, less case £15.76.

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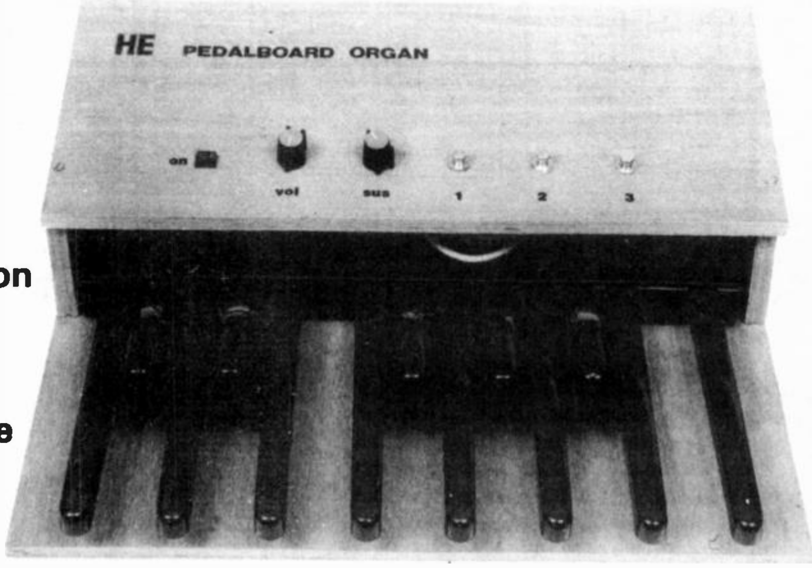
PEDALBOARD ORGAN



Although this project has been produced to complement the HE Electronic Organ, that is not its only use — it can be played in combination with most other instruments to provide a supplementary bass line. With its large-sized pedals, the project could also be adapted for use by the disabled

IF YOU HAVE ever played a solo musical instrument you will appreciate the HE Pedalboard Organ. It can be used to provide a back-up bass accompaniment line while you play your organ, guitar, flute or whatever. Consisting of 13 foot-operated pedals (C to C, to give one octave of bass notes), the project can add many possibilities to your music.

A single printed circuit board (PCB) contains all circuitry for note generation, sustain and pre-amplification. There are three foot-operated switches for choice of instrument voicing and two rotary controls for sustain length and volume. Power amplification is provided by a BI-PAK 10 watt amplifier module (AL30A).

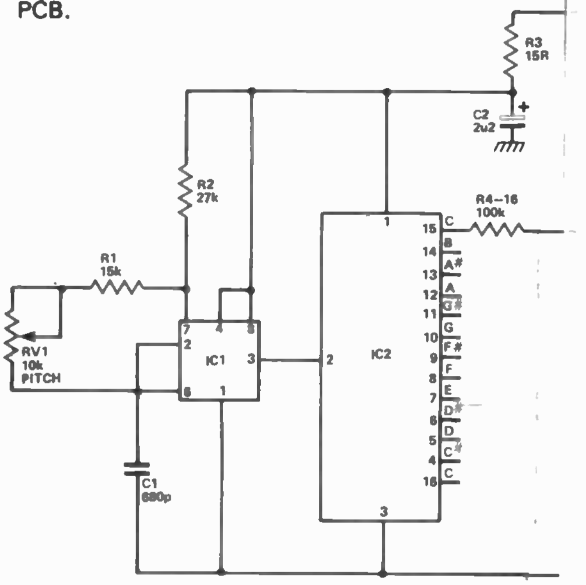
The pedalboard is tuned so that the lowest note is pitched at a frequency of 65 Hz (C) and this corresponds to an 8-foot pitch in organ terms. In our prototype the 13 pedals are mounted onto a wooden baseboard and the generator PCB, amplifier module, controls and mains transformer are all mounted on the underneath of another piece of wood over the rear of the pedals. Readers may like to follow our case style or they could design their own.

Construction

Make up the PCB first — insert and solder each component as shown in Fig.2 making sure that all polarised components are the right way round, but don't insert IC1,2 or 3 yet.

Insert and solder circuit board pins into the board where off-board connections are to be made.

Following the connection details in Fig.3 wire up the underneath of the PCB.



Parts List

RESISTORS (all ¼ W, 5% except where stated)	
R1	15k
R2	27k
R3	15R
R4-16,88	100k
17-29, 69-81,87	4k7
R30-42	22k
R43-55, 56-68,91	33k
R82,84, 86,89,90	10k
R83	56k
R85	15k
R92	330R, 2W
POTENTIOMETERS	
RV1	10k miniature horizontal preset
RV2	10k linear potentiometer
RV3	100k miniature horizontal preset
RV4	22k logarithmic potentiometer
CAPACITORS	
C1	680p polystyrene
C2,20,22	2u2, 16 V electrolytic
C3-15	22u, 16 V electrolytic
C16	100n polyester
C17	470n polyester
C18,19	220n polyester
C21	220u, 16 V electrolytic
C23	2200u, 40 V electrolytic
C24	1000u, 16 V electrolytic
SEMICONDUCTORS	
IC1	555 timer
IC2	M083 13-note generator
IC3	741 operational amplifier
IC4	7812, 1 A voltage regulator
Q1-13	BC183 NPN transistor
D1-13	1N4148 diode
D14-17	1N4001 diode
MISCELLANEOUS	
SW1	double-pole, double-throw toggle switch
SW2,3,4	push-on, push-off switch
T1	240/24 V mains transformer
Neon with integral resistor	
SK1	mono ¼" jack socket
AL30A	10 W power amplifier module
Knobs to suit	
13-note pedalboard (see Buylines)	
3-way terminal block	
Wood for case	

Buylines

A complete kit of parts is available from:
Portative Instruments
23 Blenheim Road,
St Albans,
Herts AL1 4NS

Kit price is £58. This includes VAT but please add £4 to cover p&p.

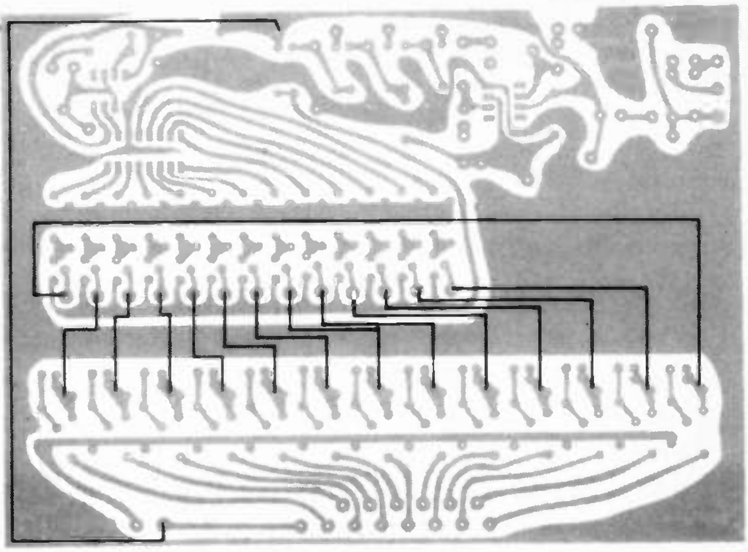
The pedalboard alone will cost you £22 plus £3 to cover p&p.

Delivery within the UK only.

Now, following the connection details shown in Fig. 4, wire up the project. Connect the transformer primary to a 240 V mains supply and, with a voltmeter, check that: +30 to +35 VDC is present across capacitor C23; that +12 VDC is present across capacitor C24. Disconnect from mains power supply.

Insert IC1,2 and 3 into their correct places making sure they are the right way round. It now only remains to house the project.

Figure 3. Wiring details of the underside of the PCB



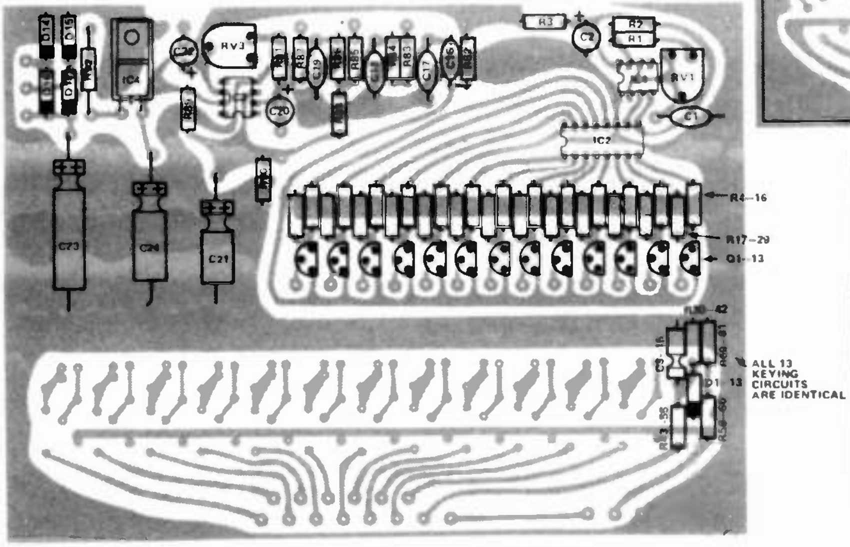
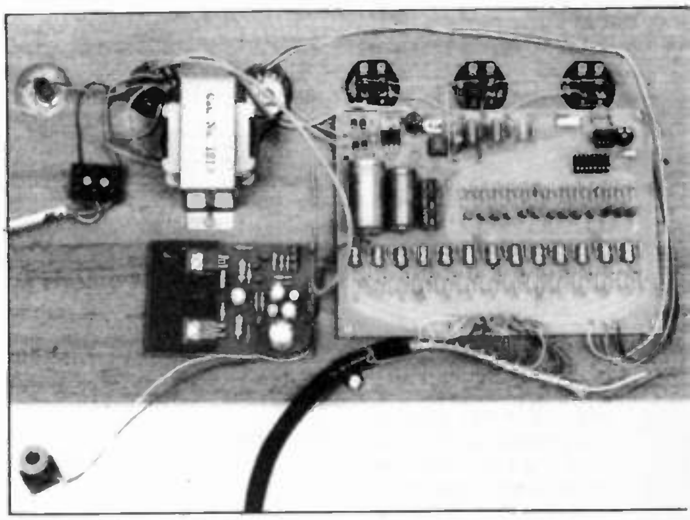


Figure 2. PCB overlay and connection details of the project



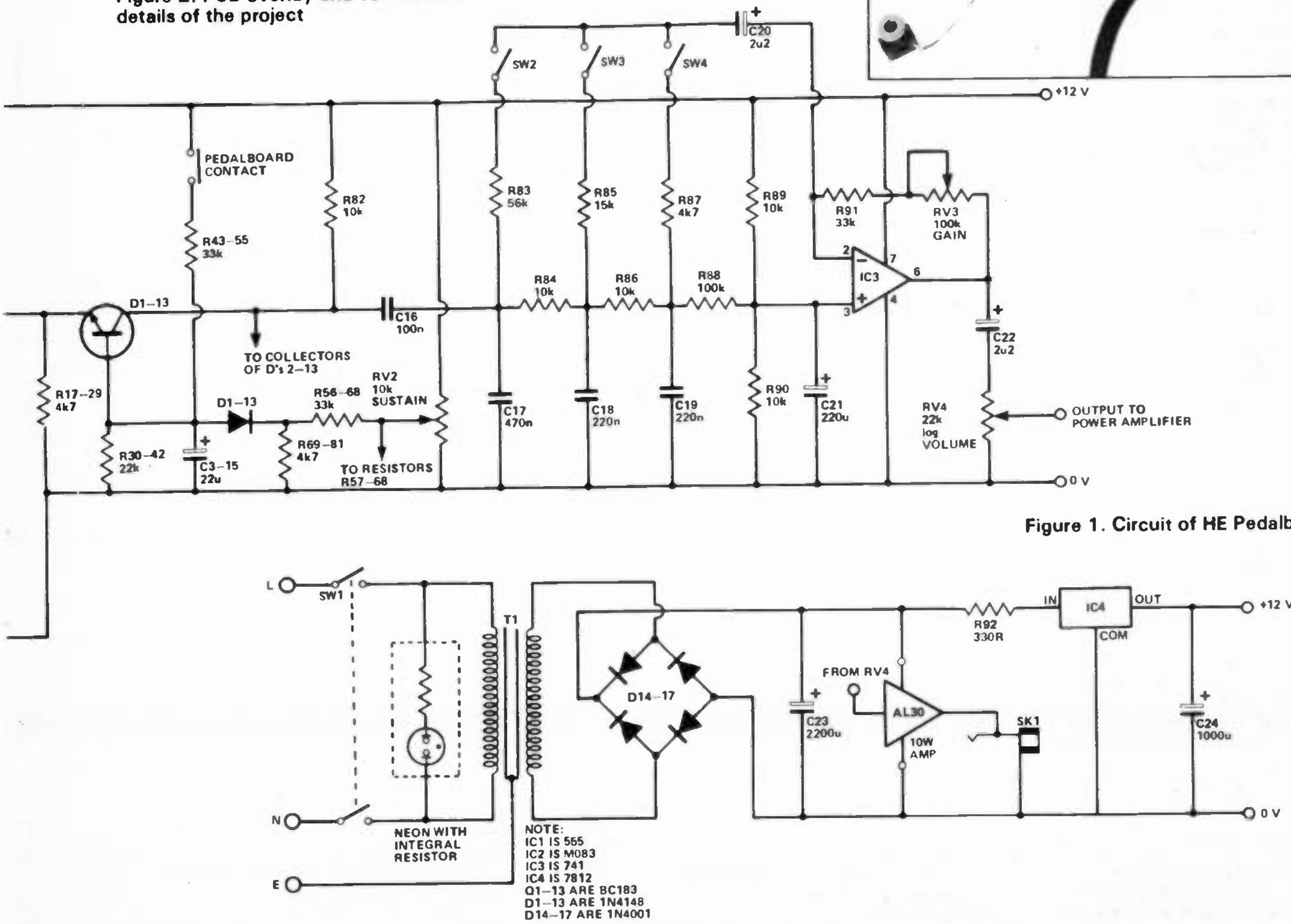


Figure 1. Circuit of HE Pedalboard Organ

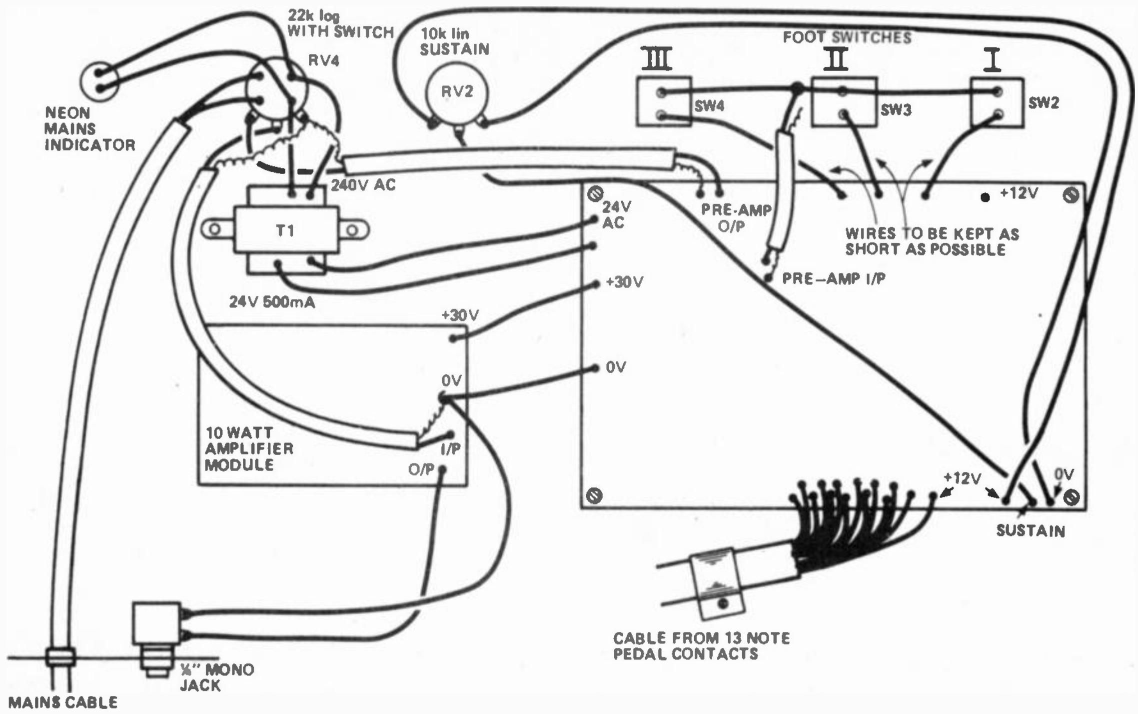
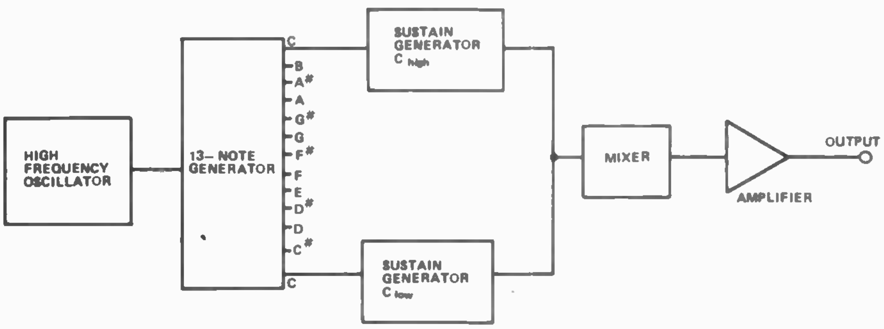


Figure 4. Connection details

How It Works

A high-frequency oscillator, runnng at 31.24 kHz, provides the clock input to a 13-note generator. The generator divides down this clock frequency to give the 13 notes of one musical octave from 65-130 Hz. Each note is continuously available at its respective output.

Whenever a pedal is operated, the sustain generator circuit for that pedal (only two are shown) is triggered. Thus the corresponding note from the 13-note generator is allowed through to the amplifier after being mixed with any other notes played simultaneously.



The high frequency oscillator is formed around a 555 timer, IC1. Preset resistor RV1 is a pitch control. The output of the 555 is directly coupled to the clock input of IC2, an MO83, 13-note generator, which divides down the high frequency signal in a musical ratio. The 13 outputs of IC2 form an octave, the individual frequencies of which are thus directly related to the clock input frequency.

Each output signal from IC2 is taken through a 100k resistor (R4-16) to the emitter of a transistor (Q1-13) in a common-base configuration. Depressing an organ pedal causes a +12 VDC keying signal to charge up a 22u capacitor (C3-15) through a 33k resistor (R43-55) and this slowly-rising voltage is fed to the base of the transistor. The transistor turns on and the squarewave note-signal at the emitter thus appears at the collector. All the collectors are connected together, so that any signal appearing will be passed on to the next stage.

The discharge rate of the 22u capacitor defines how long the transistor stays on and thus how long the note lasts. After the pedal has been released, the capacitor discharges through a 4k7 resistor (R69-81). Sustain control RV2 provides a variable bias voltage of between + 12 V and 0 V to the 4k7 resistor. This affects the capacitor discharge rate and hence the length of note sustain.

Power supply is from: a 240/24 V mains transformer (T1); bridge rectifier (D14-17); filter capacitor (C23). An unregulated voltage of about 30-35 VDC is produced and this provides power for the AL30A power amplifier module. Integrated circuit IC4 is a 12 V voltage regulator which supplies up to 1 A of current, at 12 VDC, for the oscillator, note generator, sustain and mixing circuit. HE

GADGETS GAMES & KITS

It's in-car entertainment time in this month's GG&K. Hugh Davies installs a pair of Philips door-mounting loudspeakers and Steve Ramsahadeo fits a complete audio system from Videotone. There's also comment on the installation of Blaupunkt Quick Fit 723 loudspeakers.

Meanwhile, back at the office, Ian Graham checks out his state of mind with a brainwave sensor from Aleph One

Installing Philips EN8751 Car Door Loudspeakers

PHILIPS' AUDIO DIVISION presented us with a small box containing an EN8751 loudspeaker kit for the car, saying: 'How would you like to try installing this?' We had a Ford Escort (series 2 model) with unblemished door panels and so it seemed worth a try.

Contents Of Kit

The kit comprises:

- two EN8751 5" loudspeakers, 15 W rating
- two 'speedy mount' water covers (these protect the speakers from any water dribbling down inside the door)
- two lengths of twin flex, fitted with non-reversible sockets at one end and with polarity marking on one lead
- pack of fixing screws and clip nuts
- template to aid marking out of the speaker mounting holes (forms part of box front)
- instruction sheet

Philips also provided, for the purpose of our test, some information (not supplied with the kit) on how to fit its radios, radio/cassette players and loudspeakers to Ford Escorts. All that we required from this information was the recommended position of the loudspeakers in the doors.

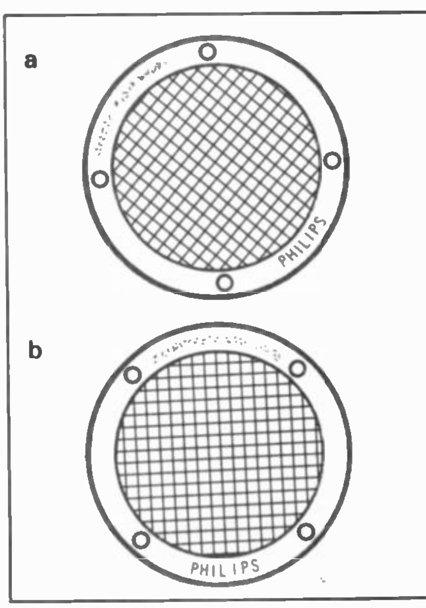
Installation

We removed the right-hand door panel and marked out horizontal and vertical lines, in the positions suggested, on the inside of the panel (180 mm from the panel edge vertically and 90 mm from the lower edge horizontally).

Next the template was carefully detached from the box and aligned with the two lines on the panel. Marking out was easy: with the template in position the aperture and mounting holes could be marked out on the panel with a pencil.

To prevent damage to the panel, a string of 3/16" holes was drilled around the inside of the circle marked out for the speaker aperture. The disc of waste material was cut out with a sharp knife.

One of the EN8751s was tried in the aperture at this stage, and a discovery was made. If the loudspeaker had been fitted with its four mounting holes lined up with the vertical and horizontal lines marked out on the panel (which seemed natural enough to do) then the legends on the rim of the loudspeaker would have been tilted, as shown in **Fig. 1a.** To prevent this happening, it was found necessary to mark out fresh mounting hole positions on the template, thus moving the loudspeaker through 45° (see **Fig. 1b**).



After all the holes had been drilled and cut, the panel was tried in position on the door. Part of the aperture was obstructed by the metal panel of the door, and this left us no choice but to remove part of the metal (see comments at the end of this report).

When a loudspeaker is fitted into a car door it is necessary to bring the connecting flex out at one point on the hinged edge of the door and to pass the flex into an adjacent hole in the car body. No difficulty was experienced in finding appropriate places for these holes but we suddenly realised that two important components had not been included in the kit, namely protective grommets.

These tiny rubber fittings serve two purposes. The first is to protect the flex from being chaffed on the sharp edge of the hole and the second is to help seal the hole against the ingress of water.

Also missing from the kit were plugs to connect the flex from each speaker to our radio/cassette player: we had to provide our own.

On Test

When the two speakers were connected to the Escort's ICE system (in-car entertainment system or, if you prefer plain English, stereo radio/cassette player!) the results were impressive. A smaller tweeter cone, complete with metal dome is fitted in the centre of the 5" paper cone of the EN8751, and we thought that the overall frequency range, from bass through to crisp treble, was good. The speakers gave, for instance, a good account of some recorded music on 'metal' tape. The EN8751s are rated at 15 W.

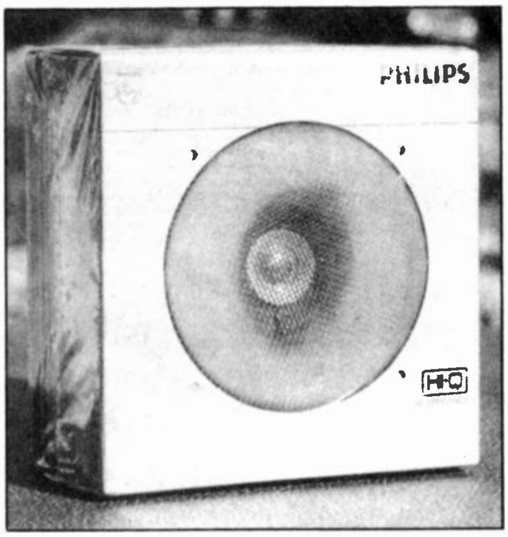
Looks

When mounted on the black door panels of our test vehicle the speakers were inconspicuous. (The EN8751s have a dark grey rim and a black protective grille.)

Comment

Apart from the niggles about the template and the omission of the grommets and plugs, the speakers performed well for a reasonable cost — around £19 including VAT.

● We contacted Philips about our niggles. The spokesman was surprised to hear that grommets had not been included in the kit: he claimed that they were supplied with most Philips car radio kits. The omission of plugs on the leads was more a result of company policy, because the plugs are usually supplied with the radios or radio/cassette players and not with the speakers. He agreed to discuss these points with the Dutch parent company.

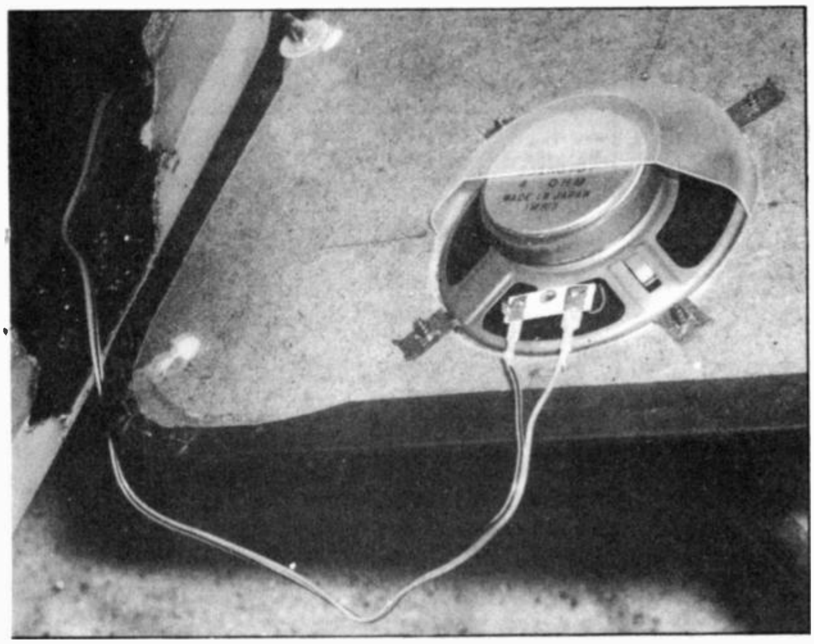


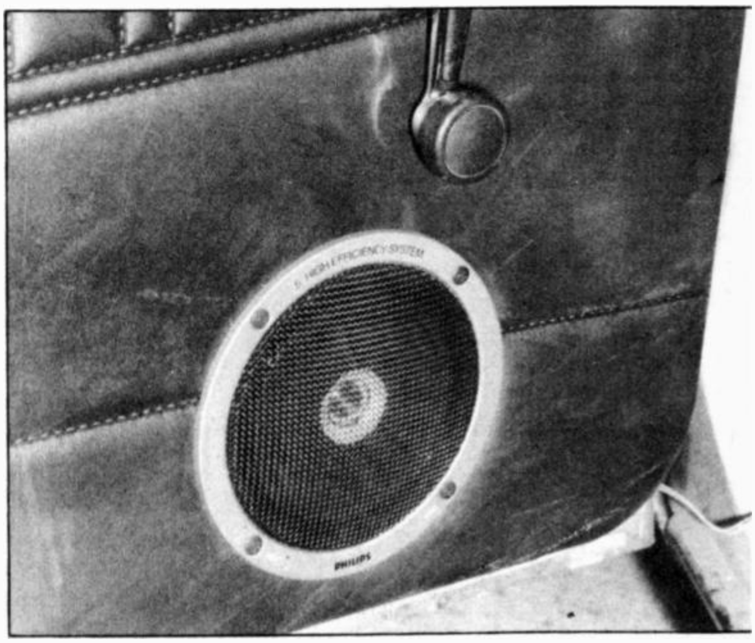
The spokesman also passed on some tips about those grommets. To prevent rusting, after the holes have been drilled in the doors and car body it is advisable to apply a little petroleum jelly (such as Vaseline) around the holes. Some of the jelly applied to the flex as it enters each grommet also helps to prevent the ingress of water.

● A further note about installation: the EN8751s *will* mount in the doors of a series-2 Ford Escort without the need to cut any metal from each door. However, when the speakers are mounted in the ready-cut aperture in the doors, the window-winding handle is uncomfortably close to the loudspeaker and may even touch the grille. If you use the dimensions given by Philips then you *will* have to cut a portion of the metal away, but the lower hole position will keep you clear of that handle.

When marking out the hole in the metal, allow for clearance of the loudspeaker terminals and also of the lower mounting nuts and screws. Simply mark out a rectangular flap (we did it the hard way and followed the shape of the speaker) and drill a string of 3/16" holes along the lower line (that is, parallel with the bottom edge of the door). The vertical lines can be easily cut down using a junior hacksaw. When the cutting and drilling is completed, break out the flap along the line of holes and file smooth the jagged edges (*mind your fingers when doing this*).

To prevent rusting, it's also worthwhile treating the freshly-cut metal with a dab of underseal or thick paint before you fit the door panel. ▶





NEW KITS

COMBINATION SWITCH
Battery operated, would control solenoid lock or any electrical device, virtually impossible to decode. Uses no power when in the off position. Complete kit £4.50.

A SECRET SWITCH
Can be hidden behind a panel, door, wallpaper, etc. Will light the lamp or whatever device is secretly controlled and it will also latch itself on. Complete kit £1.95.

3 - 30v VARIABLE VOLTAGE POWER SUPPLY UNIT
With 1 amp DC output, for use on the bench, students, inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit £13.80

IONISER KIT
Refresh your home, office, shop, work room, etc. with a negative IDN generator. Makes you feel better and work harder — complete mains operated kit, case £11.95. post £1.50.

40 WATT AMPLIFIER
Module form. Complete kit (no case) £9.50.

T.V. AERIAL FILTER
Designed to eliminate C.B. and other interference complete

MORSE TRAINER
Complete kit £2.99.

DRILL SPEED CONTROLLER
Complete kit £3.95.

MAINS POWER SUPPLY
Gives any voltage from 3v to 16v at up to 300mA. Complete kit less case £1.95. Case 90p.

SUPER HI -FI SPEAKER CABINETS

Made for an expensive Hi- Fi outfit — will suit any decor. Resonance free. Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacron. The completed unit is most pleasing. Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.

GOODMAN SPEAKERS

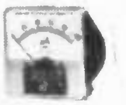
6½" 8 25watt. £4.50. 2½" 8 tweet. £2.50. No extra for postage if ordered with cabinets. Xover £1.50.

Vu METER SNIP.

Approximately 1 5/8" square, suitable for use as a recording level meter power output indicator or many similar applications. Full vision front, cover easily removable if you wish to alter the scale. Special snip price £1.00, or 10 for £9.00.

MOTORISED DISCO SWITCH

With 10 amp changeover switches. Multi-adjustable switches all rated at 10 amps, this would provide a magnificent display. For mains operated 8 switch model £6.25, 10 switch model £6.75, 12 switch model £7.25.



100uA PANEL METER

Japanese made (Shinohara Electrical) so very good quality, these have a full vision front, are approx. 2" square and come complete with mounting studs and nuts. A thoroughly reliable instrument usually retailed at over £4, offered at a snip price this month of £2.85 or 10 for £25.00.

12v MOTOR BY SMITHS

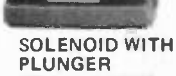
Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45. Ditto, but double ended £4.25.

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post.

UNIVAC KEYBOARD BARGAIN

50 computer type keys, together with 5 miniture toggle switches all mounted on a p.c.b. together with 12 i.c.'s many transistors and other parts. £13.50 + £2.00 post. This is far less than the value of the switches alone. Diagram of this keyboard is available seperately. Price £1.00.



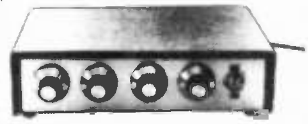
SOLENOID WITH PLUNGER

Mains operated £1.99
10 — 12 volts DC operated £1.50.

MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy to assemble modular form this should sell at about £30 — but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16.75 including VAT and post. FREE GIFT — buy this month and you will receive a pair of Goodman's eliptical 8"x5" speakers to match this amplifier.

3 CHANNEL SOUND TO LIGHT KIT



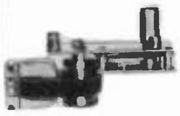
Complete kit of parts for a three-channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is £14.95 in kit form or £25.00 assembled and tested.

THIS MONTH'S SNIP

YOUR LAST CHANCE TO BUY THIS COMPUTER PRINTER FOR ONLY £4.95

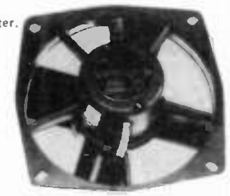
Japanese made Epson 310 — has a self starting, brushless, transistorised d.c. motor to drive the print hammers, print drum — tape forward/reverse and paper feed.
Complete, ready-built with electronics. Brand new still in maker's wrapping - price £4.95 + £1.25. Technical and practical data £1 extra.

SPIT MOTORS



These are powerful mains operated induction motors with gear box attached. The final shaft is a ⅛" rod with square hole, so you have alternative couplingmethods — final speed is approx. 5 revs/min, price £5.50. — Similar motors with final speeds of 80, 100, 160 & 200r.p.m. same price.

EXTRACTOR FAN

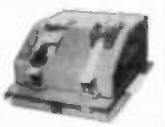


Mains operated — ex. computer.
5" Woods extractor £5.75 Post £1.25
6" Woods extractor £6.90 Post £1.50
5" Plannair extractor £6.50 Post £1.25
4" x 4" Muffun 115v. £4.50 Post 50p.
4" x 4" Muffin 230v. £5.75 Post 50p

8 POWERFUL BATTERY MOTORS

For models, meccanos, drills, remote control planes, boats, etc. £2.50.

TAPE PUNCH & READER



For controlling machine tools, etc, motorised 8 bit punch with matching tape reader. Ex-computers, believed in good working order, any not so would be exchanged. £17.50 pair. Post £3.00.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale. 11 instant range measures: DC volts 10, 50, 250, 1000. AC volts 10, 50, 250, 1000. DC amps 0 — 100 mA.

Continuity and resistence 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only £6.75 + 50p post and insurance.

FREE Amps range kit to enble you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but of you already own a Mini-Tester and would like one, send £2.50.

FREE OUR CURRENT BARGAIN LIST WILL BE ENCLOSED WITH ALL ORDERS.

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30. (Not licenceable in the U.K.).

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 comp. kit. (Not licenceable in the U.K.).

FM RECEIVER
Made up and working, complete with scale and pointer needs only a speaker, ideal for use with our surveillance transmitter or radio mike. £5.85.

CB RADIO —
Listen in with our 40-channel monitor. Unique design ensures that you do not miss sender or caller. Complete kit with case, speaker and instructions only £5.99.

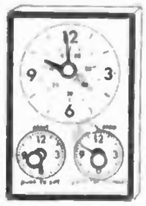
NEW ADDRESS FOR CALLERS:—
2, Bentham Road, Off Elm Grove, Brighton.
Tel: Brighton 671457. Please phone before making a special journey for any advertised item.

VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are new but without case, but we can supply plastic cases (base and cover) £1.75 or metal case with window £2.95. Also available is adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

STEREO HEADPHONES

Japanese made so very good quality. 8 ohm impedance, padded, terminating with standard ¼" jack plug. £2.99 Post 60p.



TIME SWITCH BARGAIN
Large clear mains frequency controlled clock, which will always show you the correct time + start and stop switches with the dials. Comes complete with knobs. £2.50.

SAFE BLOCK
Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit. £1.95.

6 WAVEBAND SHORTWAVE RADIO KIT
Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit includes case materials, six transistors and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy if you have an amplifier to connect it to or a pair of high resistance headphones. Price £11.95.

SHORT WAVE CRYSTAL RADIO
All the parts to make up the beginner's model. Price £2.30. Crystal earpiece 65p. High resistance headphones (gives best results) £3.75. Kit includes chassis and front but not case.

RADIO STETHOSCOPE
Easy to fault find — start at the arial and work towards the speaker — when signal stops you have found the fault. Complete kit £4.95.

INTERRUPTED BEAM
This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2.30

MUGGER DETERRENT
A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. £2.50 complete kit.

TANGENTIAL BLOW HEATER

2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95. post £1.50.

12V SUBMERSIBLE PUMP

Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. and you get a very good head. Suitable for water, paraffin and any non-explosive non-corrosive liquid. One use if you are a camper, make yourself a shower. Price: £8.50.

MINI MONO AMP

On p.c.b., size 4"x 2". Three transistors and we estimate the output to be 3 watt rms. Brand new perfect condition, offered at the very low price of £1.15 each or 10 for £10.00.

J. BULL (Electrical) Ltd.

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NEW **PACE RUNNER**

J-100
RRP
£22.95

ONLY
£19.95

Provisional specification
Time, auto calendar, calculator, alarm, hourly chimes, stopwatch
JOGGING COMPUTER

NEW

AX-210 Specification

Analog Display

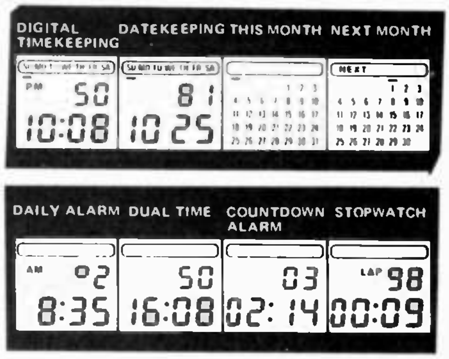
LC Display of hours and minutes
Digital display
- Local time, 12 or 24 hour
- Full calendar display
- Dual time, 12 or 24 hour
- Alarm time display
- Countdown alarm timer with memory function.
- Professional 1/100 second stopwatch.

Hourly time signal. Daily alarm-electronic buzzer or 3 selectable melodies.
Rapid forward/back setting.
9.4 x 35.4 x 36mm.

World's most versatile watch

10 alternative displays - over 60 useful functions

CASIO AX-210 (RRP £34.95) ONLY £29.95



COMMON SPECIFICATIONS: * High quality modules and cases * Mineral glass face * Accurate to +/- 15 seconds per month * Water resistant to withstand day-to-day splashing, rain, etc.

100 METRE RESISTANT

W-100 (left RRP £22.95 **£19.95**. Black resin case/strap otherwise same specification as W-150 below.

W-200 (right) RRP £19.95 **£17.95**. Black resin case/strap. Displays hours, minutes and date; seconds or day.
Alarm, hourly chimes and 1/10 second stopwatch

NEW

STANDARD CASES (SPLASH RESISTANT)

F-81/F82 (left) RRP £12.95 **£10.95**. Black resin case/strap

A-851 (right) RRP £16.95 **£14.95**. Stainless steel jacket and bracelet

Displays hours, minutes and date; seconds or day. Alarm, hourly chimes and 1/10 second stopwatch

W-150. (left) RRP £27.95 **£24.95**. Stainless steel case/bracelet.

W-150C (right) RRP £24.95 **£21.95**. Stainless steel case/resin strap.

Time and auto calendar. Alarm hourly chimes, countdown alarm timer with repeat memory function, professional 1/100 sec and stopwatch. Time is always on display, regardless of display mode

THESE SPACE INVADERS WILL ALARM YOU

Casio's most amazing watches ever

CA-90 (left) RRP £22.95 **£19.95**. Black resin case/strap.

CA-901 (right) RRP £34.95 **£29.95**. Chrome plated case, S/S bracelet.

Time and auto calendar, calculator, alarm, hourly chimes, stopwatch, dual time, DIGITAL SPACE INVADER GAME

50 METRE WATER RESISTANT

W-51 (left) RRP £25.95 **£22.95**. All S/S specification as W-150.

LW-5. RRP £10.95 **£895**. Resin case and strap. Colours as available.
Three display modes hours and minutes; month and date; seconds display. 7 year battery life.

NEW

LADIES MODELS (shown full size)

NEW

LM-3 (left) RRP £16.95 **£14.95**. Resin case and strap. Colours as available.
Ladies melody alarm chronograph. Time and calendar, 3 selectable alarm melodies, hourly chimes, professional stopwatch.

AN-8GL (right) RRP £27.95 **£24.95**. Gold plated case. Leather strap.

Gentleman's slim dress watch. LCD/analog display of hours and minutes. Sweep second hand or radial seconds. No other functions.

NEW

CLAIRVOYANT CALCULATOR

Fortune Teller, Matchmaker, Calendar and Alarm Clock

FT-7

RRP £18.95
ONLY £16.95

Predictions of individual fortunes (Health, Gambling/Investment, Business and Love) or the compatibility between two persons on any given day.
Hourly time signals. 5/16 x 2½ x 4¼ inches. Wallet.

BQ-1100 BIOLATOR

Alarm Clock Calculator

Calendar, two alarms, countdown alarm, stopwatch, time memory, three date memories, date and **BIORHYTHM CALCULATIONS.**
¼ x 2-7/16 x 4⅜"

RRP £18.95 £16.95

MQ 1200 MELODY.

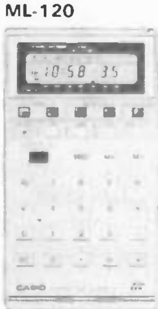
Alarm Clock Calculator.

RRP £22.95. £19.95

12 Melodies, 2 alarms, date memories, anniversary memories, calendar, night light.
1-9/16 x 6 x 2¾ inches. 7 ounces.

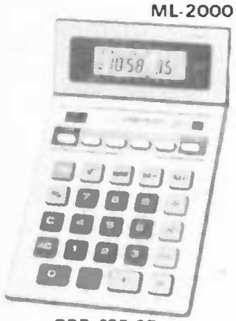
MELODY ALARM CLOCK CALCULATORS

ML-120



RRP £16.95.
£14.95

ML-2000



RRP £25.95
£22.95

12 melodies, 2 alarms, date memories, anniversary memories, calendar, stopwatch.
ML-120: 7/32 x 2½ x 4½". Wallet.
ML-2000: Office. 1¾ x 4 x 6¼".

ML-75: Card version of above. £14.95.

BANKING AND FINANCE
BF-100 RRP £16.95. ONLY £14.95.

SYMPHONIC ALARM CLOCK

MA-1
£9.95

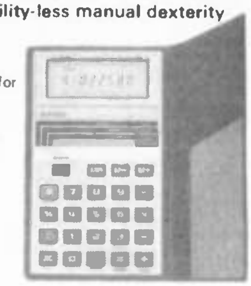
Mozart No. 40 or Buzzer.
Hourly chimes.
Snooze facility
1¾ x 4½ x 3in.

NEW

INTELLECTUAL SPACE INVADERS

More mental agility-less manual dexterity

MG-885



Three missile buttons for three level attack. 8 arcs of fire make "aiming off" essential.

Basic calculator with full memory and %

RRP £12.95
ONLY £10.95

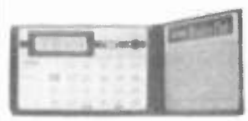
MG-880 DIGITAL INVADERS

Our best selling calculator last Christmas.

MG-880

RRP £12.95 £10.95

MG-770 Card Size



RRP £14.95. £12.95

Quick reactions and fast fingerwork are called for.
Basic calculator with full memory and %

UC-365 MELODY

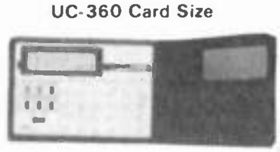
Alarm Clock Calculator.

RRP £21.95
ONLY £19.95

Three melodies, universal calendar, date memories, 2 date alarms, daily alarm, countdown alarm/stopwatch, time memory.
¼ x 4½ x 2½. 2.2ozs. Wallet.

MELODY ALARM CLOCK CALCULATORS

UC-360 Card Size



RRP £21.95 £19.95.

UC-3000

RRP £30.95
£27.95

Specifications as UC-365 above.

UC-360 7/32 x 3⅜ x 2⅜". 1.8ozs. Wallet.
UC-3000. Office. 1¾ x 4 x 6¼".

GENERAL SPECIFICATIONS

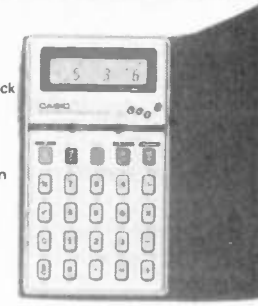
All casio calculators listed have liquid crystal displays for long battery life and a (minimum) 8 digits, with floating decimal point.
Alarm clock calculators all have a one year battery life, pre-programmed automatic calendar adjustment* and hourly time signals. (*Except FX-6100).

NEW

INSTANT MUSICIAN!

Electronic Musical Instrument and Calculator

VL-80

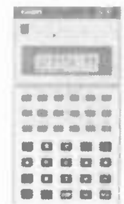


Records and plays back notes as a melody.
ONE KEY PLAY
AUTO PLAY
Manual play
Melody demonstration
Vibrato effect
8.5 x 68 x 118.5mm

Price/delivery on application.

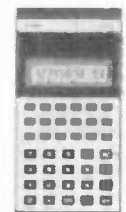
SCIENTIFICS at discount prices.

FX-81



£12.95

FX-100



£16.95

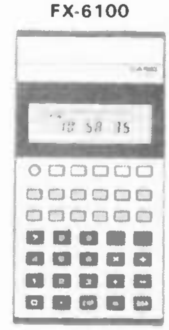
FX-550

£19.95

FX-81 8 digits, 30 scientific functions. 2x AA batteries last 4,000 hours. ¾ x 3 x 5⅞"
FX-100. 10d, 44 sc.f, otherwise as FX-81
FX-550. 50 sc.f. 1,300 hour lithium battery. 5/16 x 2⅞ x 5¼". Wallet.

WITH CLOCK AND ALARM

FX-6100



£14.95

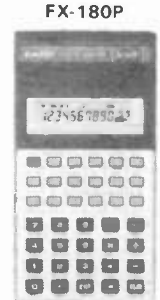
FX-8100

£24.95

FX-6100. 8d, 39 sc.f, clock with hourly time signals, alarm, countdown alarm timer, 1/100 second stopwatch. 2 x AA batteries last 1 year. ¾ x 3 x 5⅞".
FX-8100. Similar to above but 49 sc.f, auto calendar, additional timer alarm and powered by 2 silver oxide batteries. ¼ x 2¾ x 5⅛". Wallet.

LOW COST PROGRAMMABLES

FX-180P



£19.95

FX-3600

£22.95

FX-180P. 10d, 55 sc. f, including Integrals and **REGRESSIONAL ANALYSIS.** Up to 38 program steps and 2 programs; One independent memory, 6 constant memories; all non-volatile. 2 x AA batteries give 7,000 hours use. ¾ x 3 x 5⅞".
FX-3600P. Wallet version of above with hyperbolics and 1,300 hour lithium battery. 9/32 x 2⅞ x 5¼"

"BASIC" POCKET COMPUTER

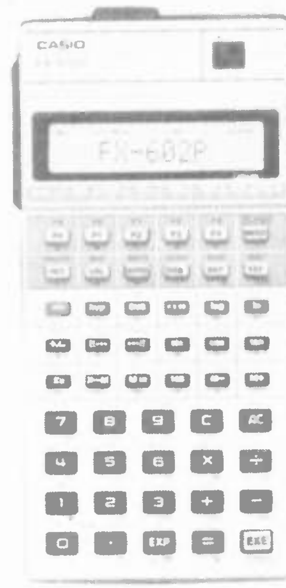
FX-702P

RRP £134.95
ONLY £119.95

LCD scrolling display of alpha/numeric (dot matrix) characters. Input can be varied from 1680 programme steps, with 26 independent memories, to 80 programme steps with 226 memories. (All retained when switched off). Up to 10 programmes can be stored (P0 to P9). Subroutine: Nested up to 10 levels. FOR NEXT looping: Nested up to 8 levels. Straightforward programme debugging by tracing. Editing by moving cursor. 55 built-in scientific and statistical functions, including regression analysis and correlation coefficient, can be incorporated in programmes. Programme/data storage on cassette tape via optional FA 2. Optional FP 10 mini printer available soon. Two lithium batteries give approx. 200 hours continuous operation, with battery saving Auto Power Off. Dimensions: 17 x 165 x 82mm (⅝ths x 6½ x 3¼"). Weight: 180g (6.3oz).

ADVANCED PROGRAMMABLE

FX-602P



- LCD alpha/numeric (dot matrix) scrolling display (86 types).
- Variable input capacity from 32 functional program steps with 88 independent memories, to 512 steps with 22 memories.
- Memory and program retention when switched off.
- Up to 10 pairs unconditional jumps (GOTO). Manual jump.
- Conditional jumps and count jumps. Indirect addressing.
- Up to 9 subroutines. Nesting possible up to 9 levels.
- 50 built-in scientific functions, all usable in programmes.
- PAM (Perfect Algebraic Method) with 33 brackets at 11 levels.
- Ultra high speed calculations.
- Program storage on cassette tape using optional FA-1.
- Compatible with FX-501/2P.
- 2 lithium batteries. Approx 660 hours continuous use.
- Battery saving Auto Power Off.
- Only 9.6 x 71 x 141.2mm. 100g.

Optional FP-10 printer available soon.

RRP £84.95 **ONLY £74.95**

HEUER

Official Timekeepers, 1980 Olympic Games

PROFESSIONAL STOPWATCH

ONLY £33.95

MICROSPLIT 1030

- 1/100 second timing up to 9 hours, 59 minutes, 59.99 seconds.
- Selectable lap or split timing.
- Quartz accuracy, certified 0.0004%.
- Water resistant case. (It floats!).
- Low battery warning indicator.
- Two year continuous battery life.
- Colour coded buttons, with precise clicking action for reassurance.
- Lightweight, shock resistant, easy-grip cases, with lanyard.

Other models available. Details on request.

CITIZEN Fast overtaking SEIKO as the world's largest manufacturer of high quality watches, with 28 million sold in 1980.

41-8510-51 Analog/Digital Alarm Cronograph

Analog time, with luminous hands. Digital second time, or calendar, with night time illumination. Professional 1/100 second stopwatch to 1 hour, then seconds to 24 hours. Alarm and hourly chimes. Countdown alarm timer, with repeater function. 100 METRE WATER RESISTANT S/S case, with crystal glass.

ONLY £87.50

Prices include VAT and P&P or carriage. Send cheques, Postal Orders or phone your ACCESS or B'CARD number to: **TEMPUS** The Beaumont Centre, 164-167 East Road, Cambridge CB1 1DB. Telephone 0223 312866

Tempus, 164-167 East Road, Cambridge CB1 1DB

Please supply ....

Name ....

Address ....

....

....

I enclose a cheque/P.O. for £ ....

or I wish to pay by Access/Barclaycard. My number is

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I saw your advertisement in ....

.... magazine.

Tempus, 164-167, East Road, Cambridge CB1 1DB

Please supply ....

Name ....

Address ....

....

....

I enclose a cheque/P.O. for £ ....

or I wish to pay by Access/Barclaycard. My number is

....

I saw your advertisement in ....

.... magazine.

Installing Blaupunkt Quick Fit 723 Loudspeakers

EARLIER THIS YEAR the installation of one of Blaupunkt's do-it-yourself car radio/cassette player kits was described under GG&K (see June '81 HE, pp 35-37).

We had experienced a few problems in mounting the loudspeakers provided with the kit, and managed to write off a door panel of a Ford Escort 1600 Sport in the process. You may recall we found that there was insufficient clearance between the speaker and the inner edge of the window winding handle. (Happy ending to this story: Rober Bosch, the UK company for Blaupunkt, covered the cost of a new panel.)

Ron Sherwood, Robert Bosch's UK product manager, suggested the use of model 723 flush-mounting speakers from the Blaupunkt Quick Fit range in place of those supplied with the kit. As promised in the June issue, we did try installing these.

Contents Of Kit

Each kit comprises:

- one 723 loudspeaker
- one self-locking threaded ring to secure loudspeaker from rear of panel
- one tool (attached to ring moulding) for use in tightening speaker in door panel hole
- two grommets

The loudspeaker has a cone diameter of about 3" (75 mm) and has a power rating of 15 W. Leads and plugs are supplied separately, according to individual requirements.

Installation

Listed on the back of the 723 pack are recommended dimensions for marking out the position of the loudspeaker on the door panels of a variety of popular makes of car, together with the recommended hole diameter for the speaker aperture. (It is only necessary to cut one 107 mm diameter hole in the panel: the speaker is clamped tightly in place by means of the threaded ring.)

We marked out our new Escort door panel according to the dimensions listed and found that, if we mounted the loudspeaker in the recommended position, its magnet would have become tangled with the window-winding mechanism.

Somewhat dismayed, HE's Editor contacted Ron Sherwood, who suggested that he should get in touch with Sound On Wheels, in Harrow, one of Blaupunkt's main outlets in the UK. A spokesman at Sound On Wheels said that the dimensions given on the back of the Quick Fit packs should be treated as a *guide only*. For Escorts, he said, it is necessary to remove some metal from the door panel to fit any model of loudspeaker. Sound On Wheels always advises its customers to *check first* before attempting an installation.

Now, when we installed a pair of Philips EN8751 loudspeakers in a Ford Escort (see report in this months' GG&K) we did find it necessary to cut metal away from the inside of the door. Providing that this is done (and it may not be necessary on other models of car) the installation of the 723s should present few problems.

Price Guide

Cost of each 723 Quick Fit pack (two are required for stereo) is £9.55.

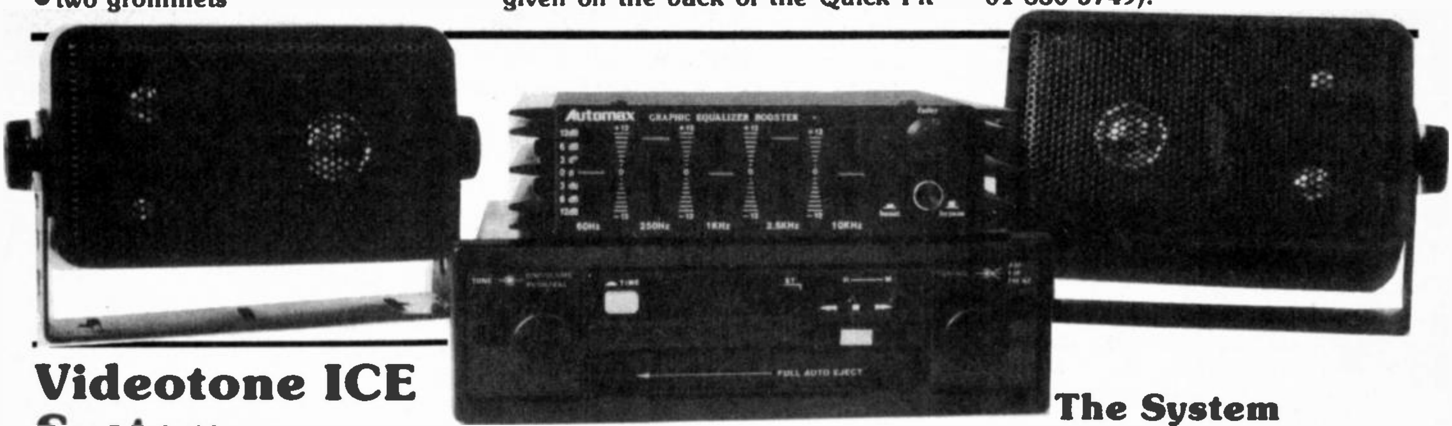
Leads, complete with plugs and sockets are priced as follows:

3'	60p
7½'	75p
15'	90p

Alternatively, you can buy a set of four (two long, two medium, two short) for £5.45.

All these prices are exclusive of VAT.

Sound On Wheels, 340 Pinner Road, North Harrow, Middlesex (tel 01 836 5749).



Videotone ICE System

OVER THE PAST few years the in-car entertainment (ICE) industry has grown to become a highly competitive and lucrative enterprise. Gone are the days when we were only too pleased to have a common-or-garden radio attached to an equally cheap loudspeaker, producing the kind of sound quality reminiscent of a radio broadcast of the early 50s.

The key to success is not only emphasised towards attaining a high quality in audio reproduction but the art of miniaturising components and systems is also playing its part as a front-runner on the technological battlefield.

Faced with a multitude of various makes and offsprings, the customer has the difficult task of selecting a suitable system.

To bring you a step closer in making your choice we have reviewed a complete ICE system comprising a stereo radio/cassette, pod-mounted speakers and a five-channel graphic equaliser/booster. All units are supplied by Videotone Ltd.

The System

The cassette player is a dash-mounting unit with AM/FM and MPX (multiplex) stereo radio. The radio covers frequency ranges of 535-1605 Hz AM and 88-108 MHz FM stereo. Additional features include digital frequency tuning, 24-hour time display and an end-of-tape eject system that also operates when DC power is removed from the player. The frequency display can be overridden by the time/frequency selector switch to obtain a constant time readout. The time-set switches are situated on the front panel for easy access.

The MS4015 is a three-speaker system (woofer, mid-range and tweeter) housed in a robust enclosure and protected by a metal grille. The rest of the hardware includes a pair of swivel brackets, speaker leads and screw fixings.

The graphic equaliser/booster controls five frequency allocations. These are: 60 Hz, 250 Hz, 1 kHz, 3k5 Hz, and 10 kHz, with a cut and boost of ±12 dB. Each slider has a click action throughout its travel. For the power-minded individual, the booster amplifier is claimed to deliver 30 W per channel into a 4 R load. Front and rear speaker connections are available at the back of the booster. If you decide to incorporate this unit, we recommend that you use this facility to get the best all-round performance. The complete system was installed in a Ford Cortina Mk 4.

On Test

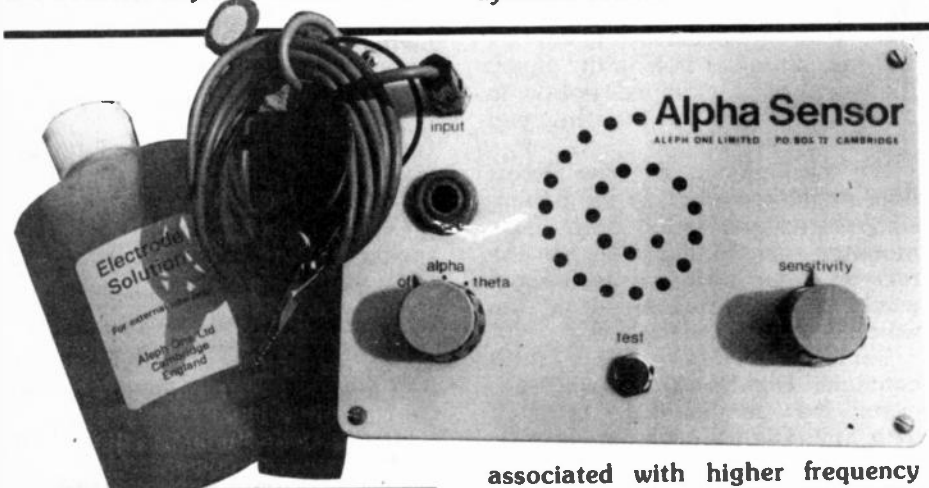
Listening to the speakers under test it was of no surprise to find, with speakers of this size, that bass response was limited and power handling capacity was lower compared with door-mounting types. However, they have the advantage of being easier to fit than door-mounted speakers, and, played within their limits, provide a clean dynamic sound.

The front speaker connection of the booster was wired to a pair of existing door-mounting speakers. The fader control was then used to adjust the balance between the front and rear speakers. Using the system in this way gave exceptional results of power output, clarity and tonal contrast.

Prices for the above units are:
Radio/cassette £79.95
Pod speakers £19.95 per pair
Equaliser/booster £24.95

All these prices include VAT but add £1.50 with your order to cover carriage.

Videotone Limited, 98 Crofton Park Road, London SE4 (tel 01 690 8511).



Brainwave Sensor

Aleph One produce a range of biofeedback equipment including a Myophone to monitor muscle activity, a Relaxometer which monitors skin resistance (skin resistance changes with stress) and the instrument they supplied me with for evaluation this month — the Alpha Sensor.

The Alpha Sensor is a battery operated device which signals when the user is producing alpha waves. Why would you want to know that you're making alpha waves? The brain produces minute electrical signals consisting of a number of rhythmically varying potentials. They are divided into four major groups according to frequency as follows:

FREQUENCY (Hz)	GROUP NAME
0.5-4	DELTA
4-8	THETA
8-13	ALPHA
13 and over	BETA

Although the relationship between brainwave patterns and personality is complex, it seems to be generally true to say that 'more highly structured mental activity is associated with higher frequency waves'.

Delta waves are found in sleep, beta waves in a state of alertness and alpha waves in a resting state — not asleep, but not active either.

Theta waves, associated with 'flashes of inspiration' or the state of mind of an experienced meditator are not normally found in adults, but can be produced by training.

Using The Alpha Sensor

The device is normally supplied in the UK with batteries already fitted. To check everything out, plug the electrodes into the test socket and touch them together. You should hear a continuous tone from the speaker behind the spiral grille.

The electrodes are small brass rings with sponge rubber inserts and Velcro backing, held against the head by a Velcro strap. One electrode is held above and just in front of the ear and the other slightly to the same side of the back of the head.

A bottle of saline solution is supplied to make good contact between the skin and the scalp. A clip has been sensibly attached to the electrode cable. When the electrodes are in place, it can be clipped to a collar or lapel to avoid awkward tugs or strains on the cable.

Plugging Yourself In

With the electrode cable connected to the input socket, there should be no signal from the unit when the user is sitting quietly with open eyes. Blink and the unit should bleep. It's picking up muscular electrical activity in the skin. At this point the sensitivity control is turned fully clockwise (most sensitive).

Now you can settle back, relax and close your eyes. If you can remain quiet but alert and free from distraction, you should soon hear the characteristic tone associated with alpha waves. With practice it should become easier to produce them and the sensitivity control can be turned down to decrease noise.

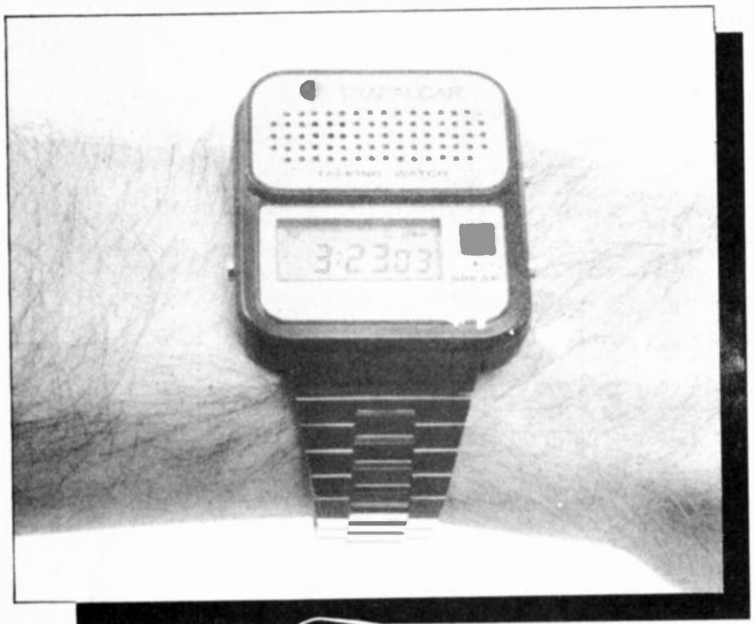
For this monitored trip into a trance-like state of relaxation you can expect to pay a staggering £188.60 including VAT and postage. As you can imagine, with that sort of price tag, the Alpha Sensor is not a toy. Alpha wave training has been used in the treatment of hyperactive children, of intractable pain and of epilepsy. It has also helped experimenters reach a suitable state of mind for ESP research or to promote suggestion under hypnosis.

Aleph One also issue a Biofeedback newsletter surveying books, articles, conferences and research in the field — subscription £1.50 per year (about four issues). In addition, Aleph One can supply books and cassette tapes covering a range of stress therapy for agoraphobics and those afraid of thunder, flying, interviews, etc.

For details of the Alpha Sensor and a range of biofeedback instruments (from £45) contact Aleph One Ltd, The Old Courthouse, High Street, Bottisham, Cambridge CB5 9BA. HE

● HE Reader Offer ● HE Reader Offer ● HE Reader Offer ●

TALKING Digital Watch



£59·95

TALKING Digital Watch

HERE'S YOUR CHANCE to own a watch that will:

- ★ announce the time at the touch of a button
- ★ announce the time on the hour
- ★ remind you, up to an hour, how much time you've used up on a parking meter
- ★ wake you up and give you two snooze periods

These are just a few of the functions provided by this exciting Talking Watch on special offer to HE readers for only **£59.95** (this price includes VAT, registered post and packing).

Just take a look at the specification given right for this *latest* model from the Trafalgar Watch Company

Announcements

- **Time of day,** at the press of a button (eg ''It's ten fifty-seven am'')
- **Selectable hourly time,** preceded by tone (eg ''It's eleven am'')
- **Alarm,** followed by melody (Anna Maqdaleua Bach Minuet)
- **Snooze,** followed by the melody 5 and 10 minutes after the alarm (eg ''Attention please, it's now seven thirty am. Please hurry!'')
- **Elapsed time,** in timer mode, every 5 minutes for one hour from the timer start. Elapsed time also announced at the press of a button

On Display

- **Normal mode:** hours, minutes, seconds, pm and day of the week. Alarm symbols are also displayed when alarm functions have been selected
- **Calendar:** when the 'speak' button is pressed the day, date and month are displayed simultaneously with the announcement of time of the day
- **Timer:** hours, minutes and seconds are displayed for periods up to 9 hours, 59 minutes, 59 seconds. Elapsed time is announced every 5 minutes during the first hour and when a button is pressed during the total period
- **Alarm:** selected alarm time can be displayed
- **Setting:** time, date and alarm displays can be set sequentially at the press of a button

The HE Talking Watch is finished with golden panels set in a black resin case, and comes complete with adjustable stainless steel bracelet. Each watch carries a 12-month guarantee.

Use the coupon supplied, and place an order today for this technological masterpiece of horology.

To: HE Talking Watch Offer, Argus Specialist Publications Limited, 145 Charing Cross Road, London WC2H 0EE

Please send me . . . . Talking Watch(es) at £59.95 each. (Price includes VAT, registered post and packing)

I enclose a cheque made payable to Argus Specialist Publications Limited for £ . . . .

or

I wish to pay by Barclaycard/Access. Please charge to my account number

BARCLAYCARD VISA . . . .

Signature . . . .

Name . . . .
(BLOCK CAPITALS)

Address . . . .
(BLOCK CAPITALS)

. . . .

Please note that the offer applies to the UK mainland only. Allow 28 days for delivery.

BUILDING SITE

In the last of the present series, HE's Master Builder, Keith Brindley, tells you how to hold your printed circuits down. He also discusses a topic of great concern in the electronics world — Murphy's Law.

FASTENING PRINTED CIRCUIT boards (PCBs) down, into a project case, can be a pain — and anything to ease this is welcome. The obvious way of doing it is with bolts, nuts and washers: a bolt at each corner. This way is shown in Fig. 1. But what happens if you haven't got room on the PCB to drill the necessary holes or, more to the point, what happens when you can't be bothered?

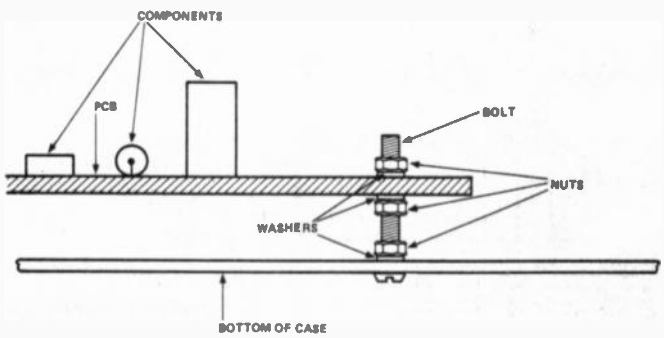


Figure 1. A method of fixing a PCB to a project case, using nuts, washers and bolts

The way the HE Project Team mounts PCBs, in most of HE projects, is with double-sided adhesive pads. The application of a pad on each corner of the underside of a PCB (as Fig. 2 shows) allows the board to be firmly held to the bottom of the project case. Once the board has been positioned, of course, it becomes impossible to remove it without damaging the adhesive pads — so all soldered connections to the copper board should be done, (and a check made to see if the circuit is working correctly) before fixing the PCB down. A good tip, regarding connections, is to insert and solder circuit board pins wherever off-board connections are to be made to the PCB: in this way off-board connections can still be made — but to the top (ie, component side) of the PCB and *after* fixing it down.

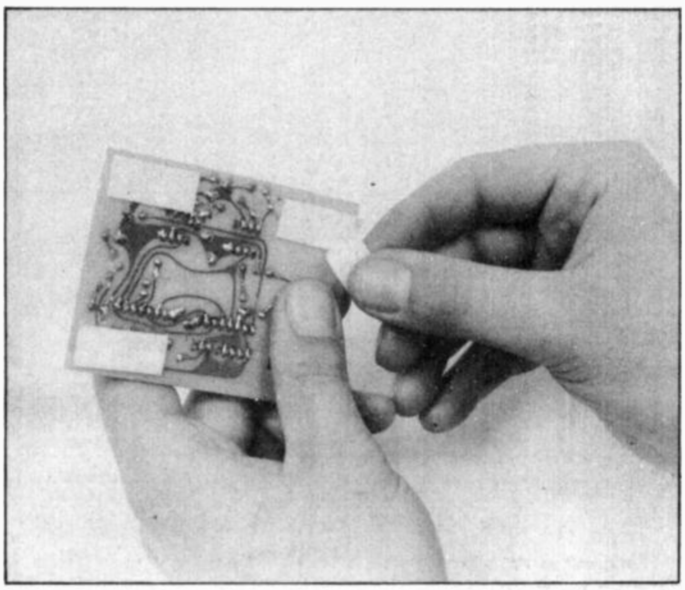


Figure 2. Using double-sided adhesive pads to hold down a PCB

Incidentally, the use of a double-sided adhesive pad allows a very convenient way of fastening down a battery in a project too (see Fig. 3).

Another simple way of mounting your PCB is on plastic guide-rails, as shown in Fig. 4. The plastic extrusion has a PCB-sized slot on one of its sides and a length of adhesive pad on the other. The idea is to mount guide-rails on the inside front and rear panels (or side panels) of the project and then to slide the PCB into the slot produced between the two rails.

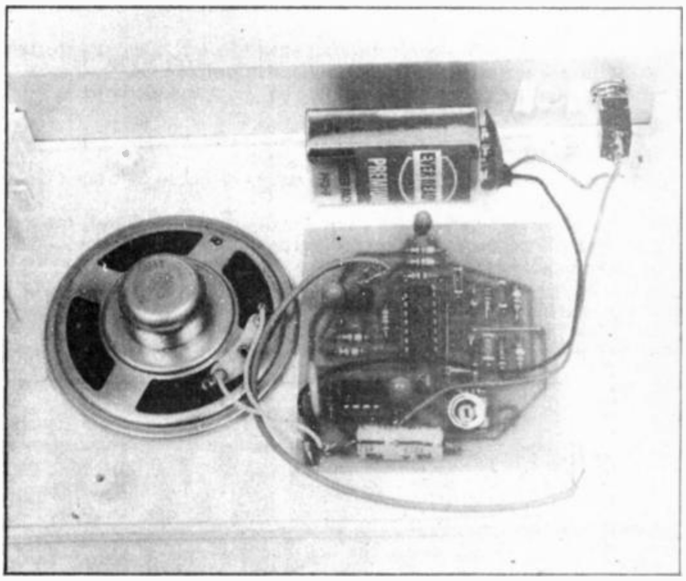


Figure 3. Double-sided adhesive pads are ideal for holding batteries in position

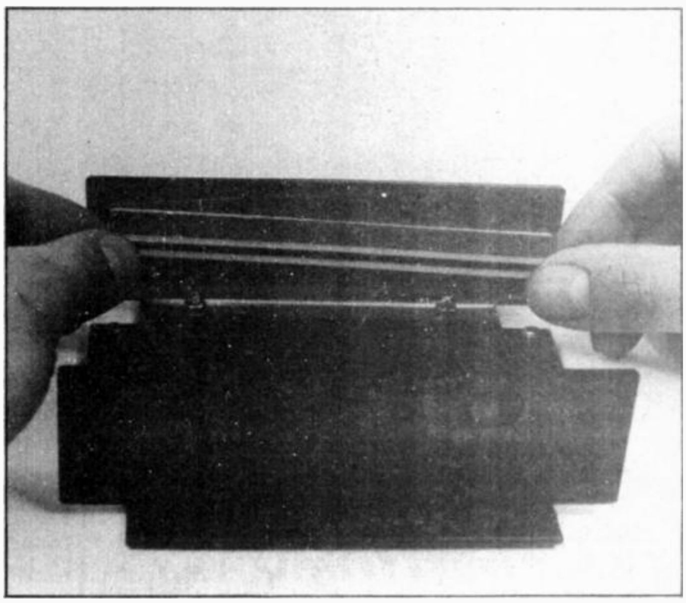


Figure 4. PCB guide-rails make an easy method of positioning and holding circuit boards

And Now For Something...

Finally, throughout this series I have occasionally referred to that well known law of inanimate object behaviour: Murphy's Law.

Now, it has come to my attention recently that some of our readers *do not believe that Murphy's Law is a true law!* To allay their doubts and prove its existence, reproduced below is an abridged version of Murphy's Law (taken from Murphy's own book: The Understanding Of Inanimate Objects). Although the Law has been stated simply as, 'If anything can go wrong, it will', a more detailed and much broader analysis of the Law is obviously beneficial to anyone involved in the study of electronics.

This version of Murphy's Law is grouped into five of the most common problem areas in electronics, but it should be realised that other areas do exist, and the Law is not specific to electronics alone:

General Electronics

I.1 A patent application will be preceded by one week, by a similar application made by an independent worker.
I.2 The more irrelevant a design change appears, the further its influence will extend.
I.3 Firmness of delivery dates is inversely proportional to the tightness of the schedule.
I.4 Dimensions will always be expressed in the least usable term. Velocity, for example, will be expressed in furlongs per fortnight.
I.5 Original drawings will be mangled by the copying machine.

Mathematics

II.1 In any given miscalculation, the error will never be traced if more than one person is involved.
II.2 Any error that can creep in, will. Furthermore, it will be in the direction that will do the most damage to the calculation.
II.3 All constants will be variables.
II.4 In any given computation, the figure that is most obviously correct will be the source of error.
II.5 A decimal will always be misplaced.
II.6 In a complex calculation, one factor from the numerator will always move into the denominator.

Project Construction

III.1 Any wire cut to length will be too short.
III.2 If a project requires n components, there will be n-1 components in stock.
III.3 A dropped tool will land where it can do the most damage. (Also known as the Law Of Selective Gravitation.)
III.4 A device selected at random from a group having 99% reliability, will be a member of the 1% group.
III.5 The probability of a component value being incorrect or omitted from a circuit diagram, is directly proportional to its importance.
III.6 Interchangeable parts won't.
III.7 A DC meter will be used on an overly sensitive range, and will be wired in backwards.

Equipment Servicing

IV.1 A fail-safe circuit will destroy others.
IV.2 A transistor protected by a fast-acting fuse will protect the fuse by blowing first.
IV.3 A crystal oscillator will oscillate at the wrong frequency — if it oscillates at all.
IV.4 A PNP transistor will be an NPN.
IV.5 After the last of 32 mounting screws has been removed from an access cover, it will be discovered that the wrong access cover has been removed.
IV.6 After an instrument has been re-assembled, extra components will be found on the bench.

Specifying

V.1 Specified environmental conditions will always be exceeded.
V.2 Any safety factor set as a result of practical experience will be exceeded.
V.3 In an instrument or device characterised by a number of plus-or-minus errors, the total error will be the sum of all errors adding in the same direction.
V.4 In any given estimate, cost of equipment will exceed the estimate by a factor of three.
V.6 In specifications, Murphy's law supersedes Ohm's Law. HE

Competition Results

RIGHT BACK in the April '81 issue of HE we announced our Project Design Competition for the IYDP. The original closing date was 31st July 1981 but, because the initial response was disappointing, we extended it to 1st September 1981 in the July '81 issue.

We've had dozens of entries and they covered a broad range of topics. For this reason we engaged the services of some people working closely with, or for, disabled people.

Our panel of judges comprised, in alphabetical order:

Simon Browning	Project Engineer, Notting Dale Technology Centre, London W10
Judy Denziloe	Development Officer, ACTIVE
John Flack	Principal, Electraid
Roger Jefcoate	Consultant Assessor and lecturer on electronic aids for the severely disabled
Patrick Poon	Research Assistant, Department of Electrical and Electronic Engineering, University of London
Heather Seaman	Paediatric Occupational Therapist, Cheyne Centre for Spastic Children

The Winners

★**First Prize** — **a cheque for £200** — went to **Anthony Nash**, of Kings Heath, Birmingham. Anthony's entry comprised two projects, both designed with the aim of helping the blind and partially sighted learn about electronics.

The first was a **Resistance/ Capacitance Indicator**, which will produce pulses of different rates as electronic or passive components are placed between two terminals. The circuit is simple and practical, and Anthony estimated its cost at about £2.50.

His second project, an **Audio Multimeter**, would enable a blind or partially sighted person to make measurements of electrical units. The position of the needle of a moving-coil meter is 'tracked down' by means of an optical sensor mounted above the meter scale. When the needle and sensor coincide (the sensor can be moved by the user), an audible warning is given and the value can be read from an adjacent scale written in Braille. To prolong the life of the battery, Anthony included a timer which turns off the meter and sensor circuits after a predetermined period. We considered that the project could be built for a reasonable cost.

According to Anthony, the aim of the two projects was to assist blind and partially sighted children in tackling electronics as part of their technology lessons. He became involved in the work as one sector of a B Ed in-service degree course at the NCST. Although the work was aimed at children in schools, Anthony envisaged the finished projects as also being suitable for use by adults.

● The First Prize was donated by Brian Brooks of **Magenta Electronics**, Burton-on-Trent, Staffs. Magenta is one of HE's regular advertisers — *see page 30 in this month's issue*

★**Second Prize** — **a Kikusui 538A Oscilloscope** — went to **R.Fairweather** of Oxted, Surrey. By coincidence, his entry was also dedicated to the blind, and was described as a **Braille Teaching Aid.**

R.Fairweather outlined a common way of teaching blind pupils to read Braille, in which they are given a board on which there are six tins, each labelled with a Braille character. The pupils are also given a pile of cards on which a Braille character is printed. The object is for the pupil to find the tin with the character that corresponds with that on a chosen card and to put the card into it.

His project works along similar lines: the pupil is given a pile of Braille cards, each with a unique code cut into its top edge, and the pupil inserts one of these cards against a slot on the equipment. The equipment also has a panel of six buttons over which is placed a master card of Braille characters. The object is for the pupil to feel the character on the card and then to feel down the master card until he or she finds what seems to be the same character. The pupil next presses the button alongside that character. A correct choice will result in one kind of noise being produced as the button is pressed: a wrong choice will result in another kind of noise. Right and wrong answers are recorded on individual digital scoreboards, thus enabling a teacher to monitor the pupil's progress.

Although the electronics is a little complicated for this project, our judges were unanimous about their decision over this entry. We understand that the project was designed as part of the A-level Design and Technology course. The prototype won a prize in the Schools Design Prize competition, run by the Design Council.

There were, as originally specified, three Third Prize winners. We had three digital multimeters as prizes, and they were awarded as follows:

★**Third Prize No. 1** — **Kaise SK-6110 Digital Multitester** — went to **C.J.Hart** of Wootton, Isle of Wight. His entry, **Distress Alarm System**, is intended to enable the elderly or disabled living on their own to call for help, or to have help summoned automatically in the event of an emergency.

This project includes some clever

AT LAST — the results of our Project Design Competition for the International Year of Disabled Persons (IYDP). You can read below about the winners and some details of the winning entries

1981

innovations. When help is needed, the user can activate an alarm situated in the house of a neighbour or warden or an alarm placed within earshot of passers-by. The alarm is triggered by pressing one of several push-buttons sited at strategic positions around the house. Alternatively the alarm will be automatically activated if the equipment has not been reset by the user within a set period from the outset of a warning signal sounded within the house. This warning signal will sound every hour or so. For ease of use, the same push-buttons double to set off the alarm if the warning signal has not been sounding and to reset the equipment if it has been sounding.

To avoid the necessity for the user to switch off the equipment during the night, for an afternoon snooze or for short trips out for shopping the equipment includes a timer which can be set for an extended 'off' period (2 or 10 hours on the prototype). After this period the system returns to 1 hour cycles.

C.J.Hart estimated that the cost of the project, excluding case, would be about £10.

★Third Prize No. 2 — Kaise SK-6220 Digital Multitester —

went to **A. Trafford**, aged 14, of Milton Common, Oxford, His project, **Temperature Alarm**, is intended for use by an elderly person living alone and who might be in danger of suffering from hyperthermia (body temperature greatly above normal) or hypothermia (body temperature below normal) as a result of the room temperature being extremely hot or extremely cold.

His design was very simple — only 10 components are used. The circuit uses a thermistor as the temperature-sensing device, and this is placed close to the person at risk. When either condition occurs (the two extremes of temperature can be pre-set) a constant audio warning is given. The project also gives a visual indication that the room is not safe for occupation.

A.Trafford estimated the cost of his project at around £5.

★Third Prize No. 3 — ICD Digital Multimeter 600D —

went to **Brian Davey** of Millom, Cumbria. The title of his project was **Lifeline.** To illustrate its simplicity of construction and operation a sample was attached to his entry form.

This project, like that from C.J.Hart, is intended for use by the elderly or disabled living alone. He envisaged that most house-bound elderly or disabled people tend to follow set patterns of activities in the house and will generally move along the same routes (such as favourite chair to kitchen, toilet, bathroom, and so on). If the person should fall over at any point on this route then they might be out of reach of any means of calling for help. Brian's Lifeline consists simply of two parallel lengths of uninsulated wire carried between two strips of flimsy paper. This 'tape' is pinned within easy reach throughout the house.

The idea is that the two wires are attached to a low-voltage alarm circuit (such as a door bell). In an emergency the elderly or disabled person simply reaches for the nearest length of tape, tears it apart and twists the two wires together. Thus by short-circuiting the wires in this way the alarm circuit is completed.

Definitely a simple — and low-cost — system. Our judges were a little worried about the flimsiness of the material and, of course, the need for the voltage on the wires to be absolutely safe but otherwise thought it to be very clever.

The general standard of entries was so good that we decided to award *two* consolation prizes!

★Consolation Prize No. 1 — Grand Prix hand-held computer car racing game —

went to **A.Trafford** (second time lucky in this competition!) for an ingenious **Radio Alarm.**

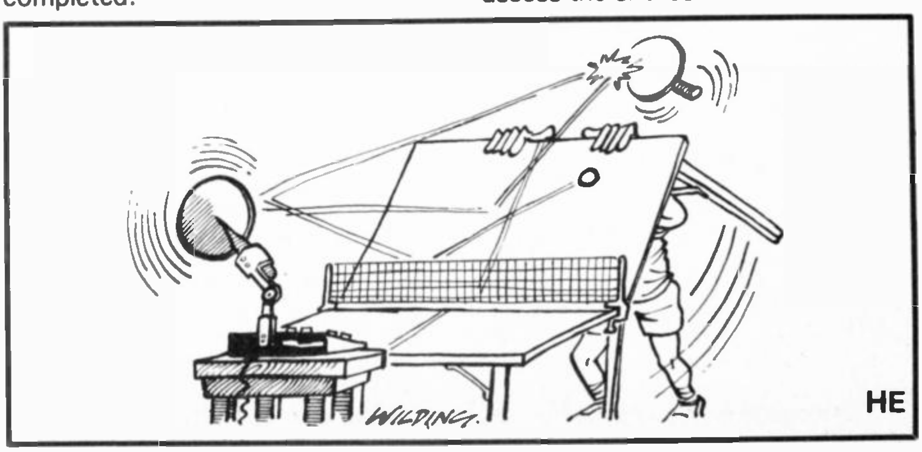
★Consolation Prize No. 2 — Galaxy Invader 1000 hand-held space battle game —

went to John L.Wigley, of Bourne End, Buckinghamshire, for his **Low-cost Communicator** for the disabled.

● The Third Prizes were donated by **West Hyde Developments Limited,** Aylesbury, Buckinghamshire and by **Danesbury Marketing Limited,** Welwyn Garden City, Hertfordshire. Consolation Prizes were donated by **Computer Games Limited,** Woodford, London.

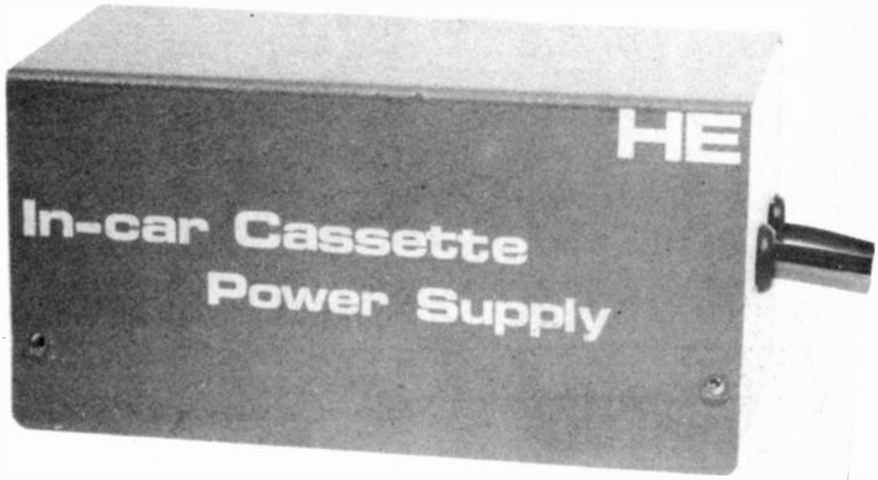
Our thanks to all who took part in our Competition — we will be in touch with all who took the trouble to enter.

Thanks also to our panel of judges, who gave up their time to assess the entries from the finalists.



HE

In-car Cassette Power Supply



If you have portable battery-powered equipment and you use it in or around the car, then this project is ideal. It will provide up to 1 A of current at a voltage variable between 5 and 12 VDC

YES, WE KNOW that strictly speaking, this project doesn't *just* supply power to portable cassette recorders for in-car use — but we thought that 'HE In-car Battery-powered Equipment Power Supply' would be too much of a mouthful — so we shortened the title.

The project will, of course, provide power for equipment which has an input socket for a low voltage power supply between 5 and 12 V. With it you will be able to run portable radios, cassette recorders, some TVs etc, from your car electrical system thus saving yourself the expense of dry-cell batteries.

The circuit is a single integrated circuit design and, with just four extra components, provides you with a working project. The IC, a 7805 voltage regulator, is well known to most electronics hobbyists and is ideally suited to this application.

Construction

Insert and solder the preset resistor RV1, resistor R1, and capacitors C1 and 2 into their correct places as indicated in Fig. 2. Make sure you polarise capacitor C2 as shown.

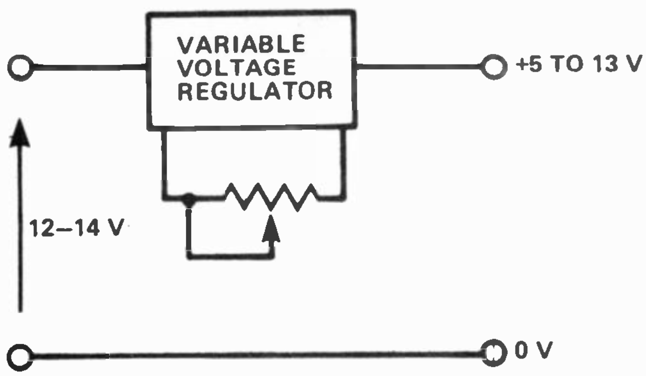
Push circuit board pins into the board where off-board connections are to be made. Now solder the pins in.

Mount and solder IC1 into the board so that it is perpendicular to the Veroboard surface.

Mark and drill the case to fit the mounting bolt for IC1. Using a mounting kit (ie, a mica washer and an insulating washer) bolt the IC and thus the whole board to the case side. It is essential that the metal case of the project is isolated from the metal tag of IC1, so it is as well to check with a meter that no electrical contact occurs between the two.

How It Works

A car's electrical system provides about 12-14 VDC, depending on engine (and hence generator) running speed. This is applied to a variable voltage regulator, the output voltage of which is adjustable between about 5-13 VDC, depending on the value of variable resistance R.



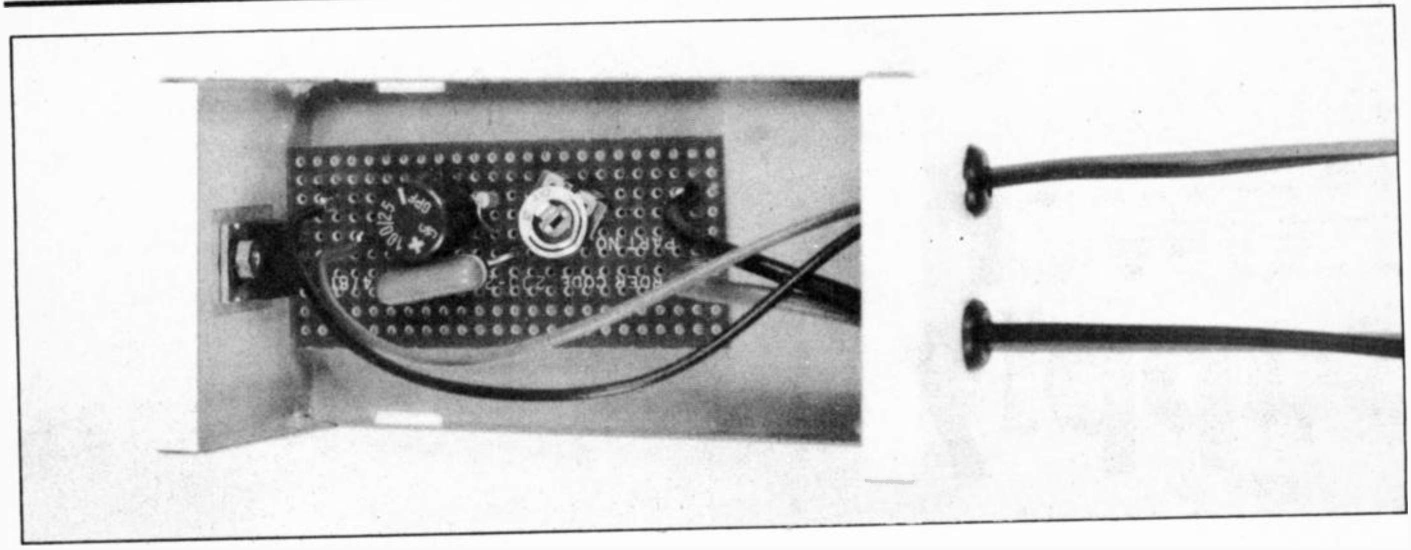
Integrated circuit IC1 is a fixed-voltage regulator which develops and holds the output voltage at 5 VDC. A typical circuit using the IC would have its common connection directly connected to the earth rail (0 V). The IC's output, in such a circuit, is at a voltage of exactly 5 V above earth. However in our circuit, a preset resistor RV1 is connected between the common connection and earth.

A small current (about 1.5mA) continuously flows from the common connection of the IC to earth. Inserting RV1 into the current flow causes a voltage across the resistance, given by Ohm's Law:

$$V = IR,$$

dependent on the value of R. With a preset resistor value of 4k7 the voltage is variable between 0-8 V.

The output voltage of the power supply is thus 5-13 VDC depending on the value of RV1.



Parts List

RESISTOR (¼ W, 5%)
R1 15k

POTENTIOMETER
RV1 4k7 miniature horizontal preset

CAPACITORS
C1 220n polyester
C2 100u, 16 V electrolytic

EMICONDUCTOR
:1 7805, 5 V voltage regulator

ISCELLANEOUS
eroboard, 10 strip x 24 hole
ase to suit

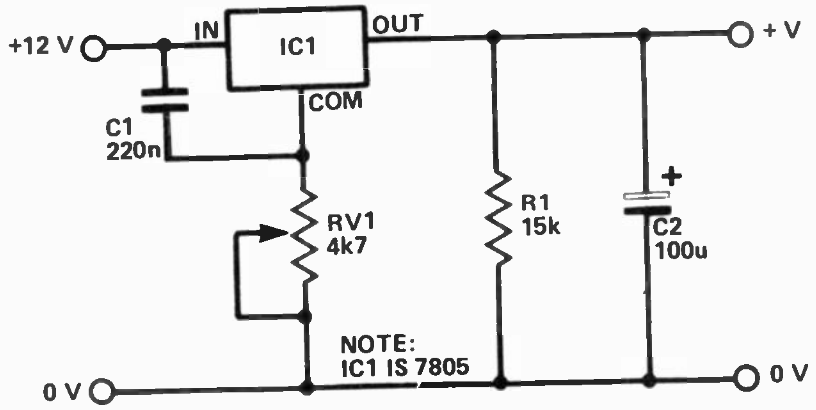
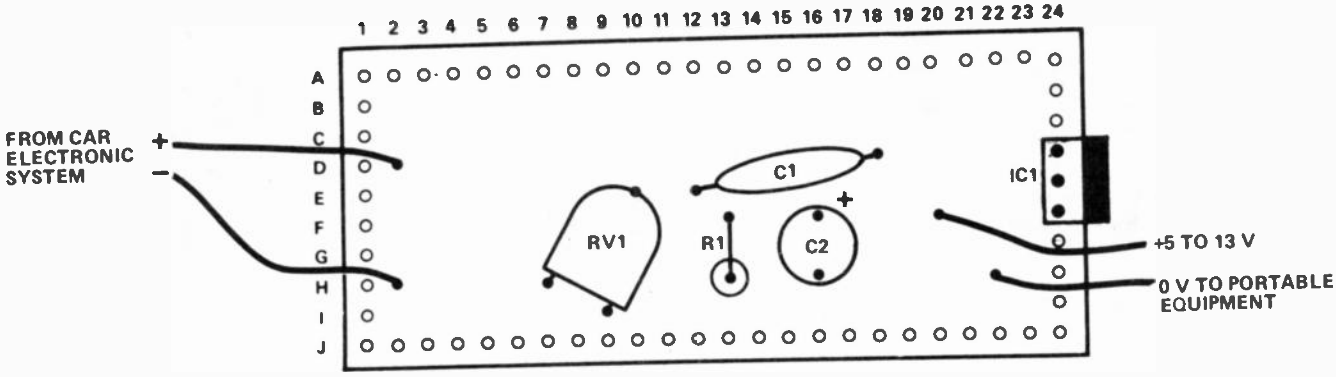


Figure 1. Circuit of the HE In-car Cassette Power Supply



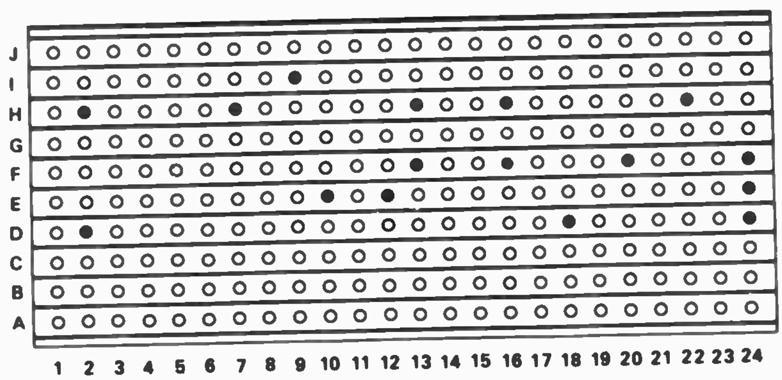


Figure 2. Veroboard layout, showing component locations along with connection details of the project. Note that there are no track breaks to make

Buylines

All of the components used in this project should be readily obtainable. Approximate price of parts (excluding case) will be £2.50.

HE

Into Electronic Components

Part five of our series for those starting out in electronics. This month, Ian Sinclair investigates inductors, tackles transformers and touches on tuned circuits

IF YOU COULD THINK of a capacitor as a well-engineered open circuit you could be excused for thinking of an inductor as an equally well-engineered short circuit. An inductor starts off life as a piece of wire, having a low electrical resistance.

Now when any piece of wire carries an electrical current, the space around the wire changes. There's nothing unusual about this, and you can't see the effect, but you can detect it with a compass-needle, as a Dane called Oersted did in the early years of the 19th Century. The space around a wire which is carrying current is, in fact, magnetised, and magnetised in a way that we can't achieve with any shape of permanent magnet (see magnetic 'lines of force' shown arrowed in Fig.1).

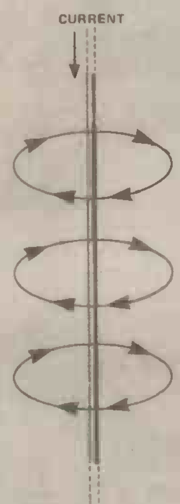


Figure 1. Magnetism around a wire when current flows. The arrowheads show the direction that a compass needle will indicate at various places around the wire

The magnetism is pretty weak, though, unless a very large amount of current flows, because the effect is spread over all the space around the wire. If we wind the wire into a coil, we greatly concentrate the magnetism, and also incidentally, create the same shape of magnetism as a bar magnet (Fig.2).

Why should we be concerned with this? There are several reasons, and one of the important ones is that we can use the magnetism to deflect the beams of cathode rays in a cathode ray tube (something visualised by A.A. Campbell-Swinton in 1911 — see *Famous Names* on page 25). One of the other reasons is one that Michael Faraday ran across in the 1830s — the generation of a voltage from changing magnetism.

Go On, Induce Yourself

When you move a magnet near a coil of wire which has been connected to a voltmeter, you can detect a voltage in the coil for as long as the magnet is moving nearby. Try it out for yourself — take a transformer of almost any kind, as long as it has a metal core and lots of turns.

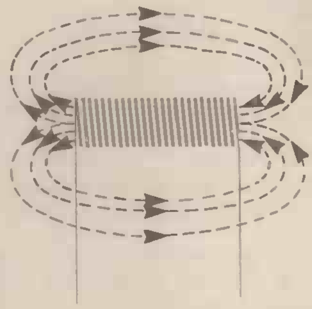


Figure 2. Shape of the magnetism when a wire is wound into a coil and current passes. This is the same shape as we would detect from a bar-shaped permanent magnet

Connect the meter to the primary terminals of the transformer (the ones which would be normally connected to mains voltage) as shown in Fig.3. Switch the HE Meter to the 250mV (0.25 V) range, and wave a magnet (not too fast) close to the transformer ironwork. You'll see the needle of the meter deflecting in one direction as you bring one end of the magnet to the transformer, and in the other direction as you take the magnet away. That's the effect that Faraday discovered and called 'electromagnetic induction' all those years ago. He also found out what the rules of this induction were — the voltage generated in the coil of wire depends on the number of turns of wire, and the rate at which the magnetism around the coil is changed.

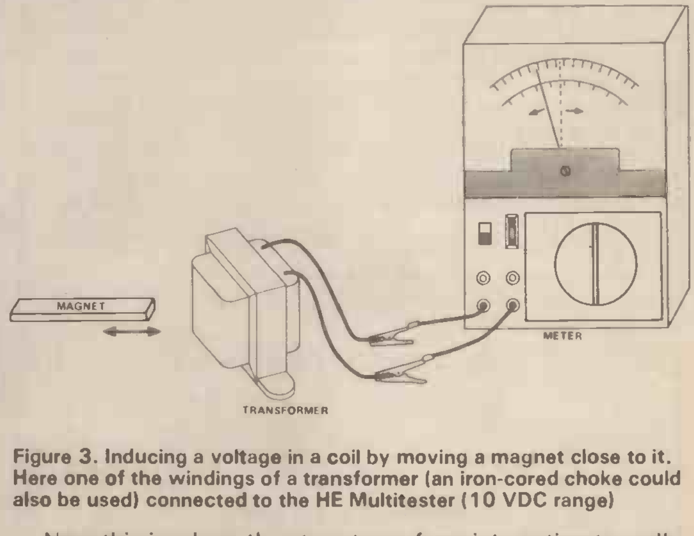


Figure 3. Inducing a voltage in a coil by moving a magnet close to it. Here one of the windings of a transformer (an iron-cored choke could also be used) connected to the HE Multitester (10 VDC range)

Now this is where the story turns from interesting to really curious. When Faraday did this experiment, he was using the magnetism of a bar magnet, separate from the coil. What happens if the magnet *is the coil itself*, magnetised by the current passing through it?

The answers to this one were investigated by the great US physicist Joseph Henry. He found that exactly the same rules apply — if you change the amount of current flowing through a coil, then the changing magnetism causes an induced voltage, and that voltage is in the opposite direction to the voltage you used to change the current! This induced voltage is called a 'back EMF', and its effects are very important, and not only in electronics.

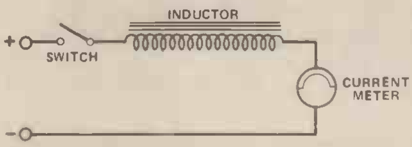


Figure 4. A circuit which shows how you can measure the slow build-up of a current in a coil, if you can get hold of a coil which has a very large inductance

Take a look, for example, at **Fig.4**, which shows a circuit with a meter and a large coil. You probably can't do this one, because the coil has to be a really large one — something like 15 000 turns of wire round a massive iron core — to produce a really noticeable effect, but you can try it if you have a large old-fashioned 'choke' in the junk box. What happens is rather like the reverse of charging a capacitor — the current starts off at a low value, and builds up to the value that Ohm's law predicts; that is, V/R. Unlike the capacitor charging and discharging, too, the effect is not improved by adding resistance — the less resistance there is the greater the time-constant of the effect (see **Fig.5**).

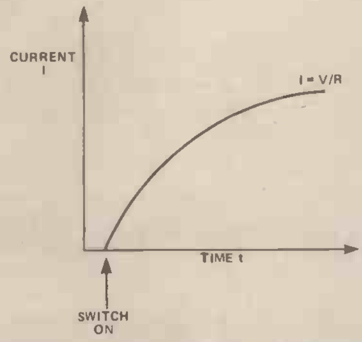


Figure 5. How the current in the circuit in Fig.4 changes after switching on

The back EMF exists only while the current is changing, and when the circuit containing the inductor is switched on, the rate at which the current can change is determined by the inductor itself. Back EMF is also generated when the circuit is switched off, however. When we switch off a circuit that contains an inductor, the current is forced to change rapidly — down to zero. From Faraday's rules, this should cause a large back EMF — it can easily be much greater then the voltage of the battery which pushed the current through the coil, but only for an instant as the current is switched off. A favourite demonstration of this is illustrated in **Fig.6**. It consists of a neon lamp connected across the winding of a transformer or choke, with a switch and a power supply of low voltage. The neon needs at least 80 V to flash, but the battery in the example is only 6 V. When the switch is closed, the current flows, rising at a rate determined by the coil until it reaches maximum, but when the switch is suddenly opened, the neon flashes, indicating that 80 V or more was generated across the coil when the current was interrupted.

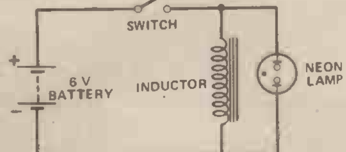


Figure 6. Back EMF can be larger than battery voltage! This circuit flashes the 80 V neon each time the switch is opened, even though the battery voltage can be 6 V or less

This effect has all sorts of consequences — one of which is the traditional type of car ignition circuit (**Fig.7**). The contact points remain closed for a time (the dwell time) to allow current to build up in the coil. At the ignition time, the points are rapidly opened, causing a back EMF which is stepped up by the transformer action of the double-wound coil. The back EMF across the contact points is enough to cause sparking, which causes a slower rate of change of current, so that the back EMF is lower than it need be. This is corrected by connecting a capacitor across the points to absorb the sudden voltage surge, suppressing the sparking to some extent, and enabling a much higher voltage to be produced across the high voltage winding of the coil.

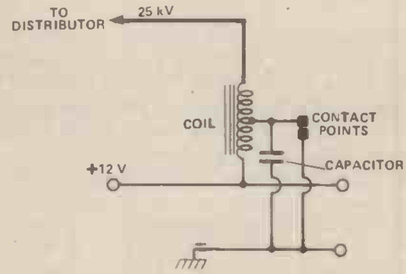


Figure 7. The traditional type of car ignition circuit. The back EMF that is generated when the contact points open is stepped up to 25 000 V (25 kV) by the coil (acting as an autotransformer, described in this article)

Back EMF also affects us in other ways. If a transistor is part of a circuit which contains an inductor (**Fig.8**), then we have to add a diode circuit which will conduct when the back EMF is generated. In the circuit shown, when the transistor switches off, the back EMF is always positive, and will exceed the collector voltage rating of the transistor if not checked. It is checked by the diode, which conducts when the voltage at the collector of the transistor rises higher than the supply voltage. Any circuit which uses a transistor to control current in a coil with a metal core (such as a relay or solenoid) must use a diode like this (a 1N4001 is a favourite type) to prevent damage from back-EMF.

Do I have to remind you, too, that you can get a shock from a 6 V electric bell? Each time the bell sounds, the current through a coil is being switched on and off, and the back EMF can be high enough to be noticeable if you put your hand on the coil connections.

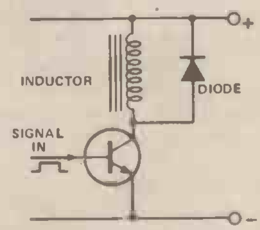


Figure 8. Protecting a transistor against back EMF from a coil

Henry's Contribution

Joseph Henry's work with back EMF produced a new unit for electrical theory, the one which bears his name. He found that the back EMF of a coil was proportional to two sets of factors — the rate of current and the way the coil was made. To avoid the cumbersome calculations which made use of coil length and diameter and the type of core used, he proposed using a single quantity, which he called self-inductance, to replace all these factors, just as we use the capacitance of capacitors rather than the area and thickness of the insulator and its permittivity.

Henry's definition is a simple one:

$$\text{Self-inductance} = \frac{\text{back EMF}}{\text{rate of change of current.}}$$

A self-inductance of 1 Henry (abbreviated to 1 H), for example, will produce a back EMF of 1 V if the current through it changes by 1 A per second, which is pretty slow switching. If you had a current of 1 A flowing, and you managed to switch it off in one millisecond (1/1000 second), then the back EMF in a 1 H coil would be 1000 V. The back EMF, you will notice, is decided entirely by the self-inductance and by the rate at which current can be changed, not by the actual value of the current or by the voltage which is used to make that current flow.

An inductance of 1 H is a lot of inductance, though not by any means an impossible large quantity. Inductors as large as this are not used so much nowadays, but smaller inductors whose sizes are measured in millihenries (1 mH = 1/1000 H) or microhenries (1 uH = 1/1000000 H) are used to a considerable extent, especially in radio and TV circuits. The modern trend is to avoid inductance as much as possible, for reasons which include the following:

1. it is impossible to make a 'pure' inductor which has zero resistance. A 'pure' capacitor, by contrast, would have an infinitely high resistance, and we can get as near as makes no difference to this ideal
2. inductors are normally not off-the-shelf components like capacitors or resistors
3. the actual inductance of a coil which uses a metal core is very difficult to predict precisely, and can change during its operating life.

Core!

We started by saying that inductance was about magnetism, and you can't talk about magnetism without coming to magnetic materials. There are in fact, two main types of magnetic materials, called hard and soft. Hard magnetic materials are the ones we make magnets from, and we're not considering them here. The soft magnetic materials ('soft' has nothing to do with how the material feels — it can be as hard as nails) are the ones which will magnetise very strongly when we wrap a coil around them and pass a current through the coil but which lose this magnetism completely whenever the current is switched off. They concentrate the magnetism in a coil rather than retaining any magnetism of their own. When we take a coil, measure its self-inductance, and then add a soft iron core to the coil and measure the self-inductance again, there is a startling difference between the two readings. Adding a core of soft magnetic material to a coil can push its self-inductance up by a very large amount — thousands of times for some inductors. The trouble is that the effect, caused by a quantity called relative permeability, varies a lot, not just from one magnetic material to another, but also with the way the material is treated. Hit the core with a hammer, heat it, magnetise it — all these things will change its permeability so that when we use it as a core, the self-inductance of the coils will also be changed. There is also a limit to the amount of magnetisation the core can take; that is, it reaches a state called saturation. When the material becomes saturated the self-inductance of the coil will suddenly drop when a large amount of current is passed through it.

The design of large value inductors which are intended to behave in a predictable way is not easy, and that's one reason for wanting to do without them. It was the main reason for welcoming the transformerless push-pull output stage in audio amplifiers, for example, because it eliminated the need for a very expensive transformer which was also very difficult to design.

Equally difficult problems arise when coils are used at radio frequencies. An AC signal applied to, or induced in, a coil will magnetise the core, and the magnetism will be alternating, like the signal. This changing magnetism needs a supply of energy which has to come from the signal, and the higher the frequency of the signal the faster the magnetism has to change, and the greater the energy needed to sustain it. Massive metal cores are out as far as radio signals are concerned, and the only method we can use to concentrate the magnetism is to use 'ferrite', an insulating material which also happens to be a soft magnetic material. Coils for frequencies ranging up to about 100 MHz can use these ferrites to some advantage, so long as the correct grade of ferrite is used for the frequency range. At high frequencies, the amount of signal energy that is wasted in any type of magnetic core makes the use of cores impossible, and air-cored coils are used instead. At the *very* high frequencies (for example, UHF television frequencies) not even a coil is used — a straight wire provides sufficient inductance.

Transform Your Life

One very useful inductive component, the transformer, is made by winding two coils on to one core. The principle is simple enough — an alternating current through one coil, which we call the primary, causes alternating magnetism of the core. Because of the concentrating effect of the core, this will cause an alternating voltage to be induced in the other coil, the secondary. The effect is that an alternating supply connected to the primary coil causes an alternating voltage at the secondary, but with no wires connecting the circuits. The connection is made through the magnetism of the core, nothing else. Because of this, we can use transformers to couple signals between points which are at very different DC voltages (see **Fig.9**) or when a pulse from a low-voltage DC circuit has to operate an AC circuit (**Fig.10**).

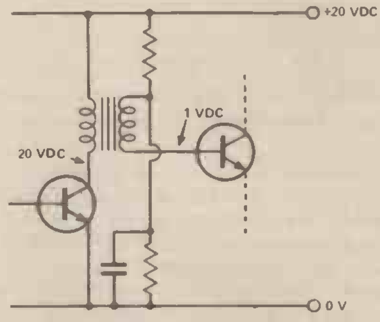


Figure 9. Using a transformer to connect signal from the collector of one transistor at 20 VDC to the base of another transistor at 1 VDC

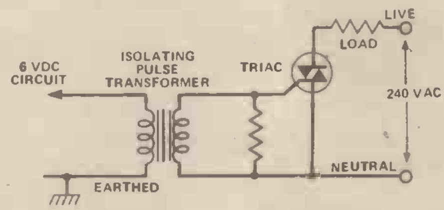


Figure 10. Using a transformer to send a pulse from a low-voltage circuit which is earthed to a high-voltage AC circuit with no earth connection

Transformer theory provides a beautifully simple law for the ratios of the voltages of the windings. If the number of turns on the secondary winding is N_s, and the number of turns on the primary winding is N_p, the voltage on the primary winding (AC, remember) is V_p, and the voltage on the secondary winding is V_s, then for a perfect transformer:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}.$$

Let's look at an example. Suppose we have a transformer with 4800 turns of primary winding and 240 turns of secondary winding. If we connect 240 V mains to the primary winding, what voltage do we get at the secondary? Using the equation

$$\frac{V_s}{V_p} = \frac{N_s}{N_p},$$

with

$$V_p = 240,$$

$$N_p = 4800,$$

$$N_s = 240,$$

gives:

$$\frac{V_s}{240} = \frac{240}{4800}.$$

This quantity is equal to 1/20, so that

$$V_s/240 = 1/20,$$

and that makes V_s equal to 12 V.

If you don't like having to rearrange equations like this, the transformer equation is shown in all of its possible forms in

Table 1, so that you can use whichever one you need.

The equation applies to 'perfect' transformers, and real transformers are never perfect. If the core is of a reasonable size for the frequency being used (low frequencies need large cores), the equation gives results that are close enough for most purposes, with a tolerance better than 20%.

$V_s = \frac{V_p \times N_s}{N_p}$	V_p AC voltage, primary
$V_p = \frac{V_s \times N_p}{N_s}$	V_s AC voltage, secondary
$N_s = \frac{V_s \times N_p}{V_p}$	N_p number of turns, primary
$N_p = \frac{V_p \times N_s}{V_s}$	N_s number of turns, secondary

Table 1. Equations you can use to calculate transformer primary and secondary voltage and primary and secondary turns

As far as steady DC is concerned, the winding of a transformer is just a low resistance, and a steady DC current in the primary of a transformer has no effect on the secondary. There will be a pulse, however, when the DC is connected and disconnected, as we can show, using almost any transformer along with a 9 V battery and the HE Multitester (**Fig.11**). This principle is used to signal instants when DC is switched on and off in circuits, and is also the basis of the use of pulse transformers.

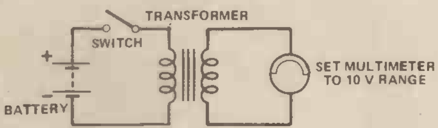


Figure 11. How to show the effect of a voltage pulse when the switch is opened or closed

Transformers that are intended for use only with high frequency signals can be much smaller than mains or audio frequency transformers. Radio frequency transformers can use ferrite or air cores, and the coils do not need to be wound tightly together. The transformer law still holds even at the very high frequencies but it's more difficult to predict exactly how the transformer will behave when the 'turns' are simply strips of metal of different lengths, as they are in TV tuners.

One notable variant on the normal two-winding transformer is the autotransformer. This has just one winding. The autotransformer behaves like a two-winding transformer with one end of each winding connected together (**Fig.12**) and is easy to wind when what is needed is straightforward transformer action without any sort of isolation between circuits. A mains autotransformer, the VARIAC, which has a variable tapping, like a potentiometer, is used extensively for providing different supply voltages for test purposes.

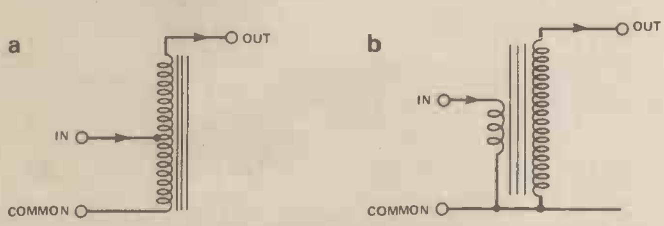


Figure 12. The autotransformer: a) circuit symbol, b) equivalent circuit, using two windings

Tune-in To L-C

One of the really important uses of inductors is where an inductor is connected to a capacitor. This type of circuit is called a tuned circuit, because of the way that it behaves when it is fed with signals of different frequencies, and it is the key to understanding all types of radio circuits from the humble tranny to the CB rig, from telly to satellite station.

We noted last time the odd behaviour of a capacitor when it is supplied with an AC voltage. A capacitor has a 'reactance' which is a large amount of ohms when the frequency of the AC is low, and a small amount of ohms when the frequency of the AC is high. There is an AC current flowing which is out of step with the AC voltage.

When we connect an inductor of any size into an AC circuit, there is also an AC current flowing for as long as there is an AC voltage across the inductor. The ratio of these two is also a reactance — the inductive reactance. Unlike the capacitive reactance, the inductive reactance *increases* for signals at higher frequencies though, so that high frequency signals cannot pass easily through an inductor. The current is out of step with the voltage, but in the opposite direction (see **Fig.13**). The voltage across a capacitor is at its peak a quarter of a wave later than the current peak, but the voltage across an inductor is at its peak a quarter of a wave earlier than the current peak.

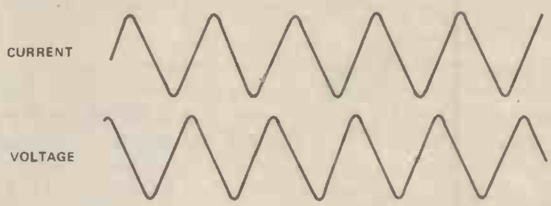


Figure 13. AC voltages and currents associated with an inductor. The current and voltage waveforms are out of step, but the voltage is one ¼-cycle ahead of the current in this case

By themselves, these out-of-step currents and voltages may not seem very important to you, but put together they start to look interesting. Consider what happens, for instance, when there is a capacitor connected to an inductor in series (**Fig.14**), with a signal connected across the pair. If the signal frequency is low, the reactance of the capacitor is high but the reactance of the inductor is low. If we make the signal frequency high, then the reactance of the capacitor will be low and the reactance of the inductor will be high. Somewhere between these two frequencies there will be a frequency at which the two reactances are exactly equal — and that's the frequency we're interested in. You see, when we have a signal current at that frequency flowing through both the capacitor and the inductor, as it must when they are connected in series, the voltages across these components exactly oppose each other and cancel each other. One voltage is quarter of a wave ahead of current, one is a quarter wave behind, so that the difference between the voltages is half a wave — and for a sine wave shape that means opposition (**Fig.15**). We would expect the voltages across points XY in **Fig.14** to be the sum of these two voltages — and we would expect from **Fig.15** that the sum would be zero.

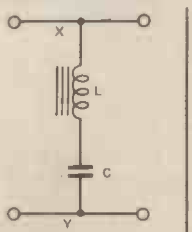
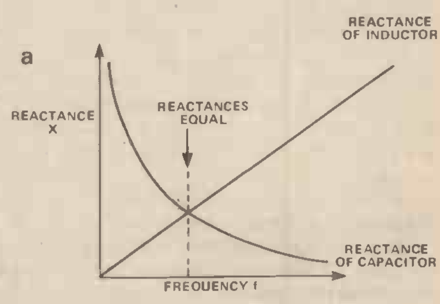


Figure 14. A series tuned circuit



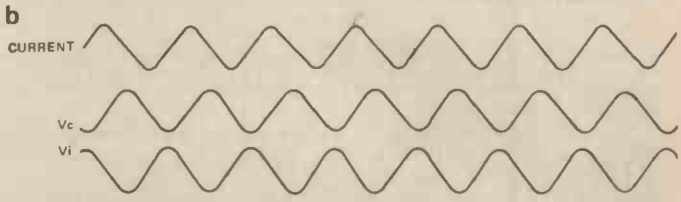


Figure 15. Reactance, voltage and current: a) how reactances of a coil and of a capacitor vary as the frequency of the signal is varied, b) voltage and current waveforms for a coil and capacitor in series at the resonant frequency of signal

It isn't quite zero. The reason is that every inductor has an inherent resistance along its length, and this resistance will have a voltage across it even when the other voltages have cancelled out. Nevertheless, at this one frequency, we have the strange effect that the current through the circuit reaches a maximum, with a low voltage across the circuit (Fig.16).

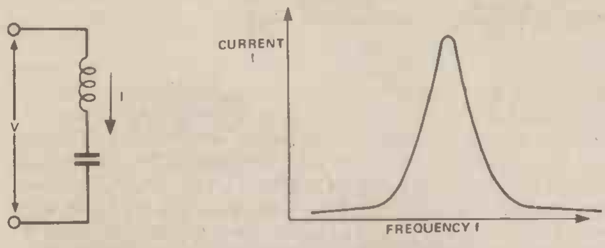


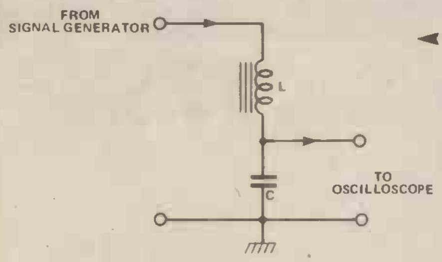
Figure 16. Resonance — this occurs at the frequency at which the reactances are equal and the current through the circuit reaches a maximum level

Stranger things happen (even without vodka!) when we measure the voltage across one of the components, capacitor or inductor. We can't do this with the HE Multitester, though, it's a job for an oscilloscope, like the one HE had on special offer a few months ago. Suppose our circuit has a capacitor and an inductor which each have a reactance of 1000 ohms (1k0) at a frequency of 10 000 Hz (10 kHz), with a resistance of 100 ohms (100R). If we connect the circuit to a 1 V supply, whose frequency is 10 kHz, then the current that flows is 1/100 A (1 V, 100R, Ohm again), which is 10 mA, because only the resistor has any effect on the current at this frequency where the reactances cancel. But if we measure the voltage across just one of the components (Fig.17), say the capacitor, then once again normal circuit laws apply and the AC voltage across the capacitor will be equal to the reactance of the capacitor multiplied by the amount of current flowing through it. But in our example, the reactance is 1k0 and the current is 10 mA, so that the voltage is

$$10 \times 1 = 10\ \text{V!}$$

Yes — it has amplified the AC voltage, changing a 1 V signal at this particular frequency into a 10 V signal. No, you're not getting something for nothing, for there is no extra power generated. The extra voltage you get across the capacitor (or across the inductor) is obtained at the expense of the current in the whole circuit, so if you take, or try to take, some current from the circuit, the voltage just collapses.

This is one type of tuned circuit in action, giving a voltage step-up at one selected frequency, the tuned (or resonant) frequency. We can use it in circuits like the one in Fig.18, which feeds the input of a field-effect transistor (FET) with signal at the tuned frequency of L and C.



◄ **Figure 17. How to measure the voltage across the capacitor in a series tuned circuit**

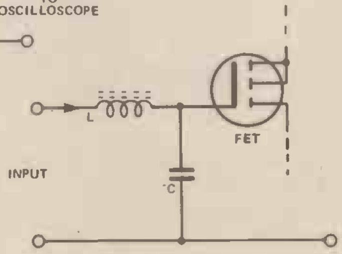


Figure 18. A circuit making use of series resonance to select a frequency to be amplified by an FET ►

There's another variation of this idea, the parallel tuned circuit, shown in Fig.19. This time, the inductor and the capacitor are connected in parallel and the behaviour is different. At most frequencies, the circuit has a low amount of total reactance, letting signal current pass fairly freely between points X and Y in Fig.19. At the tuned or resonant frequency however, the circuit behaves as if it had a large reactance, so that the signal voltage across it, assuming we keep the current constant, increases greatly. Table 2 shows the values of inductance required to resonate (series or parallel connected) with values of capacitance ranging from 10pF to 1uF, at various frequencies.

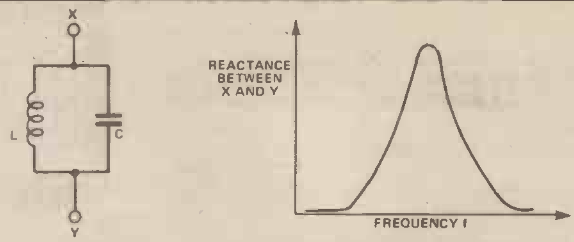


Figure 19. Parallel-tuned circuit. The reactance varies as the frequency of signal across the circuit is changed, and becomes a high value of resistance at the resonant frequency

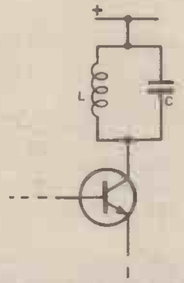


Figure 20. Using a parallel-resonant circuit as the load for a transistor, so that signals at the resonant frequency are amplified much more than signals at any other frequencies

Capacitance C	Frequency Hz 1k0	10k	100k	1M	10M	100M
1 uF	25 mH	250 uH	2.5 uH	—	—	—
0.1 uF	250 mH	2.5 mH	25 uH	—	—	—
10 nF	2.5 H	25 mH	250 uH	2.5 uH	—	—
1 nF	—	250 mH	2.5 mH	25 uH	0.25 uH	—
100 pF	—	—	25 mH	250 uH	2.5 uH	—
10 pF	—	—	250 mH	2.5 mH	25 uH	0.25 uH
Dash (—) means impossibly large or small value						

Table 2. Values of inductance to resonate with the capacitor values shown at various frequencies

A circuit like that shown in Fig. 19 is used as a load for a bipolar transistor (see Fig. 20) or an FET (Fig. 18). The idea is that the current signals through the transistor of FET flow through the LC circuit, and by Ohm's law give voltage signals — very small voltage signals when the frequency of the signals is not the resonant frequency. At the resonant frequency, the resistance of the LC circuit is much greater, and the voltage of the signal across it is much greater, so that the combination of transistor and tuned circuit selectively amplifies just one frequency. Once again, if we attempt to take much current (more than a few microamps) from the circuit, the selecting effect collapses — this is called damping. Figure 21 shows the effect of connecting resistors across the tuned circuit.

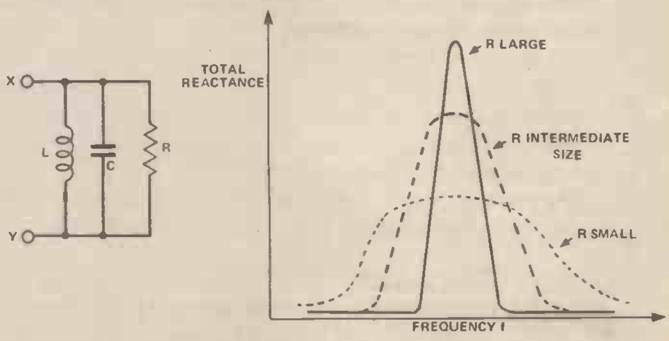


Figure 21. Effect of taking current from a resonant circuit. Adding resistance to take current causes the curve to flatten out. This is called 'damping'

Well, that rounds up inductors for this month. We haven't been able to do much practical work on these components, because the most interesting effects are high-frequency AC effects. But we'll be back in the practical business in a big way next month, when we start investigating diodes. **HE**

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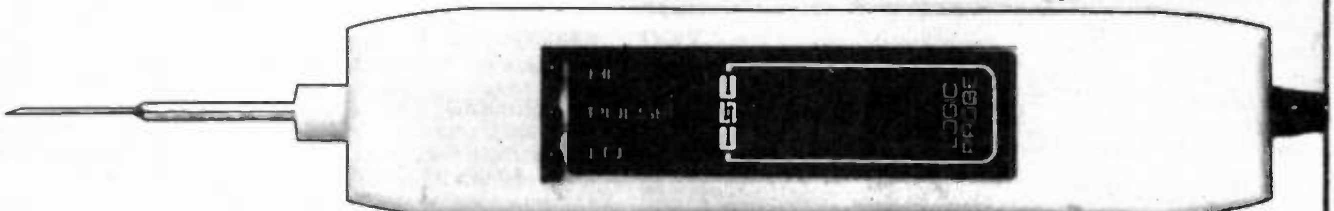

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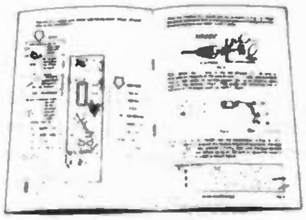

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Clever Dick

A bumper Clever Dick this month: topics range from oscilloscope tubes to obfuscation

I JUST HEARD the news: HE's Editor is leaving. Only thing is that he won't tell us where he's going. (I've heard rumours — and they're *only* rumours — that he's going to take over the post of Clever Dick. Mind you, I could do with a holiday.)

Enough of this chat and down to business. First reader has overcome the language barrier between two nations.

Dear CD,
!
Marios Theocharous
Ayios Dometios-Nicosia, Cyprus.

As mentioned last month, this business of the shortest letter that could still make sense started with the letter from Ben Chaston in the July '81 issue. Let's face it, 'I' is even used on international road signs — so Marios gets a binder.

K. Rawsthorne has been trying to track down some 'scope tubes.

Dear CD,
Your assistance is sought in the following quest.

I recently purchased a copy of "How to build your own solid state oscilloscope" by F.G. Rayer (from HE Book Service). Unfortunately, try as I might, I have been unable to find a supplier who stocks a suitable CRT.

Mr Rayer lists three types of tube in the book, they are: VCR139A, CV1588 and 3BP1. If you could locate a supplier of any of these types I would be eternally indebted.
K.Rawsthorne
Whiston, Merseyside.

First, I'd like to take this opportunity to say how sorry we were to hear of Frank Rayer's death. He became widely known and appreciated from the many technical books and articles he wrote over the years.

The three types of tube you mention are available from: RST Valve Mail Order Company, Climax House, 159 Fallsbrook Road, London SW16 6ED (tel 01 677 2424-7). A very helpful lady at RST said that the VCR139A is equivalent to the CV1588 and it costs £8 (excluding VAT). Cost of the 3BP1 is £10 (also excluding VAT). Add £1 carriage for each tube.

A query about the Stereo Power Meter (HE December '80, pp 59-61) next.

Dear CD,
I'm trying to build an LED stereo power meter. I've seen your circuit in HE Dec 80 using LM3915 IC. However, on receiving the RS Data sheet for this chip it also shows your power meter but one snag!! What if I don't want 100 watts full scale reading?

I want full scales of 10 watts and 30 watts. How can I achieve this using this chip, if it's possible? (Bearing in mind the 10 watts reading if for the car (12 VDC).)

Or is there somewhere to get a suitable circuit? I hope you can help. I'm getting desperate.
D.Conchie
Aldershot, Hants.

I woke up one of the HE Overpaid Technical Consultants (HEOTCs) to get an answer to this one. The LEDs in the published design light up at fixed points on a logarithmic scale. According to the published data on the LM3915, if you apply 1.2 V between pin 5 and ground you will get full-scale deflection; that is, all the LEDs will light up. So it is necessary to juggle with the values of Rx, Ry, R1 and R2 to obtain FSD at 10 W or at 30 W. With the correct resistor values for each FSD power reading, the readings will be subdivided as shown on the finished project (that is, 10 W, 5 W, 2.5 W, 1.3 W down to 0.02 W) but for 30 W full-scale the divisions will be more awkward (that is, 30 W, 15 W, 7.5 W, 3.9 W, 1.8 W down to 0.06 W).

P.M. Hitching's last letter was published under CD in the September '81 issue. It appears that Lascar's policy of not selling close-tolerance resistors independently of multimeter kits has changed.

Dear CD,
Not long ago I wrote to you in a state of "extreme desperation" enquiring about close tolerance resistors (0.25%). I am now back in my normal happy, relaxed state following the arrival of a letter from Lascar Electronics stating that they are now able to supply the 9M - 1k values I was seeking. Thus, a satisfactory solution to the seemingly insoluble problem, outlined in the letter published in your column of September '81, has been reached. If any other readers are interested in the above attenuator values (9M, 900k, 90k, 9k, 1k) Lascar Electronics can be contacted at Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex SS13 1LH or by telephone on 0268 727383.
P.M.Hitching
South Croydon, Surrey.

Can't see the wood for the trees in the next one.

Dear Clever Dick,
I binder am binder writing binder to binder inquire binder about binder the binder Geiger binder counter which binder binder was binder mentioned binder binder back in the binder mists of time. It was binder 'promised' binder binder as a binder project but binder never binder materialised. It binder struck me as binder a binder very interesting project binder and binder I wonder binder whether binder there are any binder plans to binder repeat it, i.e. binder actually have binder it in the binder magazine.
Yours subtly,
Edward Weeks
Godalming Surrey.

PS I think you're the Office Cat
PPS 2 million lemmings can't be wrong

No, the radiation level is so high in the HE office most cats don't survive very long here. (That goes for lemmings too.) And no, we don't have any immediate plans for a Geiger Counter project. Sorry, no Binders for Weeks.

Now a query about HE's Windscreen Wiper Controller (March '81 issue, pp 30-31).

Dear Sir,
I have just made the Windscreen Wiper Controller for my car (Morris 1000) and it works perfectly with just the ignition switch on, both single and group of sweeps.

But when the engine is on and the unit is on single wipe, the wiper blades slowly creep across the screen before and after *the single wipe is made. The relay is clicking a lot during all this.*

When on a group of sweeps, the relay is again clicking continuously and the wipers do not stop at all, until I turn the switch back to the single or off.

It does not work properly when I'm driving you see. Here are some more facts.

a) I measured 13½ upwards volts when engine is on or 12 V when ignition is on.

b) Supply voltage to unit is from the rear windscreen demister switch which runs on 12 V.

c) I used the 12 V Relay Flat 8 amp rating from Maplins, as stated in the magazine.

Any ideas of what is going wrong? Do I need a 12 V regulator? I'd be grateful for an answer.

Greg Costello
Hampstead NW3.

It sounds as if you need some decoupling on the supply to the project. (Translation: you need some interference suppression on the supply leads close to the point where they enter the Controller.) A suggestion is to connect a 1000 uF, 16 V electrolytic capacitor between the positive and negative supply terminals of the controller. (Don't forget to connect this capacitor the right way round; that is, with '+' end of the capacitor to the positive supply point.)

The next letter adds a lyrical flavour to Clever Dick.

Dear Clever Dick,
Good day to you my dear friend,
lend an ear which I may bend
By telling of my woeful tale
of circuits that like bread turn stale.
On purchasing your fine magazine,
there are projects that at first seem
so simple, but at later glance,
lead on to coma, alas a trance.
For components that are specified,
are sold by shops that long have died.
And substitutes, they don't exist,
however long I may persist.
So as I toil 'neath death's dark veil,
and stumble o'er the ones that fail,
may I emplore there be a list,
of substitutes that do exist.
For added to the component tally,
they at least would help me rally
the parts that hold out to the last
and make dud projects be the past.
A binding question I may add,
you see, I mention, this poor lad,
has no means of keeping clean
his collection of this magazine.
God bless you lad, may you remain
the man we know, so clever, sain,
and even though your brain's so fast,
you'll read this letter to the last.
Life's a bind.
Jason Pos
Newlands 7700, South Africa.

It didn't escape my reading, 'neath Argus Specialist Publications' dark veil, that you had a binding question. I think such epic verse deserves the means to keep your treasured collection clean — in short, *a binder!*

The HE Bench PSU (September '80, pp 63-65) cropped up next.

Dear Clever Dick,
In the September 1980 issue you give details for making a Bench PSU. Unfortunately it does not state what type of capacitor to use for C4. Also there is no provision made on the PCB Foil Pattern for C3.

As I am new to this hobby I am unable to relate the circuit diagram to the PCB to find out what these should be. I would be obliged if you could help me on this matter.

I would also be interested to know what case you used.

Thanks for a very interesting magazine.
P. Elstone
Guildford, Surrey.

Capacitor C4 is a 1u0, 16 V tantalum type. The holes for C3 should be sited somewhere along the '0 V' and 'SW2' printed tracks on the PCB.

The case we used for this project was a Bazelli Instrument Case B19, and it is available from Marshall's, Kingsgate House, Kingsgate Place, London NW6 4TA (tel 01 624 8582).

Dear Clever Dick
I bought 'How to Make Walkie-Talkies' recently. As I am only 12 I wondered if there are any kits available, because I find the book difficult to understand.
John Escott
Nr Beaminster, Dorset.

As far as I am aware, nobody is selling any of the designs in *How to Make Walkie-Talkies* (F.G. Rayer, £1.75 from HE Book Service) as kits. To comply with the Law, you need a licence to operate walkie-talkies, and this means a Radio Amateur's licence (you have to pass an examination to get one of these) or a Citizens' Band licence (have a look at the special report in Breaker One Four on page 69 for details of these).

Dear CD,
In the Low Power Pilot Light project (September '81) C1 should be moved down one hole from C8 to D8, and shouldn't the LED's anode go to E1 and its cathode to the 0 V line?

Also, the lead from SW1 to the circuit board of the Light, Water Alarm (September '81) should go to D24 not C24.

And in the Variable Bench Power Supply (August '81) R1 should go to the other side of the panel meter, and RV1/SW1 is not listed in the components list.

Now, isn't that worth a binder?
Fergus McDonald
Dublin, Eire.
PS I am 11 and I think HE is great.

We've definitely got an observant reader here. All your comments are correct, except that it doesn't matter which terminal of the panel meter that R1 is connected to. Pity, I've just used up a year's supply of binders in this issue. (Must be in a silly, irresponsible and over-generous mood again.)

This page wouldn't be complete without one of those horrible grovelling letters — and this one's no exception.

Dear CD,
I started reading HE four months ago but although I only started collecting this super mag recently my massive collection seems to be getting kicked about the floor because I've no place to put it (grovel, grovel, lick, lick, sob, sob).

Could you please tell me if, when you reverse the polarity on a loudspeaker, it acts as a microphone?
Andrew Megaughin
Kilmacolm, Scotland.
PS Since you are such a really clever person you may notice that I'm after a Binder (would a few more boot licks help — lick, lick, lick, lick?)

No, if you reverse the polarity of a loudspeaker it doesn't act as a microphone. It only grovels as a microphone if you connect it to the *input* of an amplifier instead of to the output. Usually, to lick this problem, it is necessary to make sure that the impedance of the loudspeaker matches that of the amplifier input. The simplest method of matching is to use a small output transformer with its high impedance winding coupled to the amplifier input and the low impedance winding coupled to the loudspeaker.

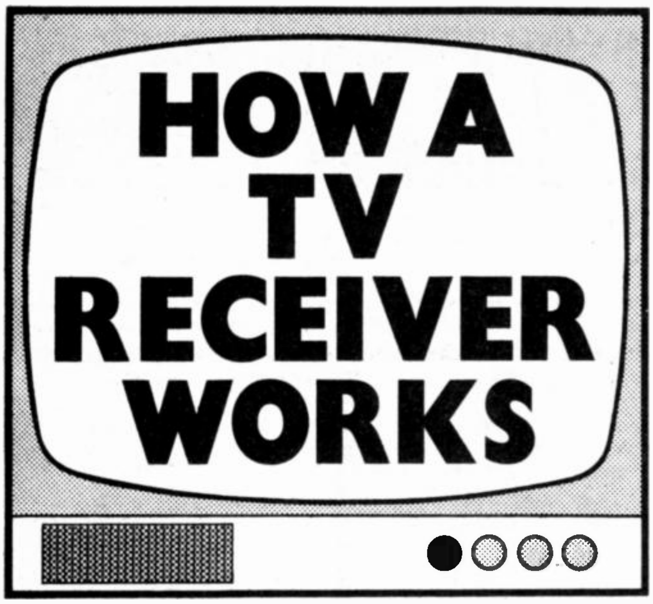
Thanks, by the way, to Joe Levine in Cape Town, South Africa, for sending us a copy of *Obfuscation* * *Made Easy — part 2*, from the Argus (Cape Town) 1 December 1980. Joe thought that some of the definitions given could describe some of the 'slobs' who may be 'working' in the HE office (see CD, HE August '81). Here are a few samples:

Active socially — Drinks like a fish
Family-oriented — Wife drinks, too
Willing to spend extra hours on the job — Wife nags him at home
Demonstrates qualities of leadership — has a loud voice
Keen sense of humour — Vast repertoire of dirty jokes.

And I'll wind it up on that note — look after yourselves. And watch out for any hot soldering iron tips.

*** Act of making topic obscure or confusing — Ed**

HE



HOW A TV RECEIVER WORKS

Hour after hour we watch that box (even described by one headmaster several years ago as a 'fool's lantern'). It's entertaining, it can be annoying but how does it work? Derek Jenkins explains, in simple terms, the operation of a black-and-white TV receiver

THIS IS THE AGE of electronics and one of the most common pieces of electronic equipment is most likely to sit in the corner of your living room — your TV set. Most of us have one of these boxes in our home, but just how does it work? In this article I will try to explain in a non-technical way some of the more important things that are happening inside your TV set.

To understand how a TV system works we must first know how a TV picture is produced on the screen. To explain this it is easiest to consider an example: Suppose we have a sheet of paper on which is drawn a black vertical column, and we wish to transfer this picture onto a second empty sheet of paper alongside it.

Proving It On Paper

Look at the two sheets shown in **Fig.1**. If we moved a pointer along the top sloping line AB on the first sheet it would cross over the white area, then over the black column and again over the white area until the end of the sheet was reached at B. Now

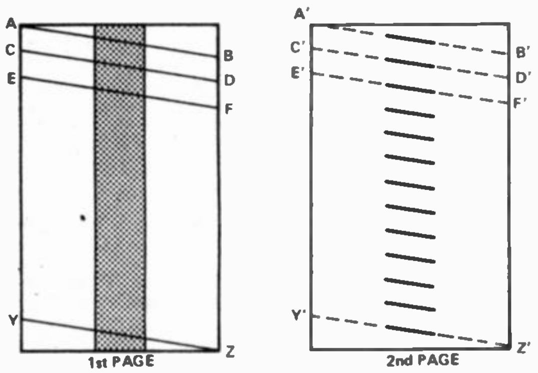


Figure 1. Transferring an image accurately from one sheet of paper to another. Light and dark areas on the first sheet are 'scanned' with a pointer and this information is transferred with a pen, line by line, to the second sheet. The pen must move in exact step with the pointer and only delivers ink to the page when the pointer is scanning dark areas. Complicated? A similar, electronic, process is used to transfer images viewed by a TV camera to the picture tube in your TV receiver

imagine that we held a pen on the second, empty, sheet of paper and we moved this pen to follow exactly the movement of the pointer. If we could also control the flow of ink through the pen nib so that it wrote only when the pointer was over a black part of the first sheet then as the pointer moved from A to B our pen would move along the line A' B' (shown dotted) but would only draw a line in the same position as the black column on the first sheet. Next imagine that we moved the pointer and the pen very rapidly to C and C' but this time did not let the pen write anything and then moved along the line CD, and so on. When the whole sheet had been scanned in this way we would have drawn a picture of the first sheet on the second sheet, this picture consisting of a series of almost horizontal lines. If we made these lines very much closer together than those on our two sheets in **Fig.1**, so that the picture on the second sheet was made up of hundreds of lines, it would be difficult to see individual lines. Thus we would see an almost exact copy of sheet 1. Also, if when the final line YZ had been drawn both the pointer and the pen were returned very quickly to A again, we would be ready to scan a second completely different page which we could then transmit onto another clean piece of paper.

The Real Thing

This is exactly what is happening in your TV receiver. The picture tube replaces the paper and a beam of minute electric particles (called electrons), which are made in the picture tube, replaces the pen. The flow of 'ink' is controlled by the number of electrons we allow to flow at any instant. The face of the TV tube (the part a viewer looks at) is coated with a material which glows when the electrons hit it: the more electrons there are the brighter the glow. This material is called the phosphor. If we made the electrons flow in a very thin beam and we swept this beam across the tube face in exactly the same way as we moved the pen over the paper in our example, and we controlled the strength of the electron beam as we did the ink in the pen, then we would show a picture on our TV tube which was a copy of sheet 1, only this time the picture tube would glow where before the pen wrote. In fact very many of the electronic components in your TV receiver are used to control the movement and strength of this electron beam pen.

If this process is repeated very rapidly then we can send many different pages in one second and in this way a moving picture, which consists of still pages shown in very rapid succession, can be seen. A modern UK television receiver does in fact produce 25 complete pictures every second and each picture is made up of 625 lines. (This is where the term 625-line system is derived.)

Let us now look a bit closer into how the picture tube and TV circuitry do all this.

Inside The TV Tube

Figure 2 shows a typical TV tube. At one end of the tube we see the cathode. This electrode, as it is called, gives off the minute electrical particles, the electrons, when it is made hot. Immediately behind the cathode are the heaters. These are thin wires which get very hot when we pass an electric current through them (they glow just like the bars of an electric fire) and they are used to heat the cathode and so make it give off electrons. Across the tube (from the cathode to just behind the screen) we apply a very large voltage (about 17 000 V!!). It is worth saying at this point that:

IT IS EXTREMELY DANGEROUS TO TOUCH A TV TUBE BECAUSE OF THIS VERY HIGH VOLTAGE WHICH REMAINS PRESENT EVEN AFTER THE SET IS TURNED OFF. THIS VOLTAGE IS SUFFICIENT TO KILL!*

Because the electrons are little particles of electricity they are attracted by this very high voltage (called the EHT or extra high tension) and so shoot out from the cathode inside the tube and hit the phosphor. It is the impact of the electrons on the phosphor that produces the glow from the screen. Thus electrical energy is converted into light energy at the phosphor coating. From the phosphor the electrons flow along a metal coating on the inside of the glass of the tube into the EHT connecting wire and back through this wire to the EHT supply and

*** We are referring here to the parts of the tube which are *inside* the TV receiver. *You should never attempt to remove the protective cover at the back of the receiver.***

through a further wire to the cathode. Thus we get a continuous flow of electrons in the tube.

Now if, for example, you were in a corridor full of people, and tried to move very quickly from one end to the other, it would be very difficult because you would keep bumping into other people. If the corridor was empty then this journey would be very easy. A similar thing would happen to electrons as they made their journey through the TV tube — if the tube was full of air then the electrons would keep bumping into the air particles and would have great difficulty in travelling along the tube. For this reason we remove all the air particles from the tube (that is, we create a vacuum in the tube) so that the electrons can flow freely.

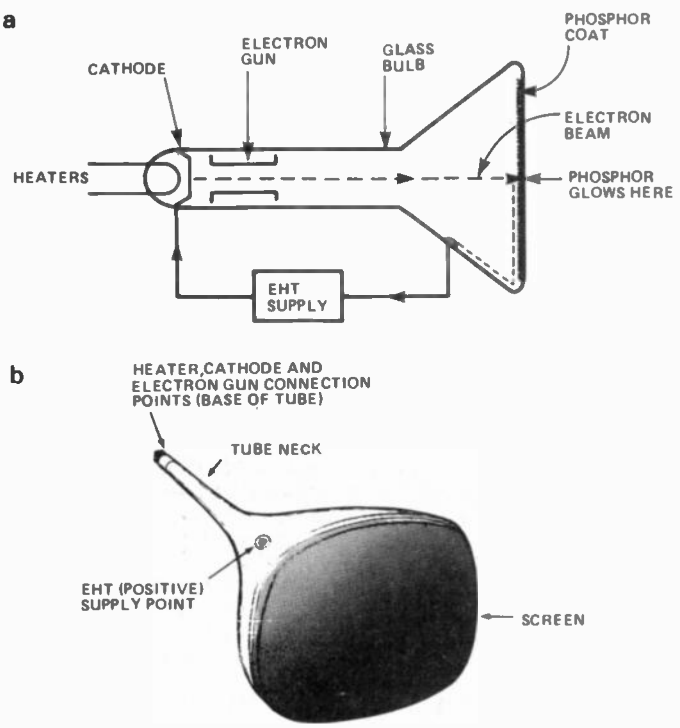


Figure 2. TV picture tube: a) main component parts and connections to EHT supply, b) outside view of picture tube

The electron beam is forced to pass through the electron gun, as shown in **Fig.2a**. This gun focuses the beam very sharply onto the phosphor — just as a magnifying glass can be used to focus the light from the sun onto a piece of paper. This focusing makes the beam very narrow and produces a sharp picture on the tube face.

The flow of electrons is also controlled by a voltage applied to the electron gun, which is connected to one of the pins at the back (base) of the tube. Because the phosphor glows at the point hit by the electron beam, we would have a very bright point of light at the centre of the tube face.

Moving The Spot

The next thing we have to do is to make the spot scan across the face of the tube and so draw out the lines necessary to have a complete picture on the screen in the way explained at the beginning of the article. This is done by means of circuits known as the timebases, and there are two of these in every TV set. One, called the line timebase, makes the spot scan rapidly from left to right (horizontally) across the tube face. The second, called the field timebase, makes the spot move at a much slower rate down the tube face (vertically), giving us the very narrow separation of the horizontal lines necessary to produce a picture.

Well, how can we move our beam of electrons? Because they are particles of electricity they can be moved by a magnet. If we placed a magnet along the side of the TV tube we would bend the beam of electrons so making the small glowing spot on the phosphor move away from the centre of the tube. The more powerful the magnet was the further the beam would move. If we now had a magnet which was just strong enough to pull the glowing spot to the left-hand edge of the screen and then slowly weakened the strength of this magnet the spot would move back towards the tube centre. If, when it reached the centre, we had a second magnet on the other side of the tube and slowly increased its strength until the spot was at the right-hand edge of the screen then we could make the electron beam draw a line across the tube centre. Also, if when the spot reached the right-hand edge of the tube face we very quickly reversed the polarity of the magnets (that is, reversed the north-south poles of each) the beam would shoot back to the other edge of the screen and be ready to draw another line. If we kept repeating this process we would be continuously drawing a horizontal line right across the centre of the tube, and if we did this quickly enough anyone looking at the screen would see a bright horizontal line right across the centre of the tube face. This is what the line timebase does in your TV set. The magnetism is generated by wire coils, called the deflection coils (since they bend or deflect the electron beam) which are placed on the neck of the TV picture tube (see **Fig.3**).

The magnetism is produced by passing an electric current through the coil windings, and the larger this current is the stronger the magnetism. If we pass a current which is slowly increasing through these deflection coils then the magnetism, and also the deflection of the electron beam (and hence the deflection of the spot on the tube face) would increase. Also, if when the spot had been deflected to point B in **Fig.3**, at one edge of the screen, we rapidly reversed the direction of the current flow until it returned to its original value the spot would very rapidly 'fly back' to its original position (point A) at the opposite edge of the screen.

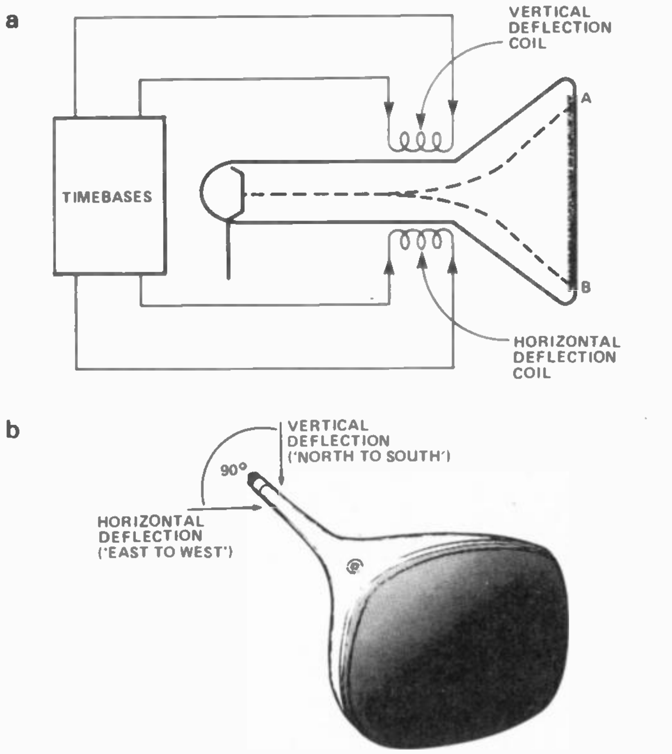


Figure 3. Position of deflection coils on neck of a TV picture tube: a) connections to timebase circuits, b) orientation of magnetic fields from coils

The shape of the current in the deflection coils would then be as shown in **Fig.4**. This is called a sawtooth current waveform. If we had a continuous string of these waveforms the spot would move continuously across the tube face, scanning, flying back, scanning, flying back and so on giving a bright horizontal line across the screen. A string of waveforms such as these can be generated in an oscillator circuit: a sawtooth generator is used to give them the correct shape. Thus our scanning circuit generates a string of sawtooth waveforms (**Fig.5**) which make the spot move across the tube face and hence draw our scanned lines.

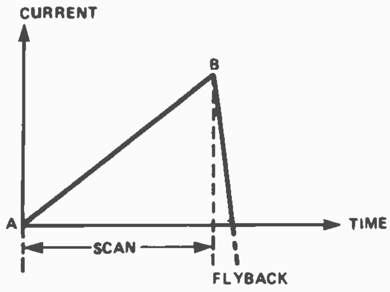


Figure 4. Shape of current waveform in deflection coils. This is known as a 'sawtooth' waveform because of its shape

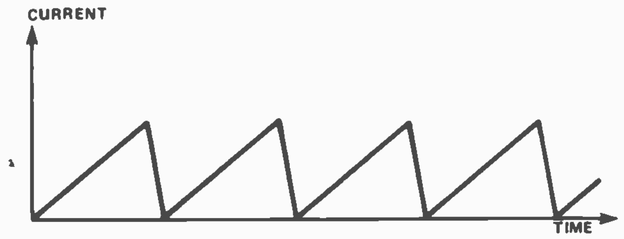


Figure 5. Because the scanning of lines on the picture tube is repetitive the current waveform is a continuous stream of sawtooth waveforms such as those shown in Fig.4. This is the picture you would expect to see on an oscilloscope connected to each coil in turn

If we had only one of these scanning circuits then we would only see a single bright line across the screen centre since each line would fall on top of the previously drawn one. To separate these individual lines slightly, and to fill the complete tube face from top to bottom with lines, a second timebase circuit is used, which works in exactly the same way as the one described above. The only difference is that it runs much slower, and it is used to drive deflection coils which are placed at right angles to those of the first timebase. In this way the spot can be moved down the tube face as well as across it.

Thus we can cover the whole of the face of the tube with almost horizontal lines, as described earlier for the pen moving across the sheet of paper. In TV receivers in the UK, the first timebase is called the line or horizontal timebase, and it produces 15 625 sawtooth waveforms every second (hence it draws 15 625 lines across the tube face every second). The other one, called the field timebase produces 50 sawtooth waveforms a second. For both timebases the scanning time lasts about 85% of the total time of one sawtooth, and the flyback time lasts 15% of this total time.

So we have now covered our screen with lines exactly as described earlier for the pen on the sheet. We now need to know what is happening in the TV studio.

At The Transmitting End

Inside the TV camera at the studio there are two timebases, similar to those described above for the TV receiver and running at exactly the same speeds as those in the receiver. Instead of a TV picture tube the camera uses a special light-sensitive tube which, in simple terms, works in reverse to the picture tube.

Behind the camera tube face is a light sensitive (photosensitive) layer which is scanned by an electron beam. (This beam is deflected in the same way as the electron beam is deflected in the picture tube.) The scene in front of the camera lens is focused onto the photosensitive layer, so producing a two-dimensional image (see **Fig.6**). (This process is exactly the same as that which takes place inside a conventional camera, where the image is focused through the lens onto a photographic film.) Inside the camera tube the electron beam scans the reverse side of the image, as shown in **Fig.6**, which will normally consist of varying degrees of brightness, ranging from brightest white to deepest black. As the beam traces its way over the photosensitive layer the differences in light intensity produce small changes in current through the tube, and these changes can be amplified for transmission by radio waves to your TV receiver.

The important thing to remember is that the electron beam in the picture tube in the TV receiver moves in perfect step with the beam in the TV camera tube at the studio.

At the end of each line, when flyback occurs in the studio timebase a small square pulse is transmitted. This is to tell the timebase circuit in your TV receiver exactly when to start a new line, so that both the 'pointer' drawing lines across the picture in the studio, and the electron beam pen are always at exactly the same point on the picture. If this was not so then the image seen on your screen would be broken up and unintelligible. These pulses are called synchronising (or sync) pulses and they lock the timebase oscillator in the receiver to the one in the studio. If we looked at a drawing of the voltage against time for the signal transmitted from the studio to your receiver for two horizontal lines it would look like the one shown in **Fig.7**.

We can see in **Fig.7** the sync pulses which are used to 'lock' the timebase oscillators at fixed rates. The voltage levels in the lines (the irregular jagged bits) are the variations in the camera tube voltage occurring as the beam scans different brightnesses of the scene before the lens.

The TV receiver picks up these signals (sent from the studio via the transmitter) on its aerial from where they enter the receiver. The variations in the voltage seen as each line is scanned are used to control the strength of the electron beam in the picture tube and hence to cause variations in the brightness of the glowing phosphor on the tube face. These variations follow the changes in brightness measured by the camera tube, and these changes occur in exactly the same place on the picture scanned in the TV studio as on your TV screen. In this way we get an exact replica of the studio picture on the TV receiver.

Together with the information required to make the picture, sound is also transmitted from the studio in the same way as for radio broadcasts. The sound is converted into electrical signals

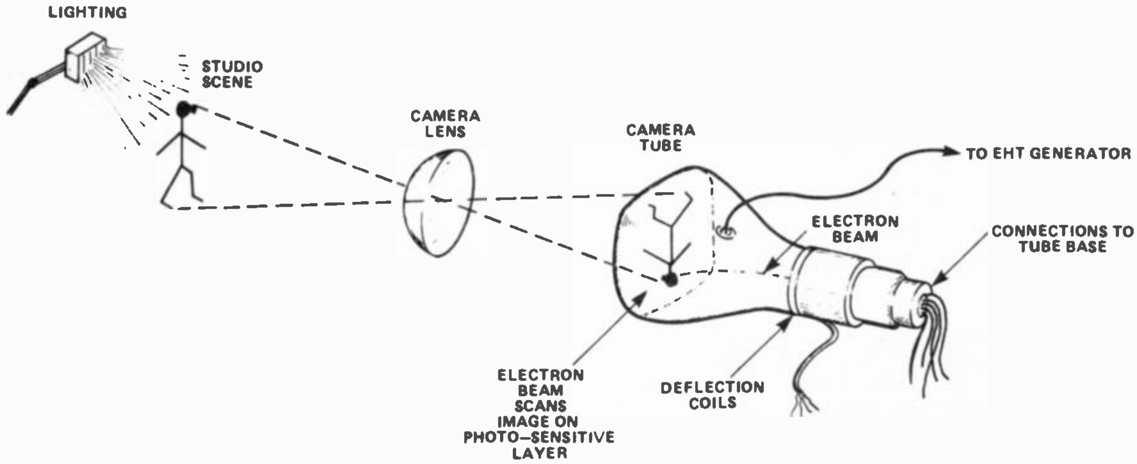


Figure 6. Greatly simplified operation of a TV camera. The illuminated studio scene is focused, through the lens system, onto the light-sensitive screen of the camera tube. (You'll notice that because a single lens is used in my example, the image on the tube screen is upside-down.) The tube has been made transparent to enable you to see the image as it would be 'seen' by the electron beam, as it scans the reverse side of the light-sensitive (photosensitive) layer

at the studio and these signals are mixed with the corresponding picture information signals from the camera. It is this combined signal which is picked up on the aerial of your TV receiver, and fed into the receiver circuit. Inside the TV the signals received by the aerial are amplified many times and the sound and vision signals are separated from each other. The sound signals are amplified and sent to the loudspeaker, and the vision signals, after their amplification, are fed to a control pin on the base of the picture tube where they are used to control the flow of electrons as described before. The synchronising pulses are also separated from the sound and vision signals, and these are fed to the line and field timebases for correct locking.

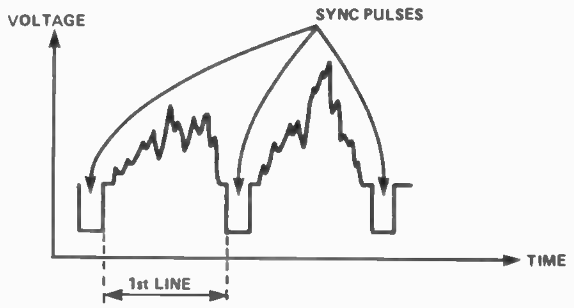


Figure 7. Waveform of signal transmitted from the studio to your TV receiver. It contains two kinds of information: regular 'sync' pulses which lock the horizontal and vertical deflection timebase circuits precisely to those in the camera, and voltage variations corresponding to the brightness information from the scene in front of the camera lens, transmitted line-by-line

Other Parts Of The Receiver

The TV receiver also has a tuner which enables the user to pick out the desired station and to reject the others. Each of the TV stations transmits signals with different frequencies from each other. The TV tuner tunes into these frequencies only one at a time, depending upon where the viewer sets the tuning knob, thus allowing the viewer to select any desired station. If this were not so then the TV would be showing all the stations at the same time and utter confusion would occur on your TV screen!

I have tried in this article to explain in a non-technical way the workings of a modern black-and-white (monochrome) TV receiver. Although it has been necessary to simplify the explanation of the various stages of the transmission and reception circuits I hope you have a better idea of what is going on inside that ubiquitous 'box' — the TV receiver.

Perhaps, in a future issue, I'll go on to explain the differences between a monochrome TV receiver and a colour TV receiver.

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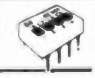

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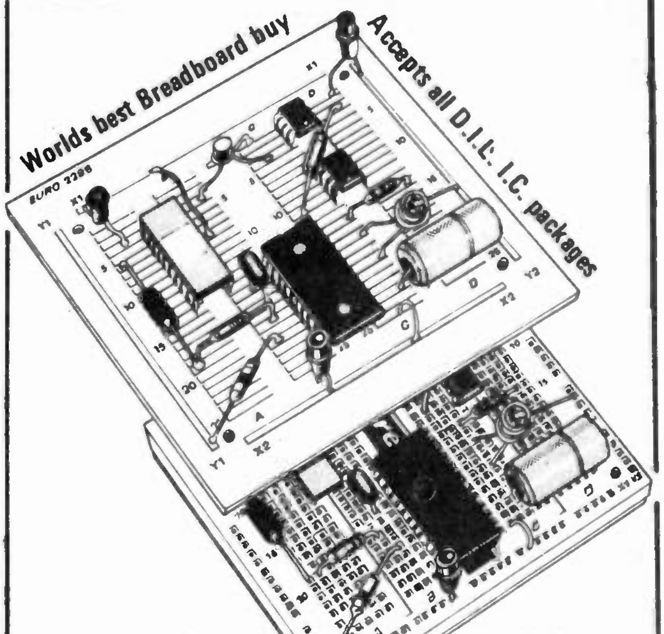

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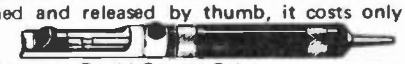

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Yes it's true. Nowhere in this project is there a 555 timer. We were fed up with doorbell/buzzer/chime circuits which featured the beast and we thought it was about time a different device was used. The SAB0600 (sounds much better than 555, doesn't it?) produces a harmonically related three-tone sequence, at a suitable power to feed a loudspeaker directly, without the need to use an amplifier. Once the third tone has decayed away the IC automatically turns itself off, ready for the next person to press the doorpush. Then in this standby mode, the whole circuit consumes only about 1 uA, so battery operation is ideal.

Construction

Insert and solder the integrated circuit socket into the printed circuit board (PCB), followed by resistor R1 and preset resistor RV1. **Figure 2** shows the PCB component overlay which you should carefully refer to.

Next insert and solder the six capacitors, making sure the two electrolytic capacitors are polarised correctly.

Now push the integrated circuit IC1 into its socket, aligning it, as shown in **Fig. 2.**

Connect the battery clip, loudspeaker and lead to the PCB. Drill the case to allow the lead to fit through.

Fit the battery and touch the two free ends of the lead together (or press the push-button if you have already fitted it) to operate the doorchime. As the chime is sounding, adjust RV1 to obtain the desired pitch.

Mount the PCB to the case using a double-sided adhesive pad. Finally fit the loudspeaker onto the guides in the box and fasten the lid down to secure it in position.

Buylines

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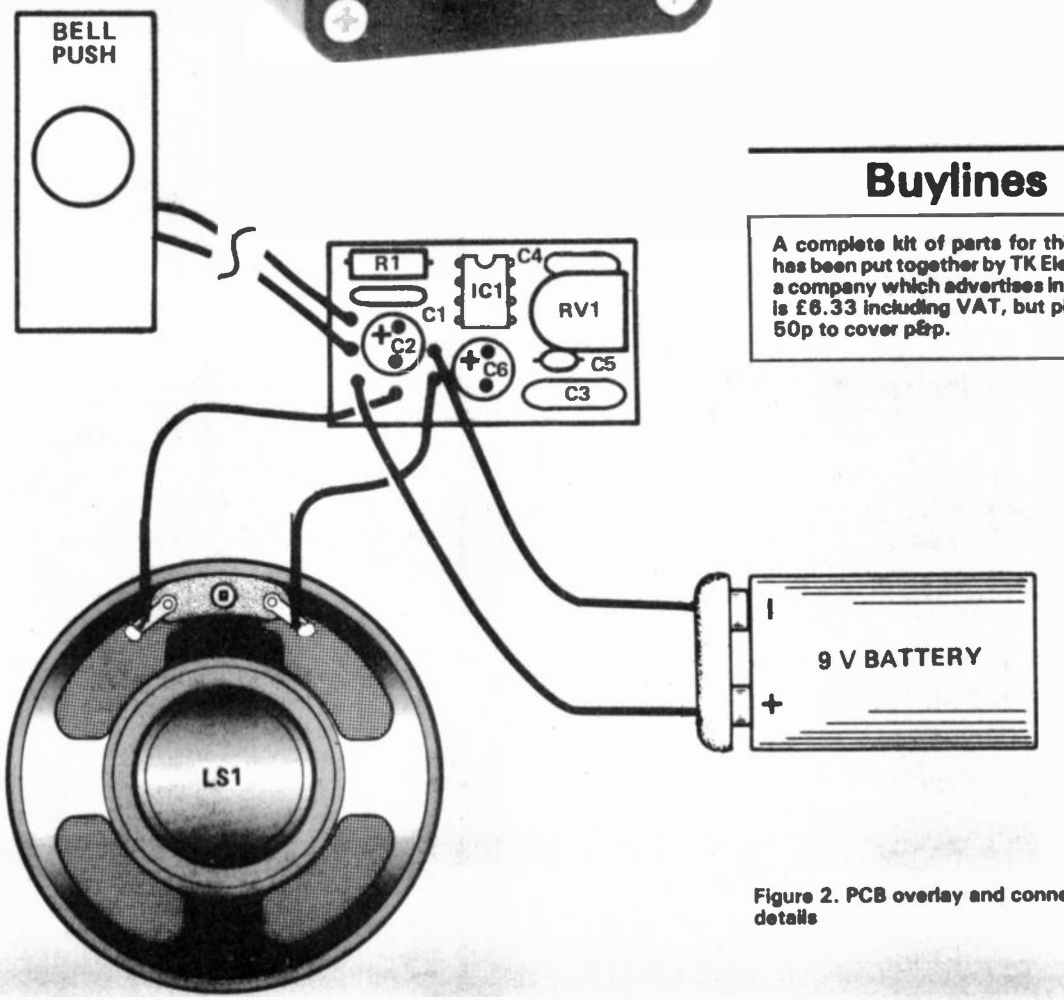
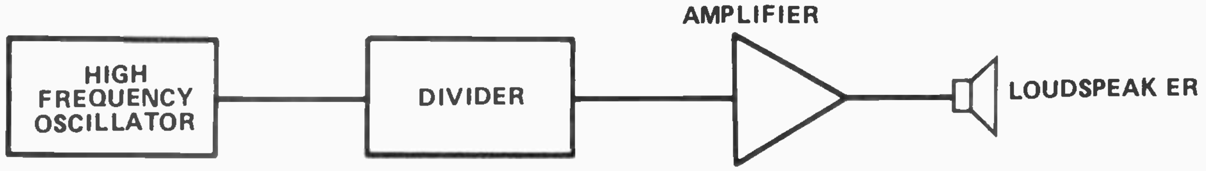


Figure 2. PCB overlay and connection details

How It Works

The output of a high frequency audio oscillator is divided down to produce the three harmonically related tones which are amplified and then fed to the loudspeaker.



The oscillator's output is a squarewave, the frequency of which is determined by the values of capacitor C5 and preset resistor RV1, connected to pin 6 of integrated circuit IC1. This frequency is divided down to produce a harmonically related and musical three note sequence (still consisting of squarewaves).

Capacitors C3 and 4 reduce the amplitude of the higher harmonics of the squarewave, to give a less harsh sound.

The circuit is triggered when a voltage over 1.5 V is applied to pin 1 of IC1. After the tones have decayed the circuit switches itself off unless the trigger voltage is still present, in which case the sequence is repeated.

Components C1 and R1 prevent spurious triggering of the chime which might occur when long leads to the push-button are used. Also, the IC contains circuitry to prevent such spurious operation.

Parts List

RESISTOR (¼ W, 5%)
R1 82k

POTENTIOMETER
RV1 47k miniature horizontal preset

CAPACITORS
C1,4 100n polyester
C2 100u, 16 V printed circuit mounting electrolytic
C3 220n polyester
C5 10n ceramic
C6 220u, 16 V printed circuit mounting electrolytic

SEMICONDUCTOR
IC1 SAB0600

MISCELLANEOUS
LS1 BR miniature loudspeaker
Battery + clip
Drilled box (with kit)
8-pin IC socket

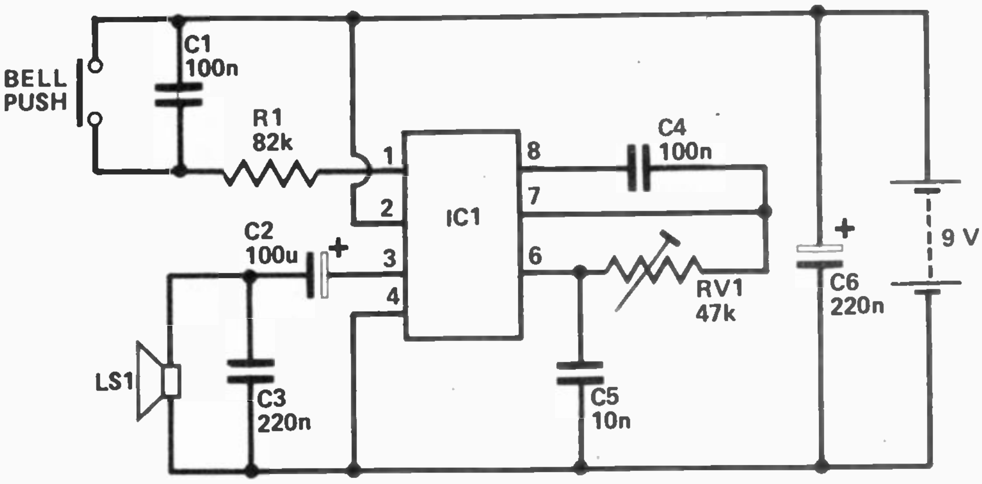
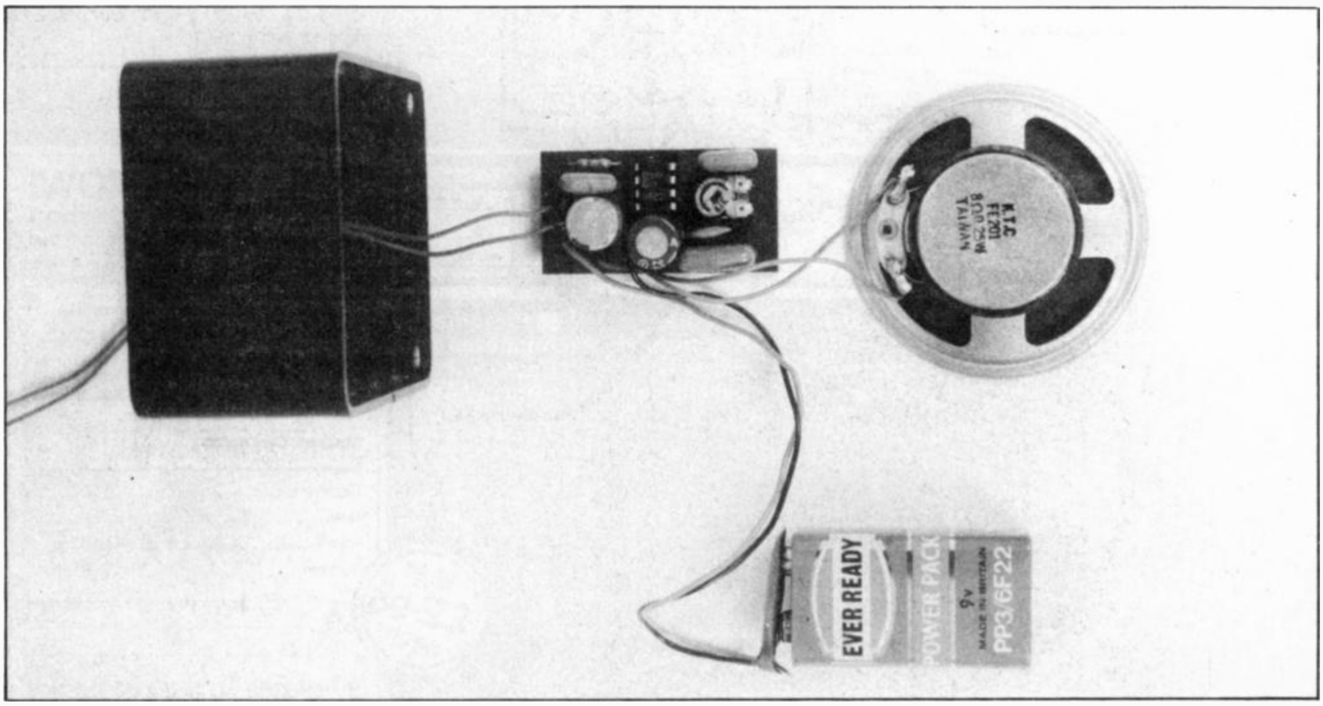


Figure 1. Circuit of the HE Doorchime



CB Breaker One Four

In this special BOF feature, Rick Maybury, in his capacity as Editor of Citizens' Band magazine, comments on the new, *legal*, Citizens' Band system for Britain

WELL, WE MADE IT — CB was officially legalised in the UK on 2nd November 1981, as if you didn't already know. At this point I would like to say a very personal thank-you to all the readers of Hobby Electronics who have participated in the campaign, signed our petitions and generally persuaded the Government that the British Public are indeed responsible enough to be let loose with radio transmitters.

From that you might deduce that I am satisfied with the system, as opposed to continuing the fight for the American system which uses AM, in contrast to our FM system. Well, you would be half right. The UK FM system does work, and works well. The equipment is not significantly dearer than illegal American equipment and, as you may have discovered by now, range, clarity and efficiency are at worst the same as the illegal system, and can be substantially better. However, there are problems.

Restrictions

First, the antenna restrictions. The system is severely limited, particularly from the point of view of base station operation. The ludicrous 7 metre (7 m) height restriction makes a mockery of the worth of monitoring stations being able to offer assistance in out-of-the way areas. Inserting a 10 dB attenuator into the feedline of an already inefficient antenna reduces the power output by a factor of 10 and makes emergency monitoring all but impossible. Fair enough, the antenna length limit which says that no antenna shall be longer than 1.5 m is no real problem on mobile installations but to try and impose the same limitations on base stations will ensure that any monitoring station will effectively be half deaf.

Second, the licensing conditions: they're too lax! For instance, no provision is made for maintenance and repair of faulty equipment. In theory, a two-year-old with a screwdriver is quite entitled to fiddle around inside a rig: it can happen and it will happen. The result? A lot of rigs will end up transmitting on frequencies that might interfere with others.

Benefits . . . And Opponents

But these are the minus points. In its favour, UK CB will offer thousands of people access to the air, lives can be saved and people will have the opportunity to talk to one another again (without the assistance, or hindrance, of the Post Office) and in this day and age that can't be a bad thing.

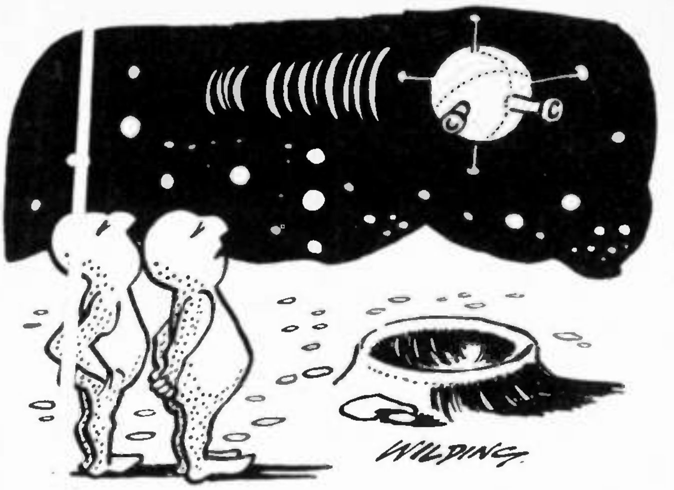
It's much too early to say whether or not the system will be allowed to work, and a lot of people have stated quite categorically that they're out to upset UK CB. These morons will try very hard to ruin CB for others: hopefully their interest will be short-lived, as is often proved to be true of such people. Given that disruption will be slight we have a unique opportunity with UK CB to establish a first class local communications system.

The Fight's Not Over Yet

It has been a long fight — regular readers may remember our very first feature on CB back in early 1979, and I sincerely believe that it has all been worth it. There were times when it seemed that the Government would never sanction CB. That's not to say I'm congratulating them now, I think they should have done it two years ago and avoided all this misery. But they have made the best of a bad job and it's up to us now to prove that we can use it responsibly. It's fairly apparent that 40 channels will not be enough. We'll need at least another 40 by this time next year, so the campaign as a whole is far from being over, and something must still be done about those aerial restrictions.

In the meantime, CB is here and you have the opportunity to participate in a great experiment, not least the demonstration that the British public can use two-way radio in a responsible manner. It shows that laws can be changed, where there's a will. Now, about those cordless telephones, wouldn't it be nice if.....?

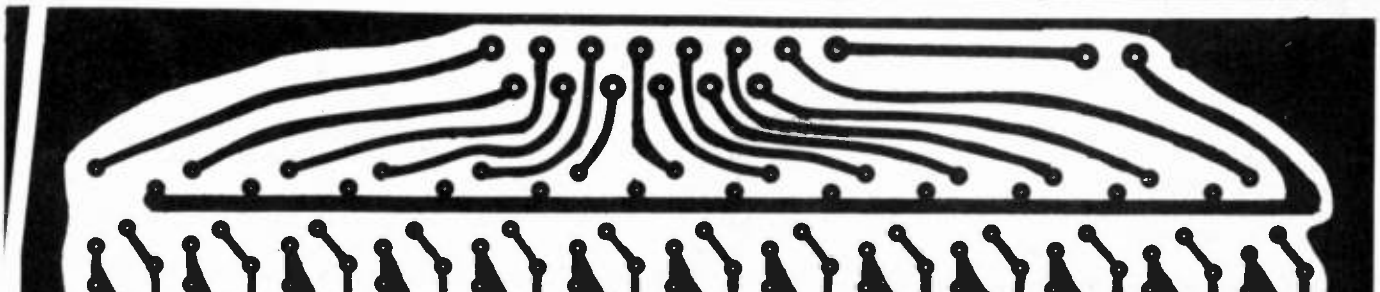
HE



"NO, IT'S T. HAT ELECTRONICS BLOKE FROM SUFFOLK, AGAIN!"

PCB Foil Patterns

Belo' w: The PCB foil pattern of the HE Pedalboard Organ project



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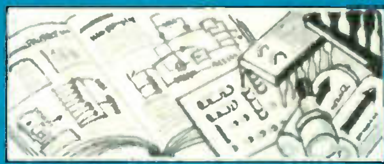

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