FREE GADGETS, GAMES & KITS SUPPLEMENT INSIDE

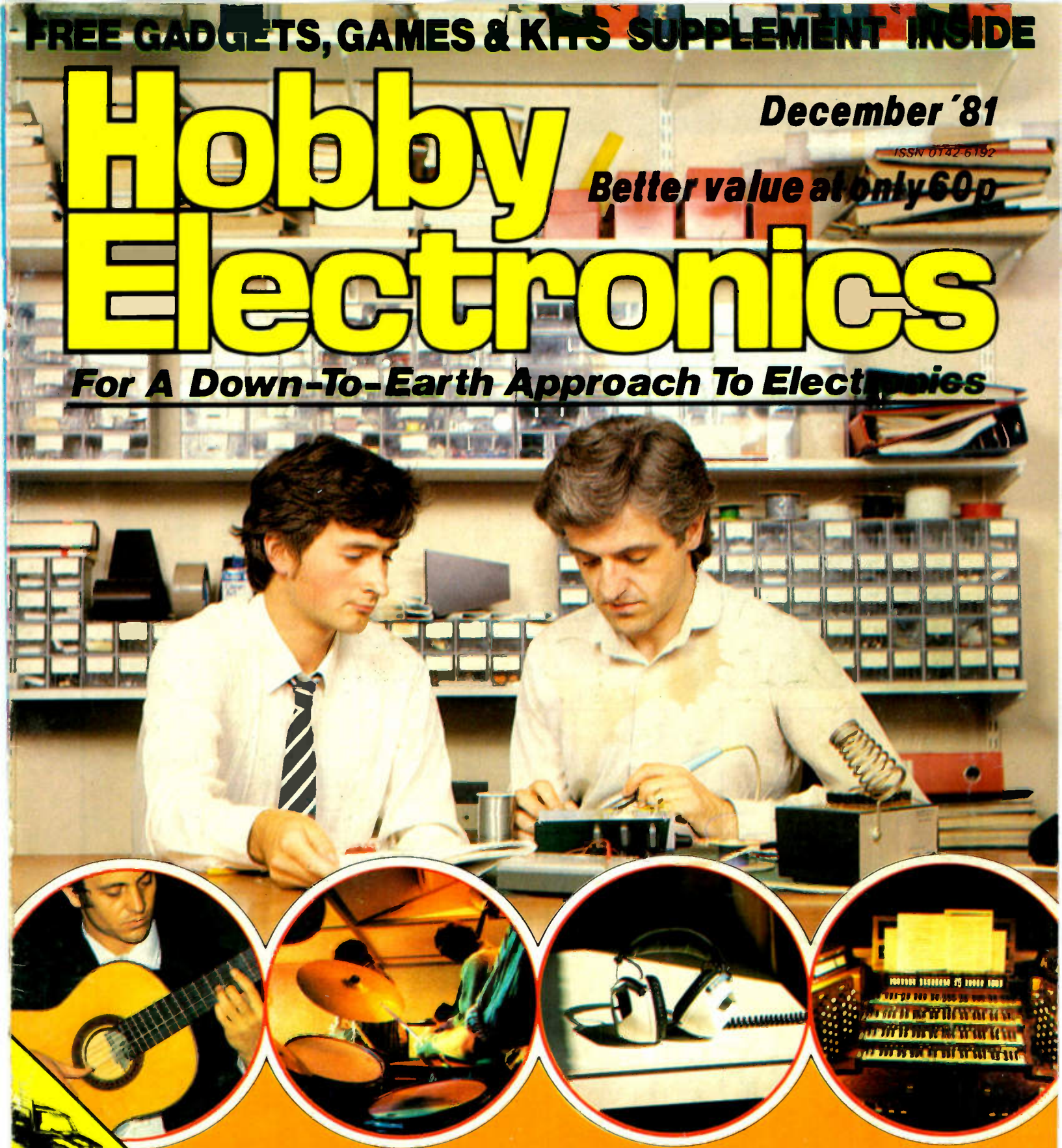
Hobby Electronics

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!

HOW TO SUCCEED IN THE ELECTRONICS BUSINESS:

INVEST 60p AND MAKE £2.40 net profit

Available at your newsagent or direct for 60p p&p inc

Buy Ambit's new concise component catalogue and get £1 vouchers. Use them for a £1 discount per £10 spent. But even without this, you will still find WR&E offers the low prices, fast service and technical support facility second to none. Here are some examples from the current issue:

I.C. SOCKETS

A range of high quality, low cost, low profile DIL sockets ideally suited for both the OEM and hobbyist. All types feature double sided phosphor bronze contacts, tin-plated for low contact resistance.

8 x 0.3" 12p	22 x 0.3" 20p
14 x 0.3" 13p	22 x 0.4" 20p
16 x 0.3" 13p	24 x 0.6" 22p
18 x 0.3" 18p	28 x 0.6" 25p
20 x 0.3" 19p	40 x 0.6" 35p
20 x 0.4" 19p	42 x 0.6" 38p

VOLTAGE REGULATORS

78XX1A TO-220 pos	0.58
79XX1A TO-220 neg	0.60
78G 1A TO-220 adj pos	1.10
78G 1A TO-3 adj pos	3.95
78H5A TO-3 5v pos	4.25
78H5A TO-3 12v pos	5.45
78HG5A TO-3 adj pos	7.45
79HG5A TO-3 adj neg	7.45
LM317.5A adj pos	1.30
LM337.5A adj neg	1.75
78S401.5A adj pos sw reg	1.20

DISCRETES

BC237	8p	BC556	12p		
BC238	8p	BC550	12p	2SK168	35p
ZTX238	9p	BC560	12p	J310	69p
BC239	8p	BC639	22p	J176	65p
BC307	8p	BC640	23p	40823	65p
BC308	8p	2SC1775A	22p	3SK45	49p
BC309	8p	2SA872A	18p	3SK51	54p
BC413	10p	2SD666A	30p	3SK60	58p
BC414	11p	2SB646A	30p	3SK88	99p
BC415	10p	2SD668A	30p	MEM680	75p
BC416	11p	2SB648A	40p	BF960	99p
BC546	12p	BF256	38p	BF961	70p
		2SK55	28p	BF963	99p

XTALS

1MHz	3.00
3.2768MHz	2.00
4MHz	1.70
4.194MHz	1.70
4.43MHz	1.25
5MHz	2.00
6.5536MHz	2.00
7MHz	2.00
8MHz	2.00
9MHz	2.00
10MHz	2.00
11MHz	2.00

Prices shown exclude VAT. Postage 50p per order (UK). ACCESS/BARCLAYCARD may be used with written or telephone orders - official MA details on application, and a special prize for those who read our ads carefully - a free 4 or 8MHz crystal filter with every CPU IC you buy - just clip out the paragraph and attach it to your order. E&OE.

CMOS

4000	0.13
4001	0.13
4002	0.13
4007	0.15
4008	0.70
4008AE	0.80
4009	0.30
4010	0.30
4011AE	0.24
4011	0.15
4013	0.32
4015	0.64
4016	0.30
4017	0.45
4019	0.38
4020	0.58
4021	0.68
4022	0.64
4023	0.15
4024	0.45
4025	0.15
4026	1.05
4027	0.50
4028	0.50
4029	0.75
4030	0.35
4035	0.75
4040	0.68
4042	0.58
4043	0.65
4043AE	0.93
4044	0.64
4046	0.69
4047	0.69
4049	0.30
4050	0.30
4051	0.65
4052	0.65
4053	0.65
4054	1.30
4055	1.30
4056	1.30
4059	5.75
4060	0.88
4063	1.15
4066	0.34
4067	4.30
4068	0.18
4069AE	0.18
4070	0.18
4071	0.18
4072	0.18
4073	0.18
4075	0.18
4076	0.60
4077	0.18
4078	0.18
4081	0.18
4082	0.18
4093	0.41
4099	0.93
4175	0.90
4502	0.79
4503	0.48
4506	0.63
4507	0.38
4508	1.95
4510	0.66
4511	0.66
4512	0.70
4514	1.45
4515	1.45
4516	0.75
4518	0.40
4520	0.75
4521	1.60
4522	0.89
4527	0.89
4528	0.78
4529	0.89
4531	0.85
4532	1.20
4534	5.30
4536	3.00
4538	0.97
4539	0.89
4543	1.05
4549	3.50
4553	3.20
4554	1.30
4555	0.48
4556	0.53
4557	2.30
4558	0.89
4559	3.80
4560	1.75
4561	2.18
4562	0.89
4566	3.80
4568	1.45
4569	1.50
4572	1.95
4580	3.25
4581	1.50
4582	1.65
4583	0.80
4584	0.45
4585	0.45
4702	4.50
4703	4.48
4704	4.24
4705	4.24
4706	4.50
4720	4.00
4723	0.95
4724	0.95
4725	2.24
40014	0.54
40085	0.99
40098	0.54
40106	0.69
40160	0.68
40161	0.69
40162	0.69
40163	0.69
40174	0.69
40175	0.69
40192	0.75
40193	0.75
40194	0.69
40195	0.69

TTL N

7400N	0.10
7401N	0.10
7402N	0.20
7403N	0.11
7404N	0.12
7405N	0.12
7406N	0.22
7407N	0.22
7408N	0.15
7409N	0.15
7410N	0.12
7411N	0.18
7412N	0.19
7413N	0.27
7414N	0.51
7416N	0.27
7417N	0.27
7420N	0.13
7421N	0.28
7423N	0.22
7425N	0.22
7426N	0.22
7427N	0.22
7430N	0.12
7432N	0.23
7437N	0.22
7438N	0.22
7440N	0.14
7441N	0.54
7442N	0.42
7443N	0.62
7444N	0.62
7445N	0.62
7446N	0.62
7447N	0.62
7448N	0.56
7450	0.14
7451N	0.14
7453N	0.14
7454N	0.14
7460N	0.14
7470N	0.28
7472N	0.27
7473N	0.28
7474N	0.28
7475N	0.35
7476N	0.30
7480N	0.26
7481N	0.20
7482N	0.75
7485N	0.75
7486N	0.24
7489N	1.05
7490N	0.30
7491N	0.55
7492N	0.35
7493N	0.35
7494N	0.70
7495N	0.60
7496N	0.45
7497N	1.40
74100	1.10
74104	0.62
74105	0.62
74107	0.26
74109N	0.35
74110N	0.54
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74112N	1.70
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74121N	0.34
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74126N	0.40
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74147N	1.50
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74155N	0.55
74156N	0.55
74157N	0.55
74159N	1.90
74160N	0.55
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74162N	0.55
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74164N	0.55
74165N	0.55
74166N	0.70
74167N	1.25
74170N	1.25
74173N	1.10
74174N	0.75
74175N	0.75
74176N	0.75
74177N	0.75
74178N	0.90
74179N	1.35
74180N	0.75
74181N	1.22
74182N	0.70
74184N	1.20
74185N	1.20
74188N	3.00
74190N	0.55
74191N	0.55
74192N	0.55
74193N	0.55
74194N	0.55
74195N	0.55
74196N	0.55
74197N	0.55
74198N	0.85
74199N	1.00
74221N	1.00
74246N	1.50
74247N	1.51
74248N	1.89
74249N	0.11
74251N	1.05
74265N	0.66
74273N	2.67
74278N	2.49
74279N	0.89
74283N	1.30
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74290N	1.00
74293N	1.05
74297N	2.36
74298N	1.85
74366N	0.85
74367N	0.85
74368N	0.85
74390N	1.85
74393N	1.85
74490N	1.85

74LSN

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74LS01N	0.11
74LS02N	0.12
74LS03N	0.12
74LS04N	0.14
74LS05N	0.14
74LS08N	0.14
74LS09N	0.14
74LS10N	0.13
74LS11N	0.14
74LS12N	0.15
74LS13N	0.28
74LS14N	0.46
74LS15N	0.14
74LS20N	0.13
74LS21N	0.15
74LS22N	0.15
74LS26N	0.18
74LS27N	0.14
74LS28N	0.19
74LS30N	0.13
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74LS139N	0.36
74LS145N	1.20
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74LS153N	0.35
74LS154N	0.99
74LS155N	0.38
74LS156N	0.38
74LS157N	0.33
74LS158N	0.33
74LS160N	0.40
74LS161N	0.40
74LS162N	0.40
74LS163N	0.40
74LS164N	0.46
74LS165N	1.20
74LS166N	0.80
74LS168N	0.85
74LS169N	0.85
74LS170N	1.40
74LS173N	0.70
74LS174N	0.55
74LS175N	0.55
74LS181N	1.20
74LS183N	1.75
74LS189N	1.28
74LS190N	0.56
74LS191N	0.56
74LS192N	0.56
74LS193N	0.59
74LS194N	0.39
74LS195N	0.39
74LS196N	0.55
74LS197N	0.65
74LS200N	3.45
74LS202N	3.45
74LS221N	0.60
74LS240N	0.99
74LS241N	0.99
74LS242N	1.65
74LS243N	1.65
74LS244N	0.83
74LS245N	1.50
74LS247N	1.35
74LS248N	1.35
74LS249N	1.35
74LS251N	0.46
74LS253N	0.46
74LS257N	0.55
74LS258N	0.39
74LS259N	0.39
74LS260N	0.70
74LS266N	0.24
74LS273N	0.90
74LS275N	3.20
74LS279N	0.35
74LS280N	2.05
74LS283N	0.44
74LS290N	0.58
74LS293N	1.30
74LS295N	1.50
74LS298N	1.50
74LS365N	0.35
74LS366N	0.35
74LS367N	0.35
74LS368N	0.35
74LS373N	0.78
74LS374N	0.78
74LS375N	1.15
74LS377N	1.99
74LS378N	1.40
74LS379N	2.15
74LS384N	2.50
74LS385N	4.20
74LS386N	0.29
74LS390N	0.68
74LS393N	0.61
74LS395N	2.10
74LS396N	1.99
74LS398N	2.75
74LS399N	2.30
74LS445N	1.40
74LS447N	1.95
74LS490N	1.10
74LS668N	1.05
74LS669N	1.05
74LS670N	1.70

RAM

2102	1.70
2112	3.40
2114/2	1.49
4027	5.78
4116/2	1.59
4116/3	1.49
4864P	12.50
6116P-3	12.50
6116P-4	11.25
8264	12.50

74CXX

74C00	0.20
74C02	0.20
74C04	0.20
74C08	0.20
74C10	0.20
74C14	0.55
74C20	0.20
74C30	0.20
74C32	0.20
74C42	0.80
74C48	1.03
74C73	0.50
74C74	0.50
74C76	0.48
74C83	0.98
74C85	0.98
74C86	0.26
74C89	2.68
74C90	0.80
74C93	0.80
74C95	0.94
74C107	0.48
74C151	1.52
74C154	2.26
74C157	1.52
74C160	0.80
74C161	0.80
74C162	0.80
74C163	0.80
74C164	0.80
74C165	0.84
74C173	0.72
74C174	0.72
74C175	0.72
74C192	0.80
74C193	0.80
74C195	0.80
74C200	4.52
74C221	1.06
74C901	0.38
74C902	0.38
74C903	0.38
74C904	0.38
74C905	5.64
74C906	0.38
74C907	0.38
74C908	0.84
74C909	1.52
74C910	3.62
74C914	0.86
74C918	0.98
74C925	4.32
74C926	4.32
74C927	4.32

Processors

8080 series

8080AFC/2	3.11
8212	1.70
8214	3.50
8216	1.41
8224	1.85
8251	4.26
8255	3.97

6800/6809

6800P	3.75
68A00	4.25
68B00	4.75
6802	5.55
6809	15.00
6810	1.75
68A10	1.85
68B10	2.04
6820	1.95
6821	1.75
68A21	2.10
68B21	2.34
6840	4.25
68A40	4.55
68B40	4.75
6850	1.75
68B50	2.17
6852	2.47
68A52	2.75
68B52	2.95
68488	5.25

Z80 series

Z80A	4.99
Z80ADRT	7.50
Z80APIO	4.10
Z80ASIO/1	14.00
Z80ASIO/2	14.00
Z80ASIO/9	14.00
Z80CTC	4.00
Z80ACTC	4.50
Z8001	65.00

PROM

2708	2.00
2716	3.55
2532	8.50
2732	8.50

AMBIT international

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

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PROJECTS

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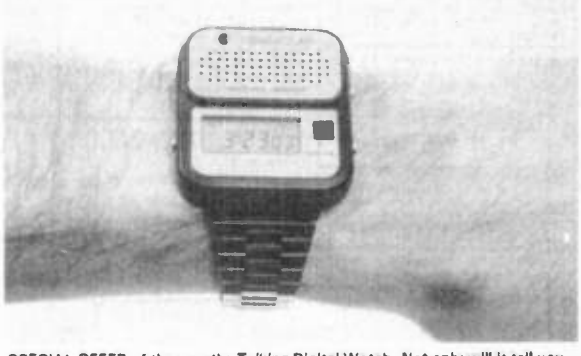
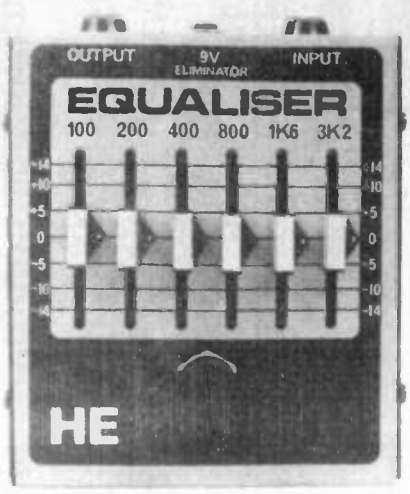
CAUGHT IN THE ACT: we found these two building our Drum Synthesiser project *(you can't beat it — see page 18)* in the HE Workshop while we were at lunch.
Son: "You've soldered that component in upside down Dad!"
Father: "Never mind son, I'm in a hurry — the Editor will be back soon!"



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, **78p**; 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 **160p**; **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**.
100V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **8p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1μ **23p**; 1μ5 **40p**; 2μ2 **46p**.

FEED-THRDUGH 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 **18p**; 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**.

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

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

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**
z200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 **21p each**
1000, 1200, 1800, 2200 **30p each**
3300, 4700pF **60p each**

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**

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

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

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**

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			8p	4p
1% Metal Film 0.5W 51Ω-1M			8p	6p

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

Telephone orders by Access now accepted (£10 min.) Just phone your order through, we do the rest

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	35p

DIODES

AA119	15
BA100	15
BY100	24
BYR26	12
BYR27	12
CRO33	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
IN5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

NOISE

Z5J	195p

VARICAPS

BA102	60
BB105B	40
BB106	40
MVAM2	185
MVAM115	185

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	84
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	105
16A 800V	220
25A 500V	220
25A 800V	295
T2800D	120

75 SERIES

75108	350
75150	140
75154	150
75188	80
75189	80
75322	165
75450	95
75451	70
75452	70
75454	225
75491	89
75492	95

NEW LOW PRICES

Computer & Linear ICs,

Texas TTL74, 74LS, Motorola CMOS.

ALL PRIME PRODUCT

Thyristors

5A/40V	32
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	90
12A100V	78
12A400V	95
12A800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

COMPUTER ICs

1702	200
1802CP	750
2101-2	260
2112-2	250
2114-450n	99
2114L-300n	99
2118-3 250n	260
2147	00
2532-450n	525
2708	200
2716-5V	250
2732-450n	465
4027	240
4116-200n	85
4118-250	460
4164-200n	780
4315 Cmos	795
4334-3 CMOS	2114-3
4864-3	00
5101-450	116
6116-3 16K	856
6502CPU	450
6503	850
6504-250	396
6505	795
6520PIA	310
6522VIA	486
6530	1350
6532RRIOT	795
6545CRTC	1450
6551ACIA	785
6582PC	625
6800	375
6802	560
6803	1350
6804	180
6805	670
6808	520
6809	1220
6810	175
6820	175
6821	175
6840	470
6843	1460
6845	975
6847	850
6850	175
6852	560
6875	560
8080A	450
8086A	580
8116	oc
8123	125
81LS95	115
81LS96	115
81LS97	115
8202	625
8212	170
8214	425
8216	170
8224	250
8228	250
8251	400
8253	799
8255	399
8257	800
8T26A	135
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	595
RO-3-2513L	775
RO-3-2513U	600
SFF96364E	800
SFC71301	825
TMS2716-3V	875
TMS4027	240
TMS4035	00
TMS6011	365
ULN2003	100
UPD80 C36C	£11
Z80CPU 2.5	390
Z80ACPU 4MI	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	155
9400CJ	356
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	235
CA3036	115
CA3043	275
CA3045	365
CA3046	70
CA3048	214
CA3059	195
CA3075	213
CA3080E	65
CA3081	190
CA3085	95
CA3088	48
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	90
CA3140	48
CA3160	95
CA3161	135
CA3162E	450
CA3189	286
ICL7106	750
ICL7107	975
ICL8038CC	300
ICL8211A	150
ICM7204	550
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AU	1950
ICM7216B	1950
ICM7217A	790
ICM7224	785
ICM7555	80
LA4032	295
LC7130	495
LF351	48
LF355	85
LF356	90
LM10	395
LM301AP	28
LM308T	95
LM311	70
LM318N	200
LM319	235
LM324A	50
LM339	54
LM348	84
LM349	115
LM358	50
LM377	155
LM379	415
LM380	75
LM381N	145
LM382	125
LM384	140
LM386	90
LM387	120
LM389	95
LM393	150
LM725CN	325
LM733	75
LM1458	48
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	148
SN76023	170
SN76023ND	240
SN76033N	210
SN76115N	215
SN76131	125
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TA7205A	125
TAA611	125
TAA621AX1	250
TAA661A	155
TAA700	250
TAA900	00
TAD100	159
TBA120S	70
TBA540Q	220
TBA550Q	330
TBA641-A12	276
BX or BX11	250
TBA651	190
TBA800	80
TBA810	95
TBA820	70
TBA920Q	260
TBA950	300
TBA990Q	270
TCA220	350
TCA270Q	250
TCA940	00
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA1034	350
TDA1490	290
TDA2002	325
TDA2020	320
TDA2030	320
TL061CP	40
TL062CP	80
TL064CN	98
TL071CP	30
TL072CP	50
TL074CN	100
TL081CP	25
TL082CP	45
TL083CP	75
TL084CN	95
UAA1003-3	935
UAA170	170
UAA180	170
UAA2240	195
ULN2003	85
ULN2004	150
ULN2238	100
XR2208	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

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
7403	14
7404	14
7405	18
7406	28
7407	28
7408	16
7409	16
7410	14
7411	20
7412	20
7413	24
7414	32
7416	25
7417	25
7420	18
7421	20
7422	20
7423	22
7425	28
7426	30
7427	27
7428	28
7430	16
7432	26
7433	27
7437	27
7438	27
7440	17
7441	68
7442	38
7443	90
7444	90
7445	65
7446	55
7447	50
7448	50
7450	16
7451	16
7453	16
7454	16
7460	18
7470	36
7472	30
7473	30
7474	25
7475	45
7476	30
7480	48
7481	120
7482	70
7483	50
7484	80
7485	95
7486	26
7489	205
7490	28
7491	45
7492	30
7493	30
7494	34
7495	50
7496	45
7497	120
74100	85
74104	54
74105	55
74107	32
74109	35
74110	40
74111	55
74112	170
74116	88
74118	80
74119	90
74120	75
74121	30
74122	45
74123	50
74125	42
74126	40
74128	42
74132	48
74136	35
74141	70
74142	190
74143	250
74144	250
74145	70
74147	99
74148	75
74150	80
74151	45
74153	45
74154	75
74155	75
74156	75
74157	45
74159	99
74160	60
74161	60
74162	62
74163	64
74164	84
74165	62
74166	65
74167	185
74170	168
74172	290
74173	65
74174	72
74175	72
74176	55
74177	75
74178	96
74179	68
74180	65
74181	140
74182	75
74184	99
74185	99
74188	290
74190	70
74191	70
74192	70
74193	65
74194	75
74195	65
74196	65
74197	65
74198	99
74199	99
74221	80
74246	150
74247	150
74248	150
74249	150
74251	80
74259	196
74265	66
74273	196
74276	150
74278	160
74279	90
74283	90
74284	199
74285	199
74290	105
74293	125
74297	236
74298	100

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

2N3441/2 148

2N3663	15
2N3702/3	16
2N3704/5	16
2N3706/7	16
2N3708/9	16
2N3710/11	16
2N3713	144
2N3771	175
2N3772	195
2N3773	275
2N3819	22
2N3820	45
2N3822/3	65
2N3824	65
2N3866	98
2N3879	150
2N3903/4	18
2N3905	15
2N3906	17
2N4037	48
2N4041	40
2N4058	10
2N4061/2	10
2N4064	110
2N4220	78
2N4234/6	48
2N4264	24
2N4286	15
2N4289	18
2N4314	68
2N4400	18
2N4427	80
2N4859	78
2N4871	55
2N4898	135
2N4901	175
2N4921	55
2N4922	60
2N5102	145
2N5135/6	20
2N5138	18
2N5172	18
2N5179	18
2N5180	45
2N5190/1	75
2N5305/8	240
2N5457/8	36
2N5459	38
2N5485	38
2N5777	45
2N5879	190
2N6027	32
2N6388	150
2SA715	60
2SC495	70
2SC496	70
2SC1096	85
2SC1173	125
2SC1306	150
2SC1307	220
2SC1449	85
2SC1678	140
2SC1923	50
2SC1945	225
2SC2091	85
2SC2314	85
2SC2166	165
2SC1679	190
2SD234	74
2SK45	90
3N128	112
3N140	112
40311	60
40313	130
40315	60
40316	95
40317/20	60
40323	60
40324	100
40326/7	70
40347	90
40348	120
40360	40
40361/2	50
40408	70
40411	285
40467A	130
40468	85
40594	105
40603	110
40636	175
40673	95

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 ways	both 105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased ways	both 145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	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

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.
6" x 6"	90p	110p	9.5" x 8.5"
6" x 12"	150p	195p	95p

DIL SOCKETS (TEXAS)

	Low Prof.	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	18p	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	Soldercon Pins
9way	95p	125p	145p	100 pins 70p
15way	135p	198p	150p	500 pins 325p
25way	170p	260p	130p	
37way	290p	398p	185p	

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
¼in Mono			
Plastic	15p	20p	15p
Metal	36p	14p	30p
¼in 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 88p

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

25way 'D' CONNECTOR
Jumper Lead Cable Assembly
18" long, Single End, Male 520
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 446p
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

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"
44Bp 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	280
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	280
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.O.
43Ω coil, 4V2-7V DC; 250V AC; 5A; 1100VA/150W 210p
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.O. 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

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 IIel 857p

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	metal case	-ve	
1A	TO3			
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		–
18V	7818	145p		–

1A	TO220	Plastic Casing		
5V	7805	45p	7905	55p
12V	7812	50p	7912	55p
15V	7815	50p	7915	55p
18V	7818	50p	7918	55p
24V	7824	50p		

100mA	TO92	Plastic Casing		
5V	78L05	30p	79L05	80p
6V	78L62	30p		–
8V	78L82	30p		–
12V	78L12	30p	79L12	80p
15V	78L15	30p	79L15	80p

CA3085	95p
LM304H	170p
LM309KP	99p
LM300H	170p
LM305H	140p
LM309K	135p
LM317K	350p
LM317H	280p
LM323K	650p
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

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		

OPTO ELECTRONICS

LEDs with Clips

TIL209 Red	13
TIL211 Grn.	17
TIL212 Yel.	18
TIL220 .2" Red	14
.2" Green, Yellow or Amber	18
.0.2" Bi colour Red/Green	65p
Green/Yelow	65p
0.2" Tri colour Red/Green/Yellow	85p
Square LEDs, Red, Green, Yellow	30
LD271 Infra Red	48
SFH205 Detector	81
TIL32 Infra Red	58
TIL78 Detector	80
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	105
TIL321 .5" CA	115
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
.8" Green CA	215
.3" ±1 Red CA	150
.3" ±1 Green CA	150
DVM176	1885
LCD 3½ Digits	675
LCD 4 Digits	750
LCD 6 Digits	850

NEON with resistor, push fit, 250V mains. Round. Red or Amber 30p
Rectangular, nut gixing Red, Amber, Green 30p
Reflective Optical Switch 296p
Slotted Optical Switch 186p

COMPUTER CORNER

- VIC 20 MICRO COMPUTER connects directly to any colour TV set. Sound reproduced through TV Speaker. PET Graphics etc. . . £165
- Cassette Dec for VIC plus 6 prog. free cassette £34
- VIDEO GENIE A complete system including Cassette recorder. Ideal for School/Colleges & Home. 16K users RAM. 12K Microsoft Basic in ROM. 64 x 16 line display £279
- SEIKOSHA GP80A Unihammer Printer, gives normal & double width Characters as well as dot resolution graphics. 8" tractor feed. Parallel interface standard. £195
- EPSON MX80T 10" Tractor Feed, 9 x 9 matrix, 80 column, Speed 80 CPS, Bi-directional, Centronics interface, Baud rate 110-9600 (RS232) £365
- EPSON MX80FT Has Friction feed & Tractor feed plus all the MX89's facilities £395
- EPSON MX80FT2 Has high resolution Graphics option plus all the MX80FT's facilities £435
- EPSON MX100 132 Column Printer plus has all the facilities of MX80FT2. Value for money £570
- SOFTY-2 As reviewed in PE Sept. '81 by Dr A. A. Berk. The complete microprocessor development system for Engineers and beginners alike. New powerful instructions. Accepts any 24 pin 5V single rail EPROM. Supplied fully built, tested. Enclosed in a black ABS case. Plug-in power supply included £169
- VIDEO MONITOR 9", fully cased & guaranteed. B & W. Excellent value for money £89
- TEX EPROM ERASER Erases up to 32 ICs in 15-30 minutes. . . . £33
- SPARE 'UV' Lamp bulb £9
- 5V/5A Power Supply Ready-built & tested £25
- ABS CASE Attractive, Beige/Brown for Superboard, UK101 NASCOM, or HOme brew £26
- Extra 4K RAM (8 x 2114L-300n). 795p
- C12 CASSETTES in library cases 40p
- STAK-PAK 10 x C12 Cassettes in stackable drawers 550p
- WEMON Watford's own 4K Ultimate Monitor IC specially designed to produce the best from your Superboard, UK101 & Enhanced Superboard. As reviewed by Dr A. A. Berk in Practical Electronics 1981. . . . . 1995p

(p&p on most of the above items is extra)

Call in at our shop for demonstration on any of the above items. Be satisfied before you buy.

ETI/WATFORD'S MICRO EXPANSION SYSTEM

This versatile economical Expansion System, as published in ETI, provides a cheap but reliable expansion possibility for most of the popular Micro-computers.
Send SAE for details.

WATFORD'S BOOKSHOP CORNER

Texas TTL Data Book (Revised Edition)	680p
TTL Cook-Book	750p
European CMOS DataBook (Comprehensive)	750p
CMOS Cook-Book	750p
Personal Computer Book	695p
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BASIC with Style	540p
A Bit of BASIC	540p
Advanced BASIC	790p
BASIC Computer Games	550p
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Z80 Assembly Language Programming	1485p
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PET Graphics	1200p
Some Common Basic Programs/PET	1100p
PET/CBM Personal Computer Guide	1200p
PET Revealed	1100p
Library of PET Subroutines	1000p
Apple II Users' Guide	1200p
Practical Intro. to PASCAL	550p
PASCAL with Style	600p
Programming in PASCAL (revised)	800p
CRT Controller Handbook	600p
CP/M Handbook	995p
Microprocessor Interfacing Technique	1120p
S-100 Bus Handbook	1100p
Writing Interactive Compiler & Interpreters	1340p

Please add 55p P&P charge on books

No VAT on books

MONITOR

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

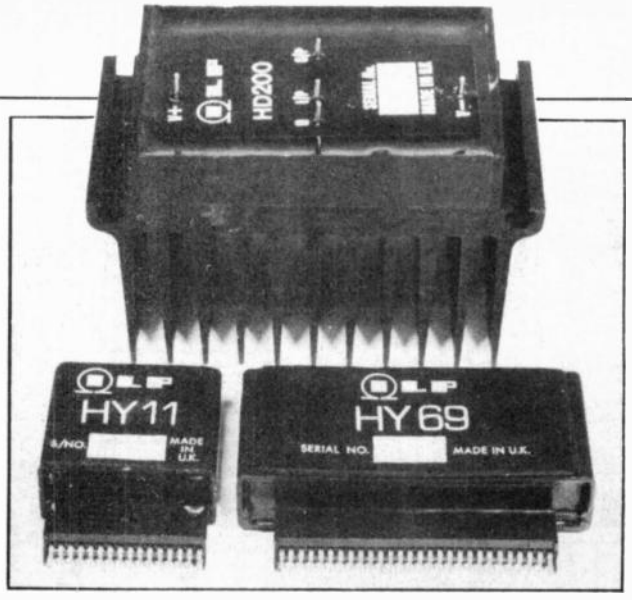
News For Radio Control Enthusiasts

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



Sounds New

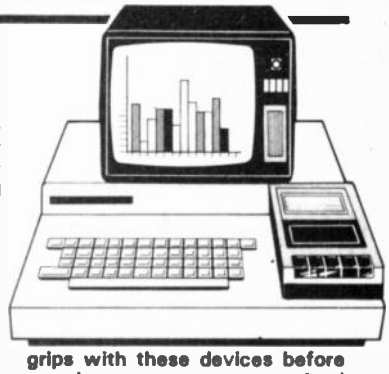
A RANGE OF new modular products for home hi-fi and disco/guitar amplifier constructors has been announced by ILP Electronics of Canterbury.

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).

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 pege 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.)

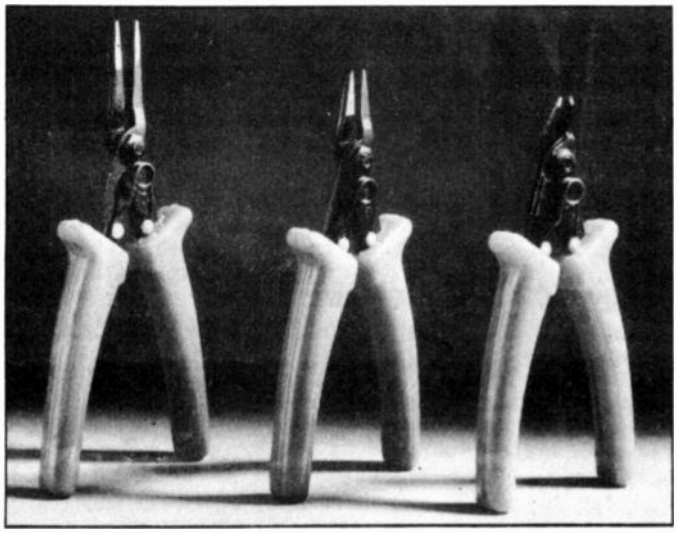
Now four lines have been allocated to the service, with one of four magazines of page information allocated to each line.

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.

Electronics News



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 SSO 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.

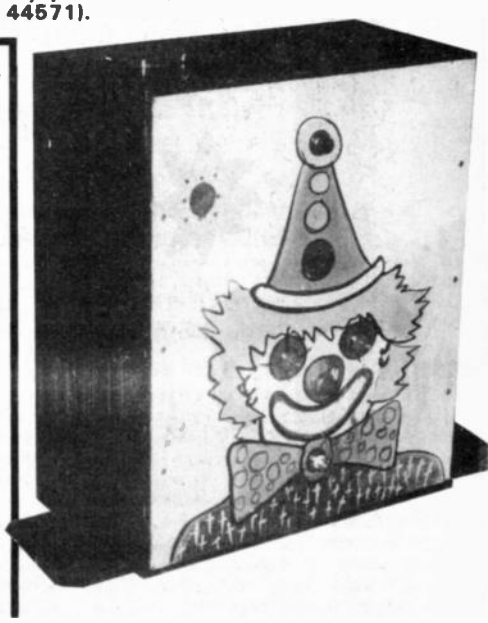
This week-long residential course has been a regular event over the last few years and has as one of its main aims the dissemination of information on the latest advances in technology, and how these advances can benefit handicapped children.

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 OHE (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

Hobby Electronics

Five easy projects for you to build:

Nicad Charger

Your batteries (rechargeable nicads, that is) will get a kick out of this one. Build our charger and your nicads need never let you down again.

Simple Timer

Our easy-to-build timer will enable you to dispense with hour glasses, clockwork ticking timers or guesswork.

Intruder Confuser

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

Guitar Graphic Equaliser

Seven steps to control the sound from your electric guitar:

- **1 Build this project**
- **2-7 Adjust the controls to suit**

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.

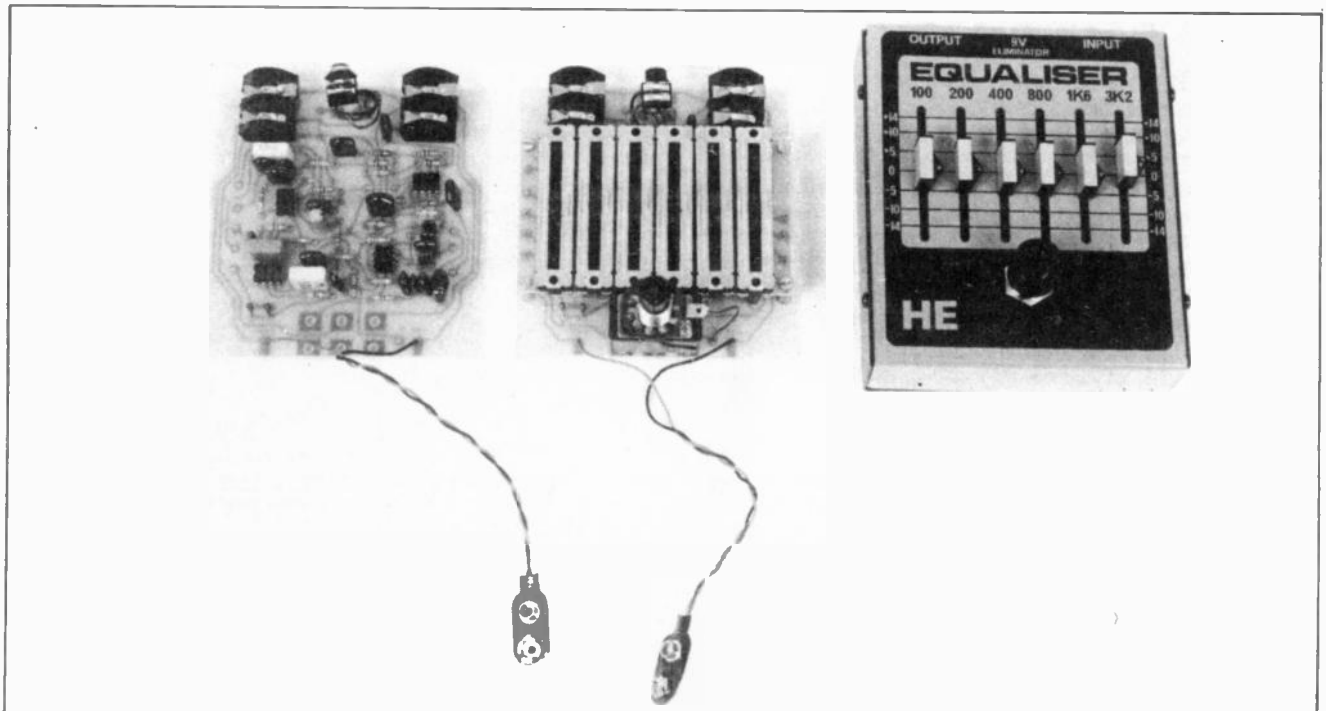
Using nuts, bolts and ½" spacers, mount the slider board above the main board.

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.

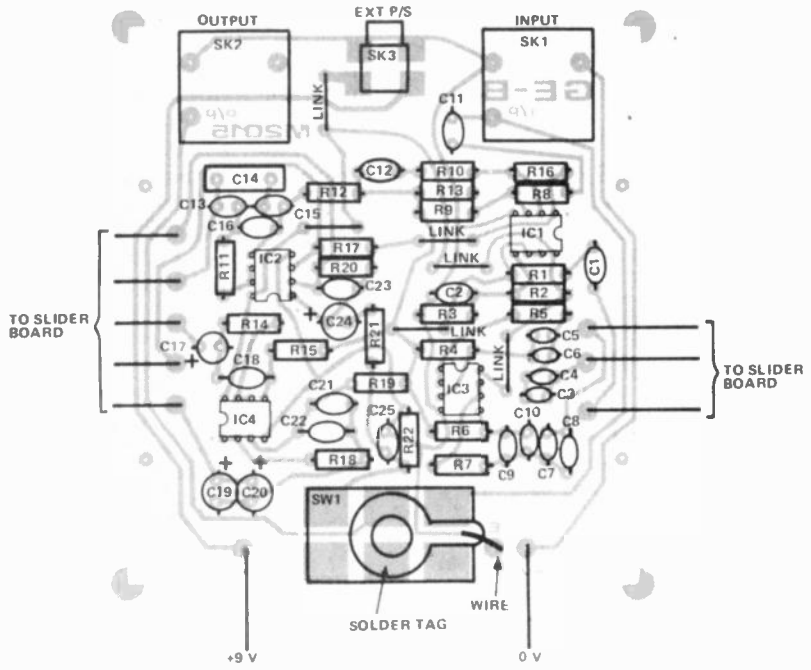


Figure 2. Component overlay of the main component PCB

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

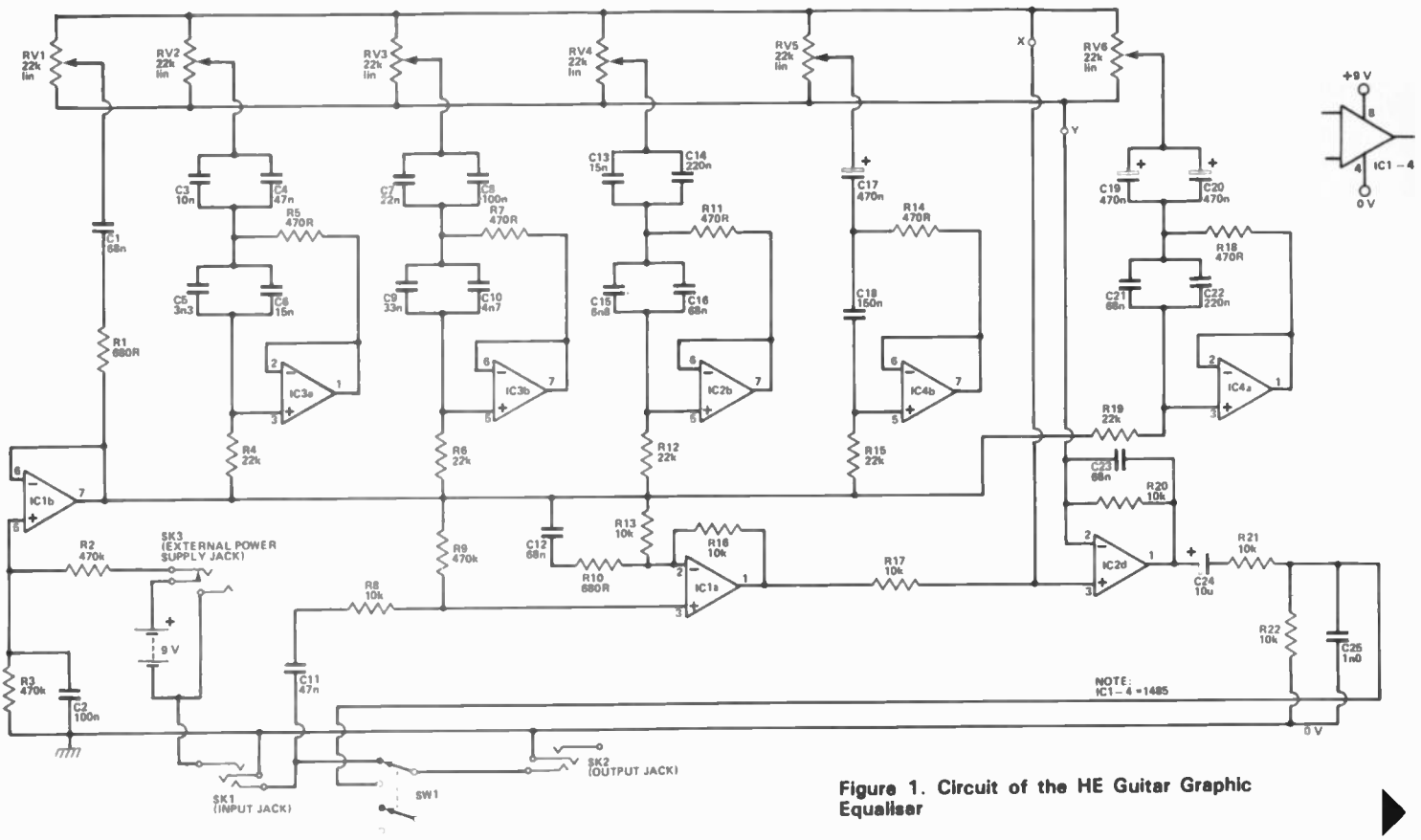
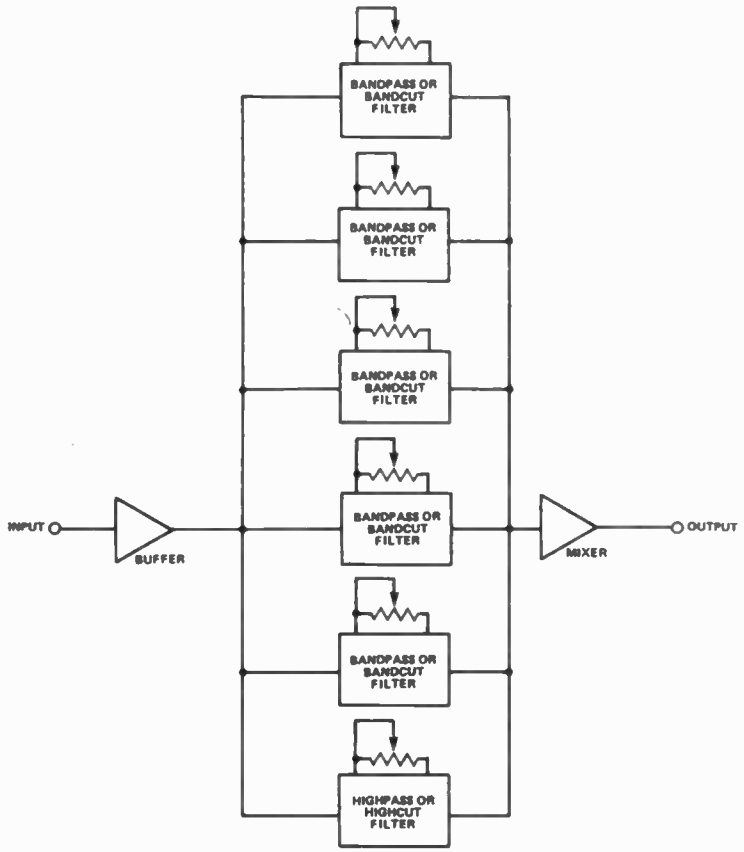


Figure 1. Circuit of the HE Guitar Graphic Equaliser

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.

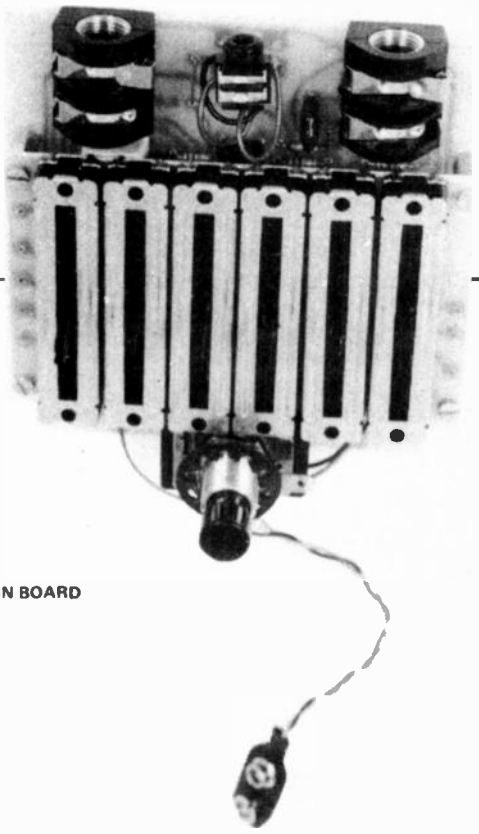


Because all integrated circuits are of the conventional 741-type operational amplifiers, they need a three-rail power supply (ie, + V, 0 V, − V). This is not possible from a 9 V battery alone, so an artificial mid-rail has to be formed electronically. Operational amplifier IC1b is a non-inverting buffer 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.



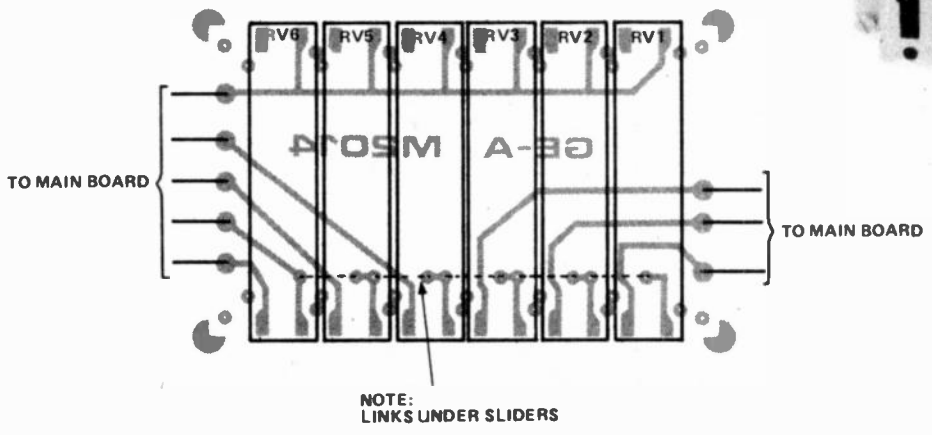


Figure 3. Component overlay of the slider PCB

HE

GREENWELD

443F Millbrook Road, Southampton, SO1 0HX

All prices include VAT@15% – just add 40p post

AMAZING! COMPUTER GAMES PCBs FOR PEANUTS!!

A bulk purchase of PCBs from several well-known computer games including Battleships, Simon, Logic 5 and Starbird enable us to offer these at incredible low prices:

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

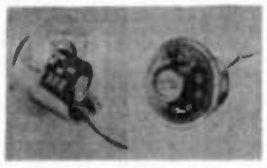
LOGIC 5

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 £2.80

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. 85 x 60mm deep Only £9.95

DEVELOPMENT 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: £7.66.**

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 ¼ 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 zeners. **PRICE: £19.95.**

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

CAPACITOR BARGAINS

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.**

1N4002 DIODES

Lowest ever price!! – full spec by Motorola. Pre-formed leads for horiz. mntg., 10mm pitch. 100V 1A rating. 100 **£1.75**; 500 **£7.50**. 1k **£14**, 5k **£65.**

TOROIDAL TRANSFORMER

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**

1,000 RESISTORS, £2.50

We've just purchased another 5 million preformed resistors, and can make a similar offer to that made two years ago, at **the same price!!! K523** – 1,000 mixed ¼ and ½W 5% carbon film resistors, preformed for PCB mntg. Enormous range of preferred values. 1,000 for **£2.50**; 5,000 **£10**; 20k **£36.**

200 ELECTROLYTICS, £4

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.**

GAS DISCHARGE DISPLAYS

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**

Z651 3 digit as above **£1.70**

Z652 3 + 2 digit as above **£2.50**

Data supplied.

FILAMENT DISPLAYS

Z653 7 seg display 12.5mm high. Ideal for TTL operation, taking 5V 8mA per seg. Std 14 DIL package. Only **£1** each, 4 for **£3.00.** Data supplied.

MK4027 SHIFT REGISTER

2048 bit dynamic shift register, 6MHz, ideal for CRT displays, buffer memories etc. Special low price **£1** each, 8 for **£6.**

OPTO/REGS/OP-AMPS

FNA5220 2 digit ½" 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**, 78C8 **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**

K505 20 assorted potentiometers, all types including single ganged, rotary and slider **£1.70**

K511 200 small value poly, mica, ceramic caps from a few pF to .02uF. Excellent variety **£1.20**

K514 100 silver mica caps from 5pF to a few thousand pF. Tolerances from 1% to 10% **£2**

K520 Switch Pack. 20 different, rocker, slide, rotary, toggle, push, micro, etc. Only **£2.**

K521 Heatshrink Pack, 5 different sizes each 200mm, 50p

PANELS

Z521 Panel with 16236 (2N3442) on small heatsink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. **60p**

Z482 Potted Oscillator Module works from 1.20V, can be used as LED flasher (3V min.). Supplied with connection data, suitable R, C & LED **£1**

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**

RELAY/TRIAC PANEL

Z537 PCB 100 x 75mm containing a wealth of components:

2 x 12v DPCO min. relays, 2 x 47uf 16v tants, SC146E 10A 500v triac, C112d 8A 400v SCR, 555 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.**

1W AMP PANELS

A011 Compact audio amp intended for record player on panel 95 x 65mm including vol control and switch, complete with knobs. Apart from amp circuitry built around LM380N or TBA820M, there is a speed control circuit using 5 transistors. 9V operation, connection data supplied **ONLY £1.50.**

VU METERS

V006. Very attractive 55 x 48mm scaled -20 to +5dB. 250uA movement. Only **£1.75** or **£3** pr.

VEROBLOC BREADBOARD

New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocs can be joined together. Bus strips on X & Y axis – total 360 connexion points for just **£4.15.**

REGULATED PSU PANEL

Exclusive Greenweld design, fully variable 0-28V & 20mA-2A. Board contains all components except pots and transformer. Only **£7.75.** Suitable transformer and pots **£6.** Send SAE for fuller details.

WHY AN ILP MOSFET POWER AMP?

Because ILP MOSFET power amps give you ultra-fi performance without costing big money. Performance you thought you couldn't afford at a price you know you can.

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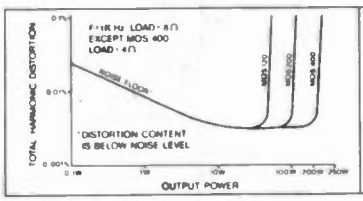

Load impedance, all models, 4 ohm — infinity
Input impedance, all models 100K ohm
Input sensitivity, all models, 500 mV
Frequency response, all models 15Hz-50kHz-3db

MOSFET Ultra-Fi, with heatsinks

Model No	Output power Watts rms	DISTORTION THD Typ at 1kHz	DISTORTION IMD 50Hz/7kHz 4:1	Supply voltage Typ/Max	Size mm	Wt gms	Price inc VAT	Price ex VAT
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).

Ultra-fi specifications:

Slew rate 20V/µs. Rise time3µs. S/N ratio 100db. Frequency response (–3dB) 15Hz-100kHz. Input sensitivity 500mVrms. Input impedance 100k. Damping factor (8Ω/100Hz)>400.

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STAY AHEAD. STAY WITH US

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.

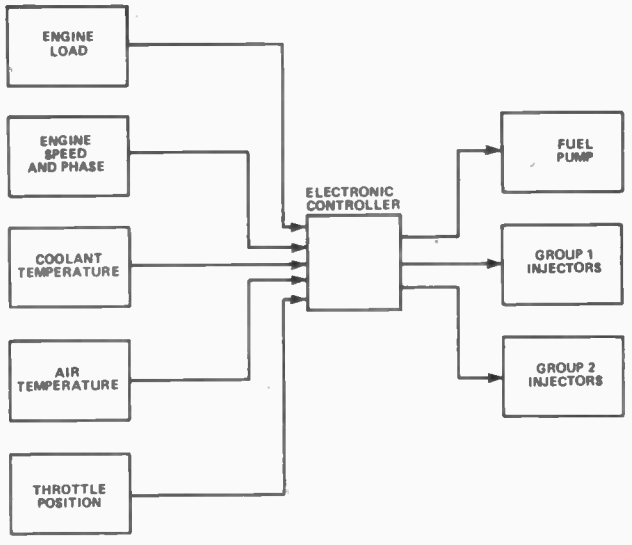

Figure 1. Input/output signals of Lucas Electrical's Electronic Control Unit

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.

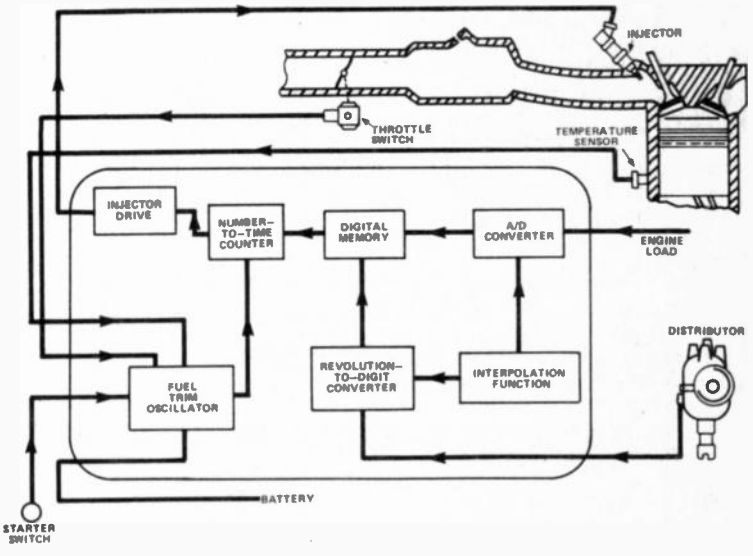

Figure 2. Signal processing with Lucas Electrical's Electronic Control Unit

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-

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.

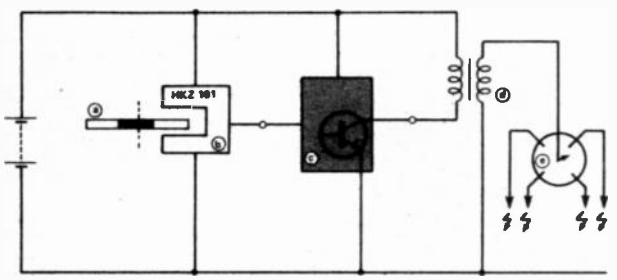

Figure 3. Siemens' integrated ignition controller used with a Hall-effect ignition system

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.

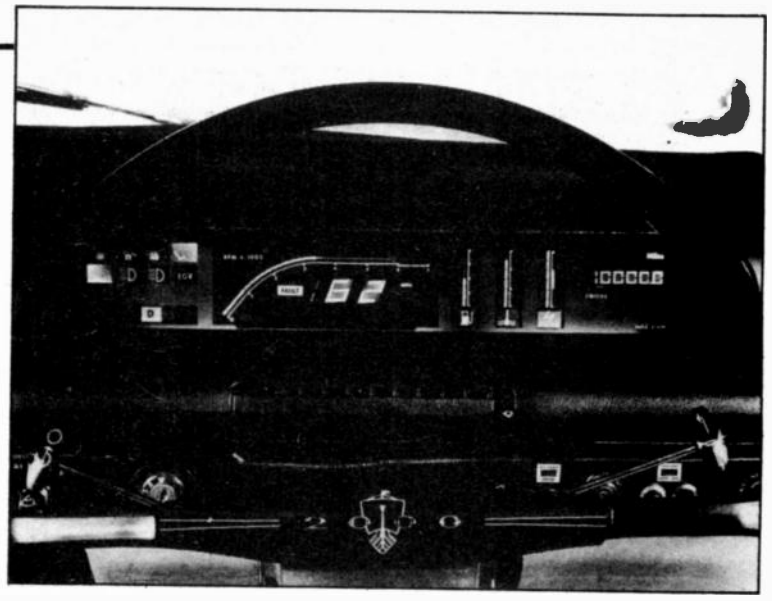

Figure 4. Smiths Industries' DC electroluminescence display system installed in a prototype vehicle

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

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HY 9	Stereo pre-amp	Two channels, mag. cartridge, mic + volume control	10 mA	£7.71	£6.70
HY 12	Mono pre-amp	Mixes two signals into one, with bass/mid-range/treble controls	10 mA	£7.71	£6.70
HY 66	Stereo pre-amp	Two channels, with inputs for mic./mag. cartridge/tape/tuner/auxiliary, with volume/bass/treble/balance	20 mA	£14.02	£12.19
HY 69	Mono pre-amp	Two input channels, mag. cartridge mic. with mixing and volume/treble/bass controls	20 mA	£12.02	£10.45
HY 71	Dual stereo pre-amp	Provides four channels for mag. cartridge/mic with volume control	20 mA	£12.36	£10.75
HY 73	Guitar pre-amp	Provides for two guitars (bass + lead) and mic with separate volume/bass/treble and mixing	20 mA	£14.09	£12.25
HY 75	Stereo pre-amp	Two channels, each mixing two signals into one with bass/mid-range/treble controls	20 mA	£12.36	£10.75

For easy mounting we recommend B 6 mounting board for modules HY6-HY13 £0.90 inc. VAT (0.78 ex. VAT) B 66 mounting board for modules HY66-HY77 £1.12 inc. VAT (0.99 ex. VAT). All modules are encapsulated and include clip-on edge connectors. All operate from + 15V minimum to + 30V maximum, needing dropper resistors for higher voltages. Modules HY6 to HY13 measure 45 × 20 × 40mm. HY66 to HY77 measure 90 × 20 × 40mm.

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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

A complete kit of parts (including case and PCB) is obtainable from:
Bewbush Audio,
26 Hastings Road,
Pound Hill,
Crawley, Sussex.
Order as DS1 kit. Price is £29.95 inclusive of VAT and p&p.

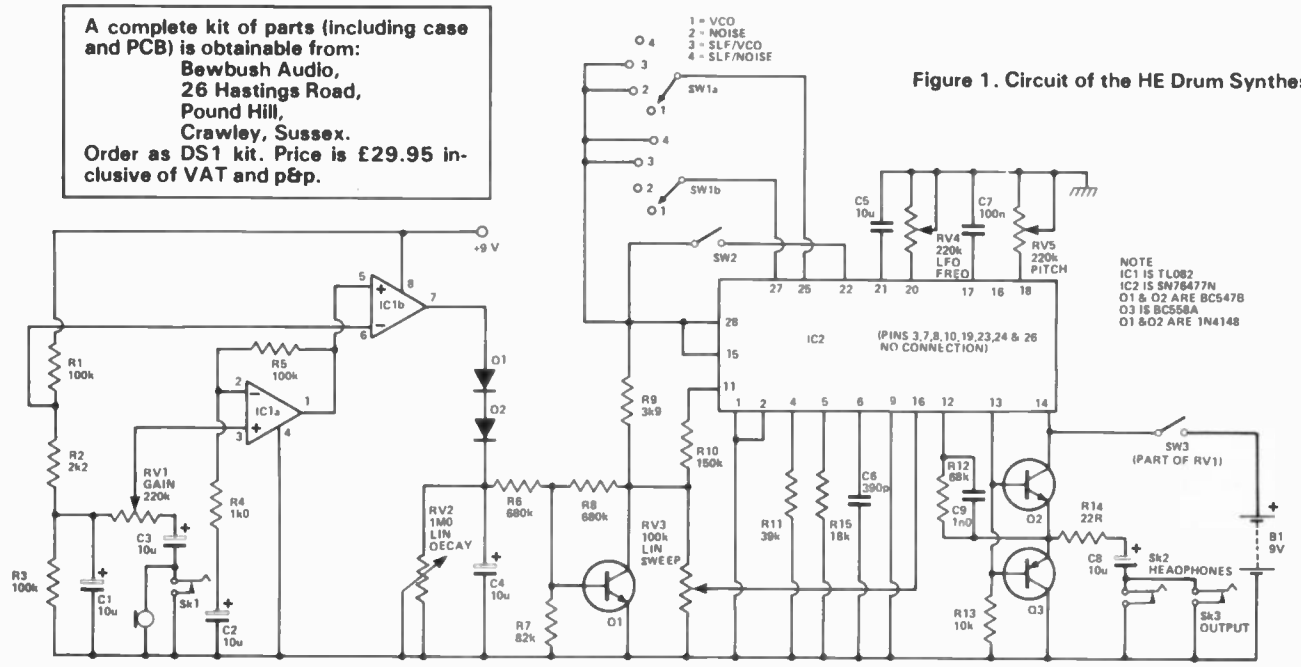
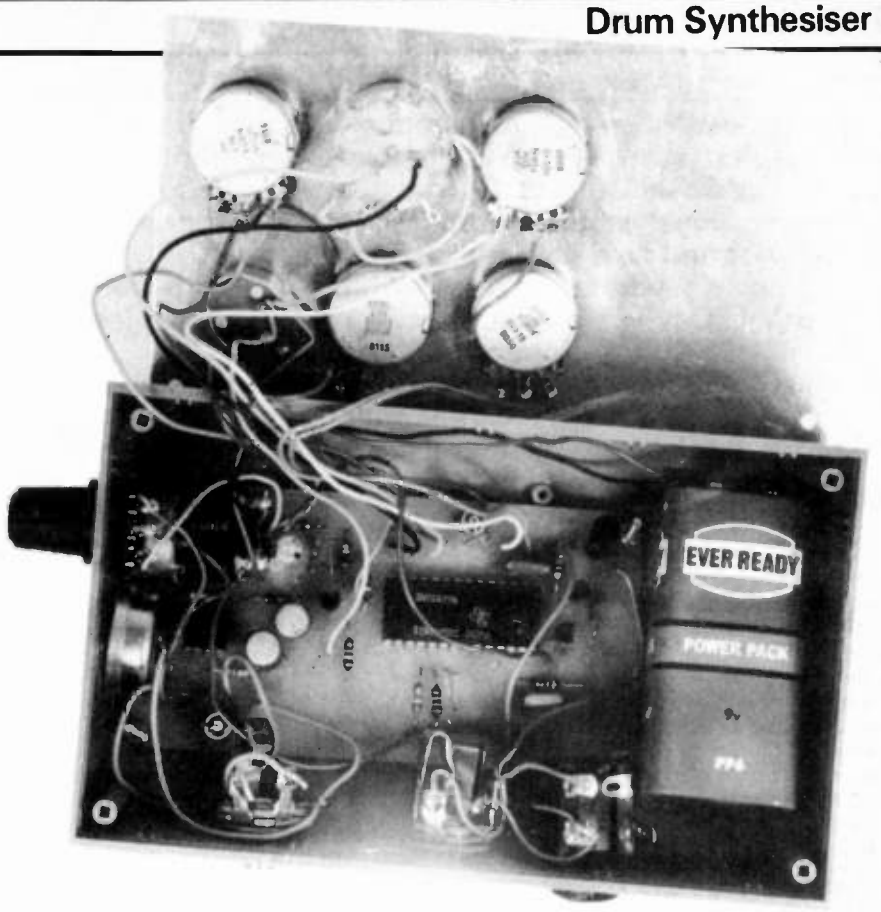


Figure 1. Circuit of the HE Drum Synthesiser

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	



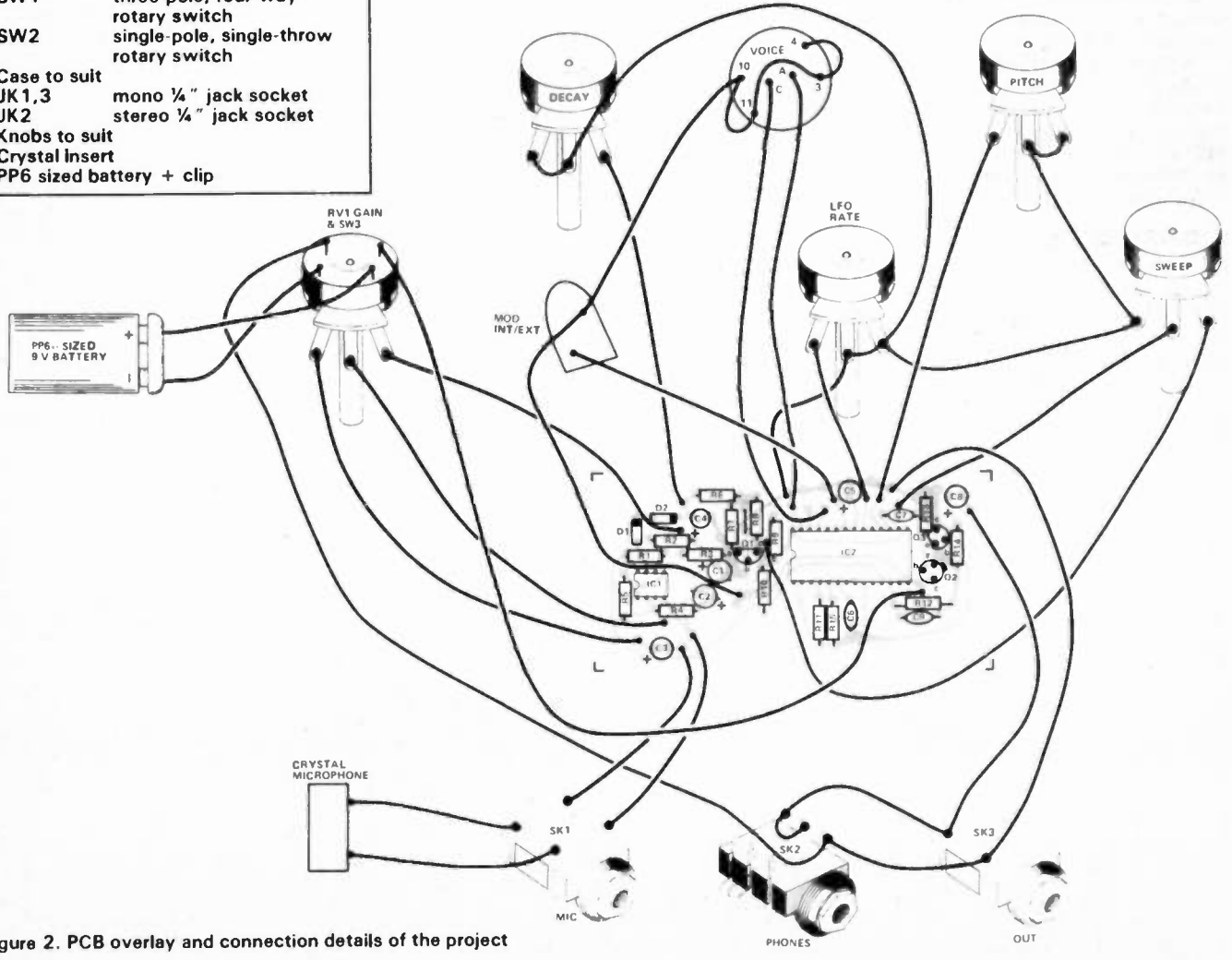


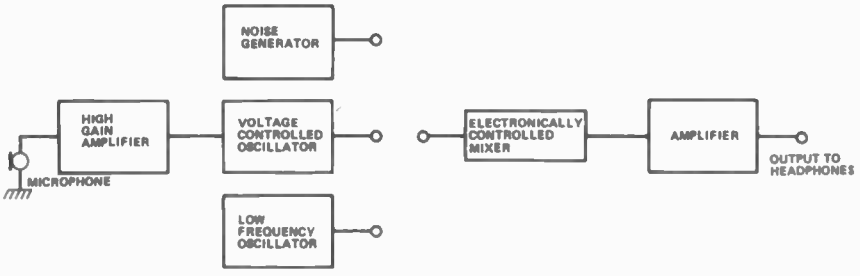
Figure 2. PCB overlay and connection details of the project

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.)

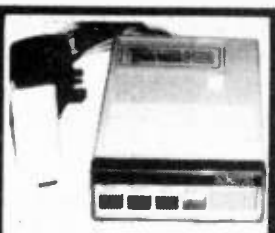
Third, try RST Valve Mail Order Company, Climax House, 159 Fallsbrook Road, London SW16 6ED, for the valves. I understand from RST that the 6V6 (GT version) costs £1.60 and the 6L6 (GC version) costs £2.50. Postage charge to Norway (both valves sent together) is 72p.

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



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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.

£8.95 + 50p P&P

2-SPEED MICRO CASSETTE RECORDER

This is a very compact pocket size cassette recorder. It can be used for dictating or any other speech recording purpose. The high speed gives 15 mins of recording on each side and low speed gives 30 mins each side. It runs on 1 PP3 battery or an external 9V DC supply

£19.95 + £1.95 P&P

FLUORESCENT PORTABLE LIGHT

A very useful battery-operated high-power fluorescent light for use in the car or for camping. Uses 8 'D' size cells and it has a socket for 12V DC input for use in the car. Power consumption is 6 watts. New circuit makes batteries last longer.

£4.95 + 95p P&P

FM WIRELESS MICROPHONE

This high quality Electret microphone can be tuned to transmit in the range 85-95MHz FM. It can be received on any FM receiver, the range depends on the sensitivity of the receiver. Uses one penlight battery which fits inside the microphone. Ideal for parties, discos and clubs.

£8.95 + 50p P&P

TALKING WATCH

Speaks the time plus digital display. Speaking and musical alarm function. Lightweight and easy to set and use. Stainless steel strap.

£49.95 + £1.95 P&P

SPACE INVADER BLOCK BUSTER

Two electronic games in one, with 2 skid levels, 2 digit score and sound effects. It plays a tune at the end of each game.

£15.95 + 95p P&P

WALKIE TALKIES WITH AM RADIO

These walkie talkies have AM radio built into them. Other features include Morse Code key, volume control and telescopic antenna. Frequency 49MHz AM. Range approx. ⅛th mile.

£19.95 per pair + £1.95 P&P

LADY'S SUGAR COATED WATCH

Beautifully styled lady's LCD watch with matching bracelet, functions include: hours, mins, secs, month, date and back light. Super value for money. Its available in chrome or gold colour.

£5.95 + 50p P&P

CASIO AX-210 LCD ANALOGUE + DIGITAL WATCH

LCD and Digital Display shown side by side. Functions include: daily, hourly & countdown alarms, dual time and stopwatch mode, three selectable melodies, chrome finished case with dark blue surround, and adjustable stainless steel bracelet.

£25.95 + 50p P&P

GAME & WATCH

Watch/game combination. 4 games available, each with two options. Fireman (pictured above) rescuers catch the LCD figures in a net as they jump from a burning building and bounce them into the ambulance. Also available – Exterminator, Juggler and Flagman.

£13.95 + 75p P&P (EACH)

SEARCH 2 WALKIE TALKIES

These are good quality walkie talkies made by GENERAL ELECTRIC CO. Features include Morse Code key and colour code telescopic antenna. Frequency 49MHz AM. Range approx. ⅛th mile. Price elsewhere £19.95. Our price

£12.95 per pair + £1.95 P&P

PUSHBUTTON TELEPHONE

This is a superbly styled, one piece, very compact push button telephone with last number redial facility (on pressing one button it will redial the last number you dialled). A special MUTE Button enables you to talk at your end without the other party hearing you. The electronic buzzer can be switched on or off.

£23.95 + £1.95 P&P

LEGAL FM CB TRANSMITTER AND RECEIVER

£79.95 + £2.90 P&P

SAE for details

QUARTZ TRAVEL ALARM CLOCK

This is a very versatile alarm clock, you can use it in the car, in the kitchen or as a desk top clock. Large (1cm character size) display makes it easy to read from a distance. It has 4-year auto calendar, backlight, AM/PM indicator and alarm on indicator.

£7.95 + 75p P&P

MINI COM WALKIE TALKIES

These are very neat and very small walkie talkies, they will fit in your pocket. Ideal gift for all ages. Frequency 49MHz AM. Range approx. ⅛th mile. Our price per pair is

£10.95 + 95p P&P

SLIM PENDANT WATCH

This watch is beautifully designed as a slim pendant and comes complete with a 26in. long neck chain. The functions include: hours, minutes, seconds, day, month and 4-year auto calendar. Comes in gold colour and is ideal for day and night wear.

£6.95 + 50p P&P

AM/FM STEREO RADIO

This is a lightweight 2-band receiver with hot line facility to let you know what is going on around you. It comes complete with stereo headphones and a carrying case. You can wear it on your belt or carry it on your shoulder.

£19.95 + £1.95 P&P

2-BAND HEADPHONE RADIO

You can buy this AM/FM Headphone radio for the price of just headphones. Runs off a single PP3 battery, has a voluma control and a telescopic aerial for FM waveband. The ideal gift for youngsters.

£9.95 + £1.95 P&P

CAR STEREO PLAYER WITH AM/FM-MPX RADIO

This compact, quality product is designed to provide you with exceptional listening pleasure. The features include: AM/FM dial-in-door, local, distance attenuator switch for better stereo reception, AM/FM indicator, FM stereo indicator. Fast forward and eject button for cassette, balance, volume and tone controls.

£29.95 + £1.90 P&P

Suitable speakers £5.00 per pair + 95p P&P

CB/TV1-FM/ AIR-PB-WB PORTABLE RADIO

This is a specialist receiver and it covers frequency bands which are not available on ordinary receivers. It covers 54-176MHz and also receives 40 channel CB. It has volume and squelch controls.

£14.95 + £1.25 P&P

SILENT ALARM/ POCKET PAGER

This is an individually coded 4 watt radio transmitter and pocket pager receiver. It has a range of 2 miles. It can be used to protect your vehicle or a property and can also be used for paging. Power requirement for transmitter is 12V D.C

£89.95 + £2.95 P&P

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Radio Controlled Porche 928	£21.95 + £1.95 P&P
Smoke Detector Fire Alarm	£7.95 + 75p P&P
Electric Car Aerial	£7.95 + £1.20 P&P
Mini Socket Set, 17 Pcs	£3.50 + £1.10 P&P
Car Coffee Maker	£3.50 + 75p P&P
Lady's 5F LCD Watch	£3.50 + 50p P&P
Gents 5F LCD Watch	£3.50 + 50p P&P
Slim Pen Watch	£5.95 + 50p P&P
Jewellers Screwdriver Set (5)	75p + 25p P&P
2 Station Intercom/Baby Alarm	£5.95 + 75p P&P
Electronic Lighter (Battery)	£3.95 + 50 P&P
Electronic Lighters (Piezo Electric)	£4.25 + 50p P&P
Car Stereo Casst Player, 16W Output	£14.95 + £1.50 P&P

HANDHELD SPACE INVADERS

A superb game, provides endless fun for children and adults alike. (WARNING – THIS GAME CAN SERIOUSLY EFFECT YOUR PASTTIME.) It gives you 90 seconds to hit enemy craft. The elapsing time and 4 digit score is constantly displayed. Score is decremented if you hit a friendly ship or if enemy missile penetrates your defence.

£10.95 + 75p P&P

MINI LCD DESK CLOCK

This is a very versatile desk clock with large (15mm high) digit LCD. Functions include hours, mins, secs, month and date

£7.95 +75p P&P

TALKING ALARM CLOCK/STOPWATCH

This 'Sharp' Talking Clock is a 'state-of-the-art' product. On pressing the button it announces the time. At the preset alarm time a musical alarm is played and again the time is announced. It has 5 mins. snooze facility. Also has a useful timer and speaks time elapsed every 1 min., 5 mins. or 30 mins., whichever is selected in the stopwatch mode it announces the elapsed time at preset intervals or on pressing of a button at any time it is an ideal gift, especially useful for blind people. Overall size is 11.4 × 6 × 2.2cms.

£39.95 + £1.95 P&P

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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.

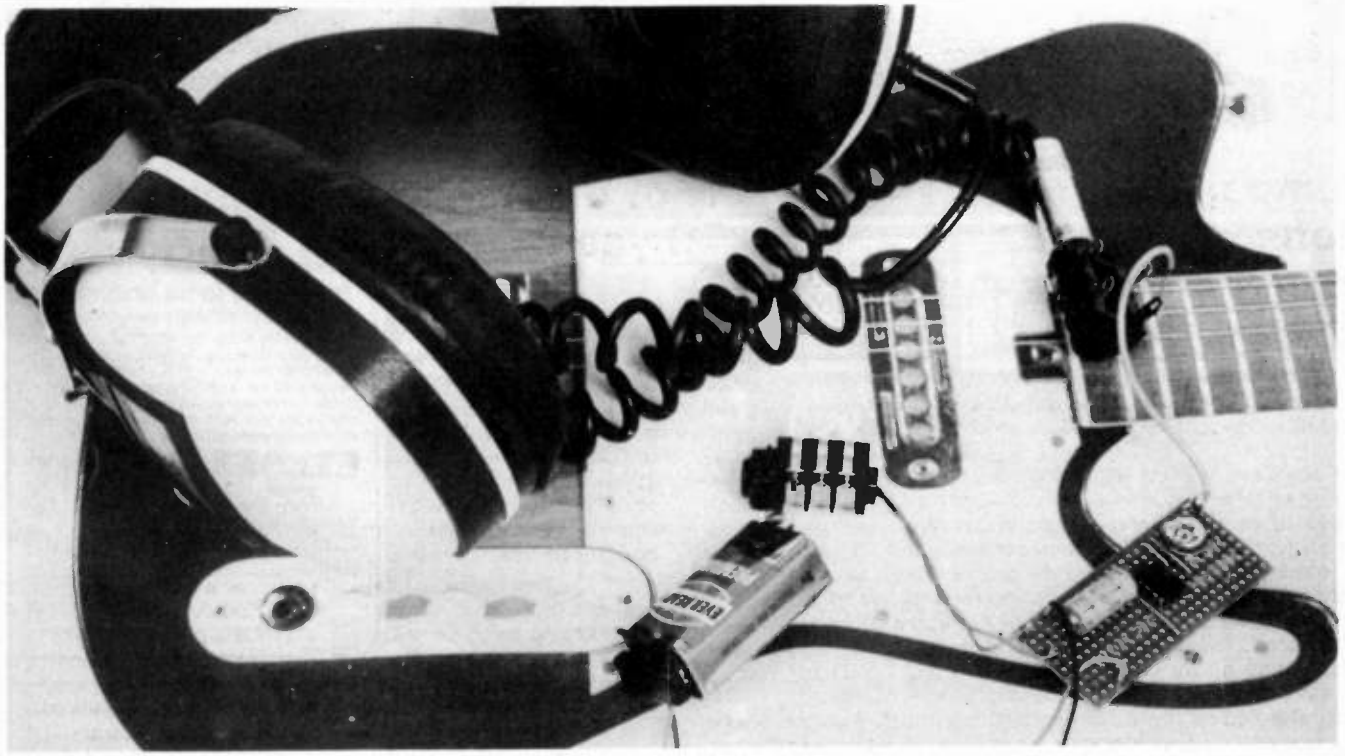
Ahead Of His Time

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.

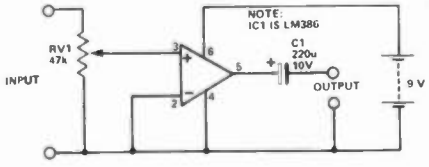


Figure 1. Circuit of the HE Guitar Headphone Amplifier

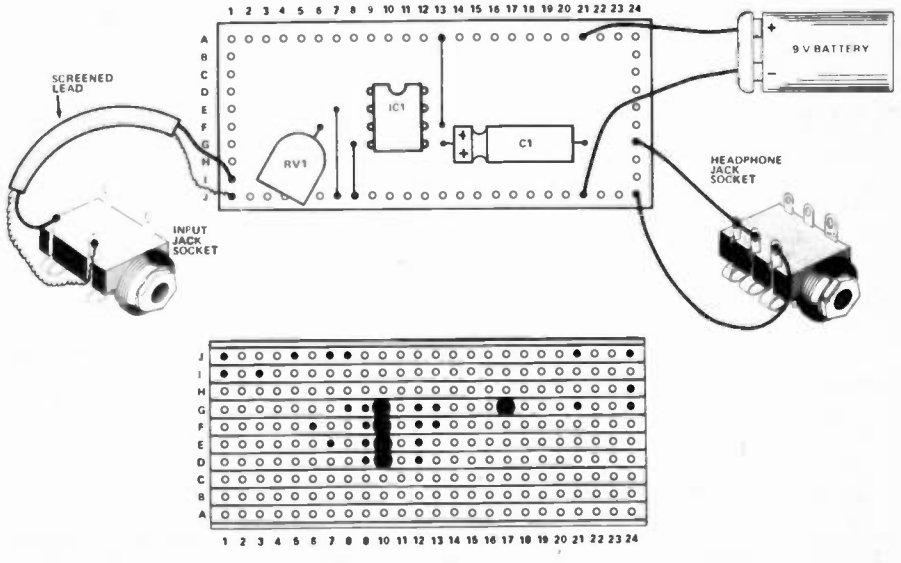


Figure 2. Veroboard overlay and underside view (showing component locations and track breaks) along with connection details of the project

HE

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.

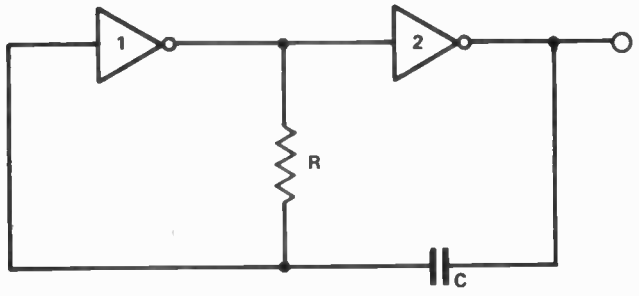


Figure 1. Simple CMOS astable multivibrator

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:

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

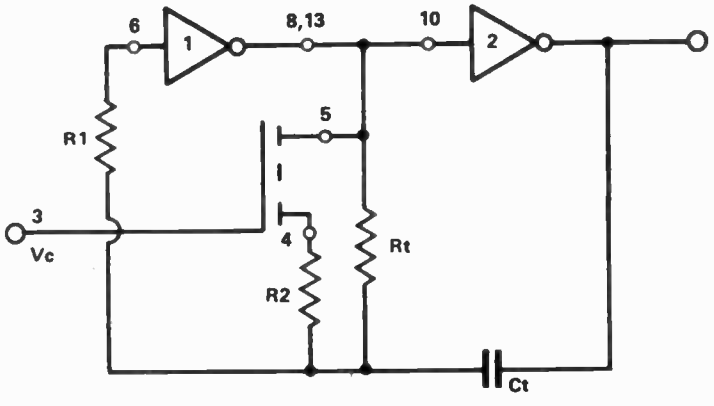


Figure 2. Voltage controlled oscillator using CMOS inverters and a CMOS field-effect transistor. Pin numbers relate to the 4007 integrated circuit. Supply connections are not shown

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.

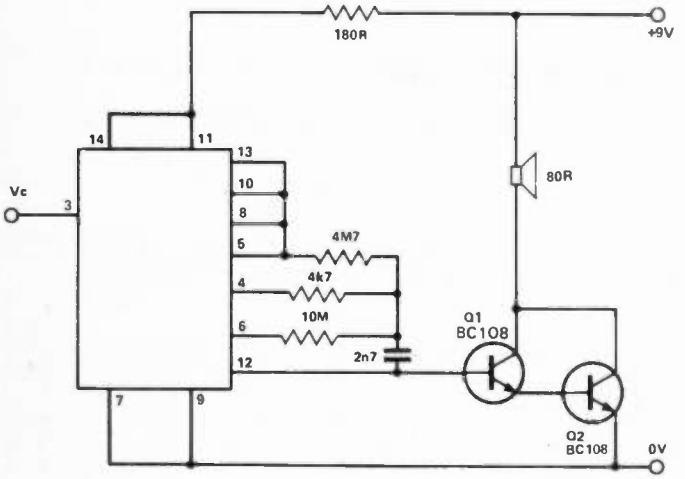
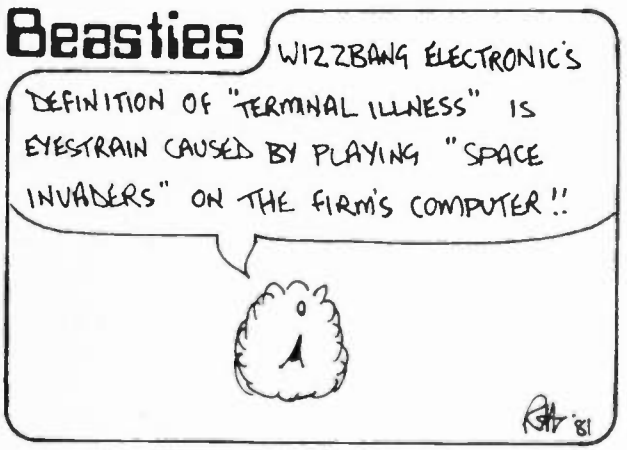
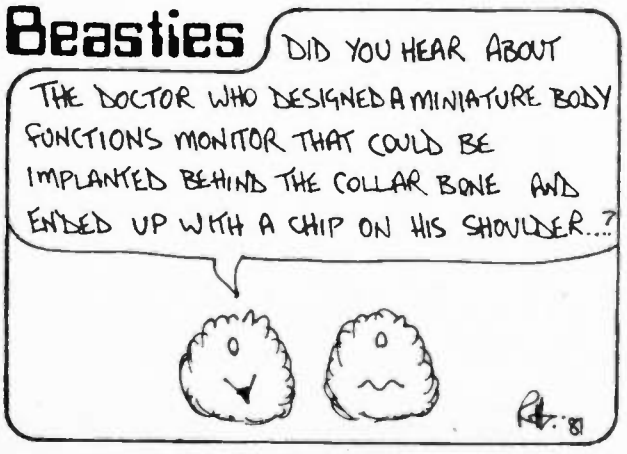


Figure 3. Complete circuit of a VCO based on the 4007

HE





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Sound Bender Kit £20.76, less case £15.78.

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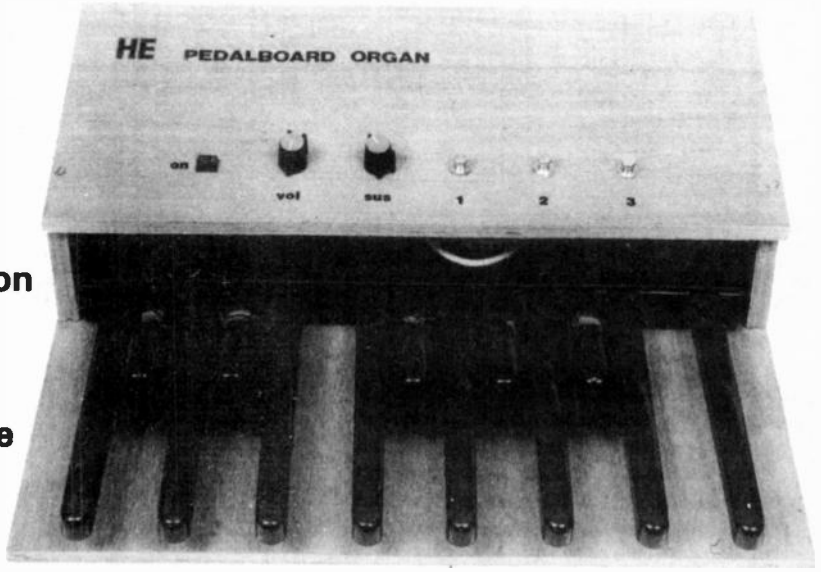
PEDALBOARD ORGAN



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 B-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.

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	MO83 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

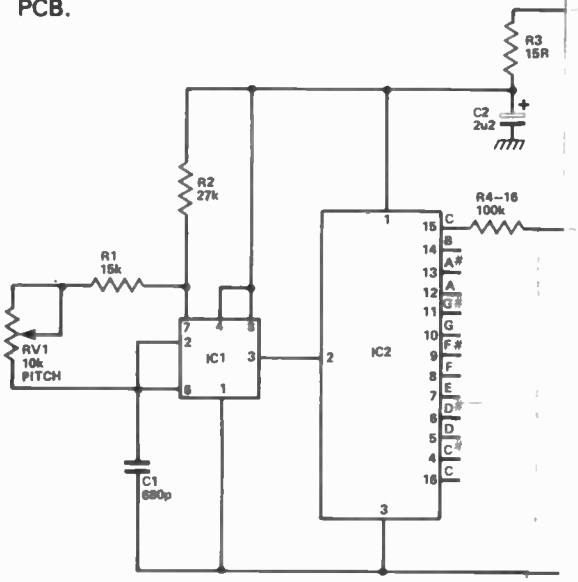
SW1	double-pole, double-throw toggle switch
SW2,3,4	push-on, push-off switch
T1	240/24 V mains transformer
Neon with integral resistor	
SK1	mono ¼" jack socket
AL30A	10 W power amplifier module
Knobs to suit	
13-note pedalboard (see Buylines)	
3-way terminal block	
Wood for case	

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.



Buylines

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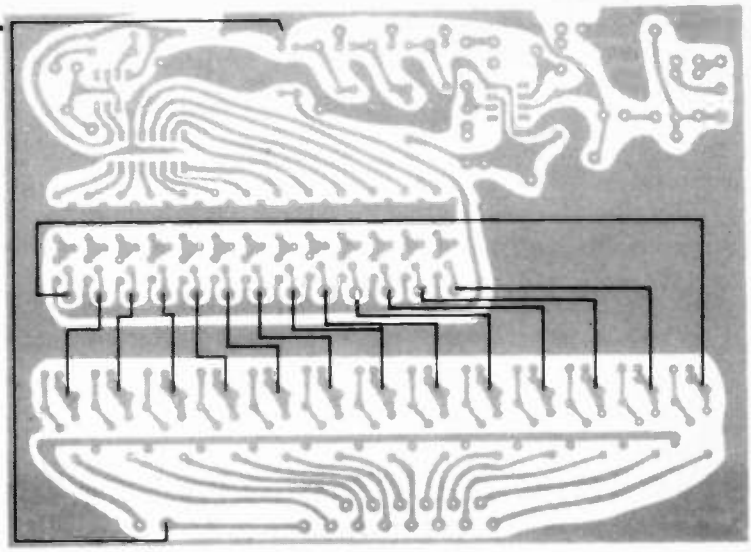
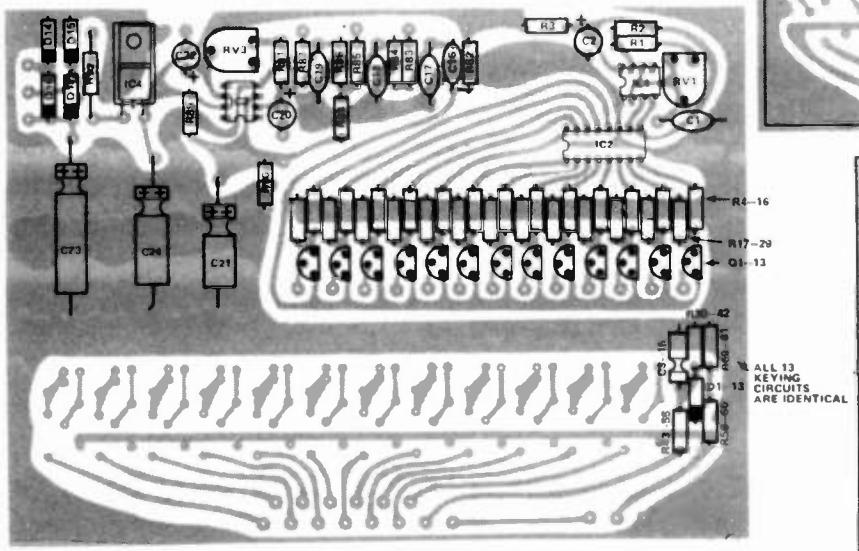
St Albans,
Herts AL1 4NS
Kit price is £58. This includes VAT but please add £4 to cover p&p.
The pedalboard alone will cost you £22 plus £3 to cover p&p.
Delivery within the UK only.

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





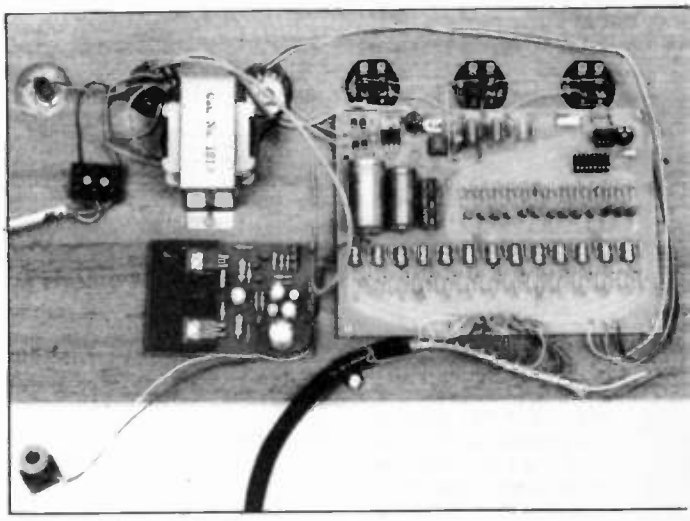


Figure 2. PCB overlay and connection details of the project

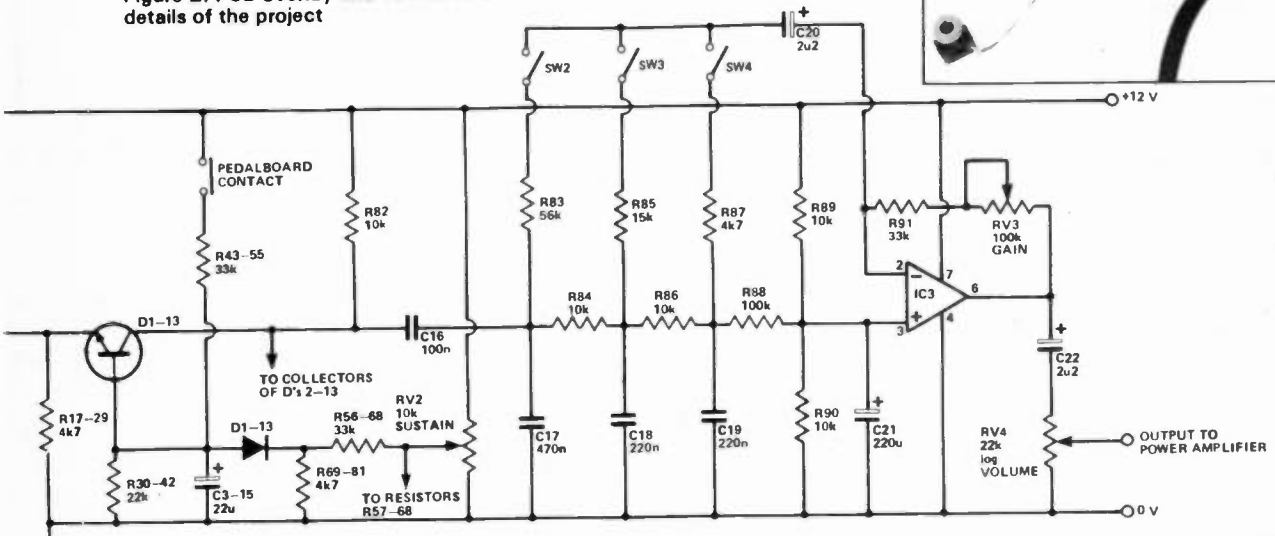
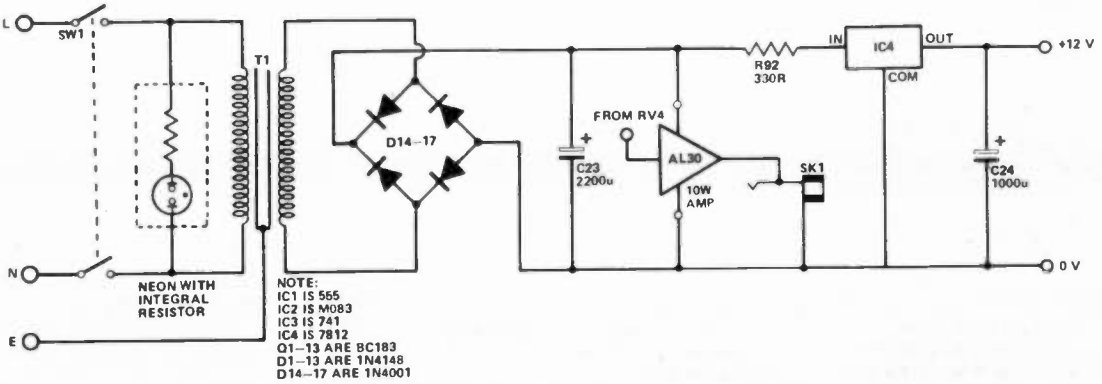


Figure 1. Circuit of HE Pedalboard Organ



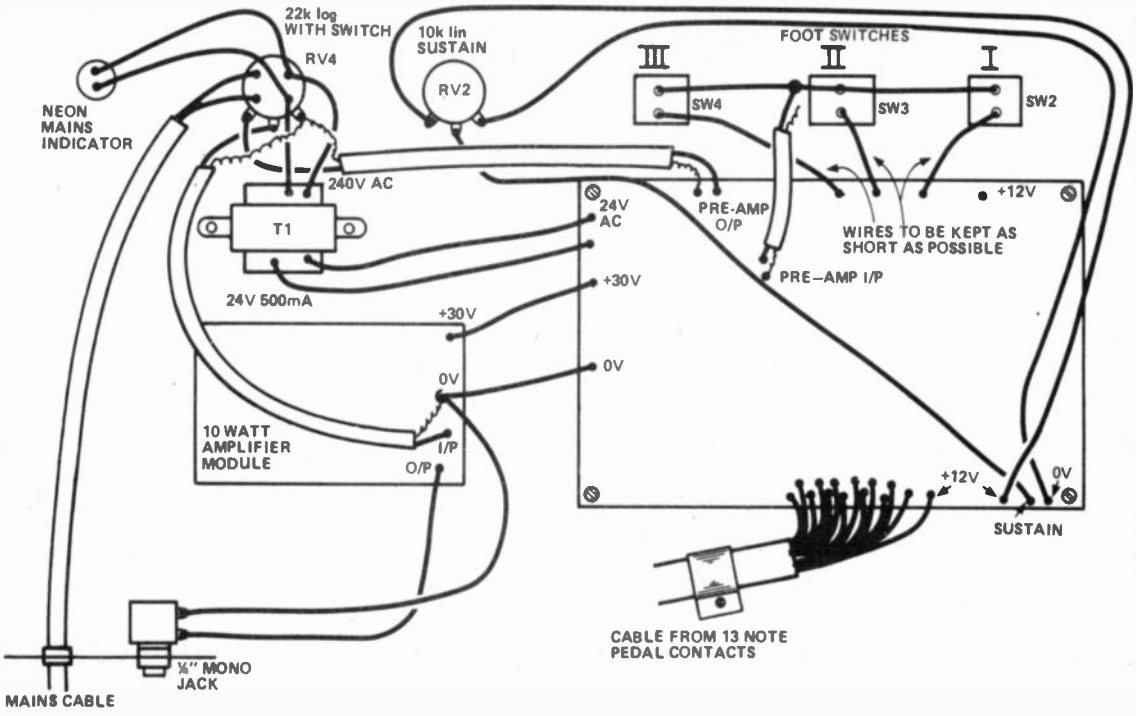
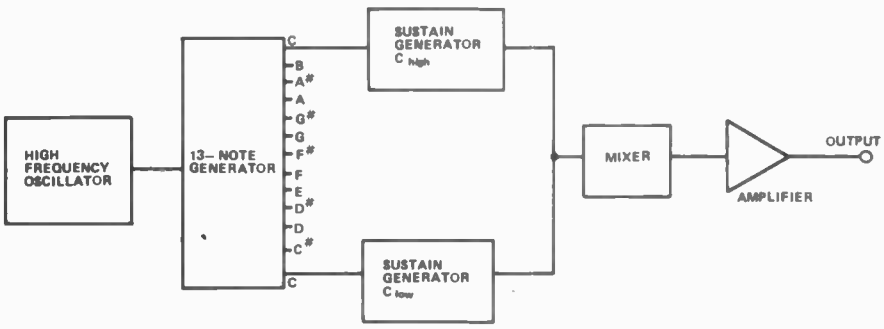


Figure 4. Connection details

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.

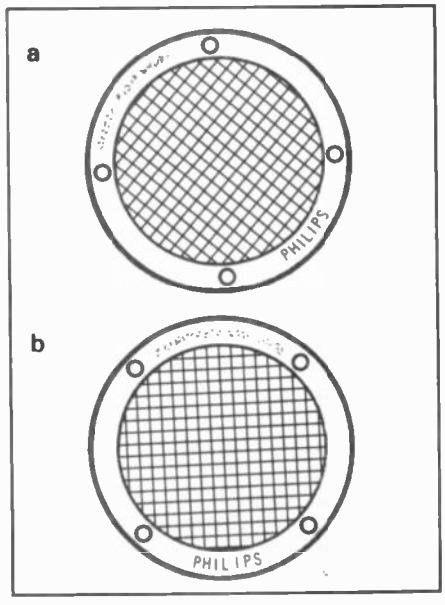
Installation

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**).



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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.

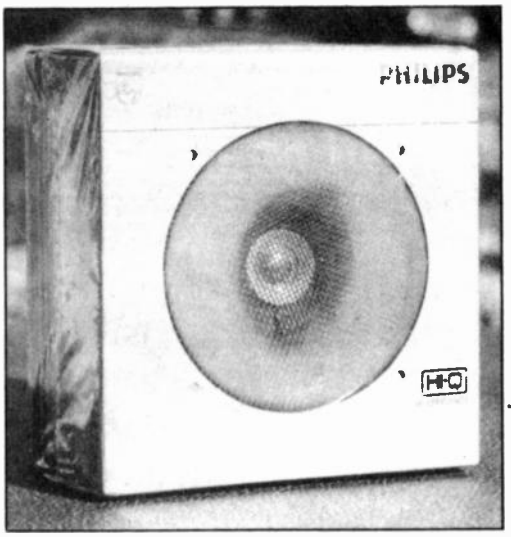
● We contacted Philips about our niggles. The spokesman was surprised to hear that grommets had not been included in the kit: he claimed that they were supplied with most Philips car radio kits. The omission of plugs on the leads was more a result of company policy, because the plugs are usually supplied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

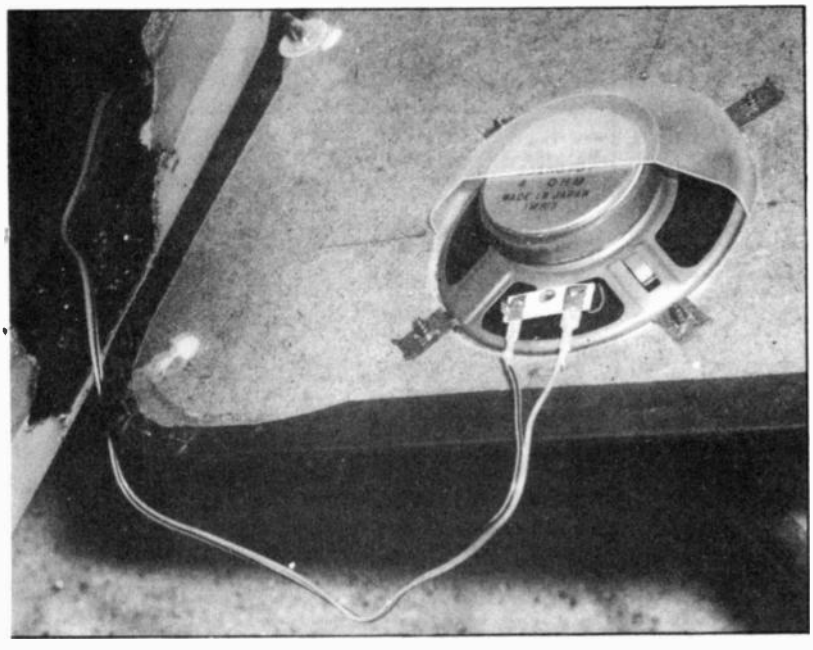
The spokesman also passed on some tips about those grommets. To prevent rusting, after the holes have been drilled in the doors and car body it is advisable to apply a little petroleum jelly (such as Vaseline) around the holes. Some of the jelly applied to the flex as it enters each grommet also helps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

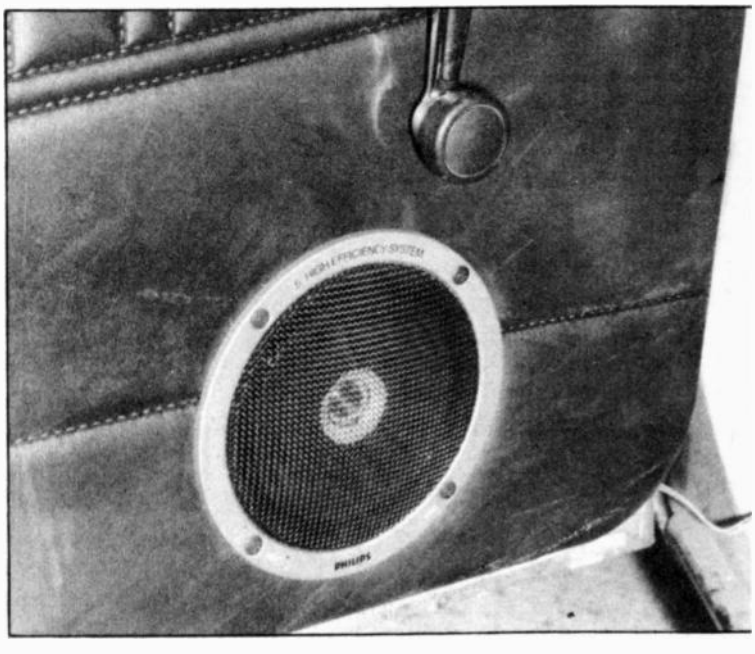
● A further note about installation: the EN8751s *will* mount in the doors of a series-2 Ford Escort without the need to cut any metal from each door. However, when the speakers are mounted in the ready-cut aperture in the doors, the window-winding handle is uncomfortably close to the loudspeaker and 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.







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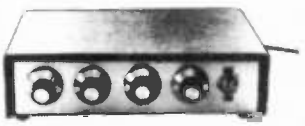

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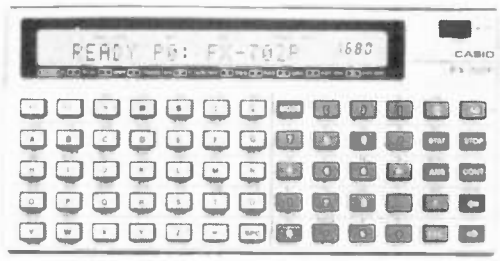

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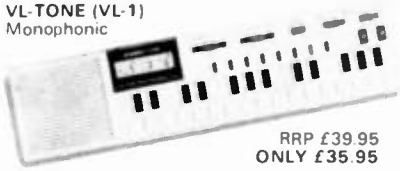

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RRP £79
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The light weight (3.5lb) and battery power allows enjoyable playing anywhere of piano, violin, flute and organ over 2½ octaves. Built-in vibrato function. 16½ x 5⅜ x 2". With soft carrying case.

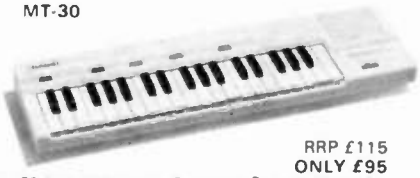
NEW

CT-403

RRP £325.00
ONLY £275.00

25 instruments over 4 octaves. Four voice memory function with push button selection. Vibrato and sustain switches. 16 rhythm accompaniments with fill-in variation. Casio Auto Chord for one finger or auto playing of major, minor and 7th chords with bass. Ten functional controls including pitch. AC only. 4⅜ x 30⅛ x 11¾. Weight 17.6lbs.

MT-30



RRP £115
ONLY £95

22 instruments over 3 octaves. Four position voice memory function. Built-in Vibrato and sustain. Battery or mains. 22¾ x 6½ x 2½". Weight 6lb.

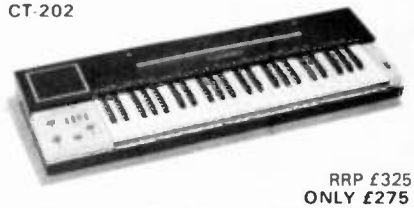
NEW

CT-101

RRP £255
ONLY £225

25 instruments over 4 octaves. Four voice memory function with push button selection. Built in vibrato and sustain. Pitch control. AC only. 30⅜ x 11¾ x 4⅜. Weight 16.8lbs.

CT-202



RRP £325
ONLY £275

"Son of success... The two harpsichords demonstrate the Casiotone's talent for sparkling, crystal clear tones... Even more impressive is the clav..."
(Melody Maker)
49 instruments over 4 octaves. 4 voice memory function with push button selection. 3 vibrato settings and sustain. Pitch control. O/P jacks. AC only. 3½ x 34½ x 11½". 16.8lbs.

OPTIONAL ACCESSORIES

CS-H domestic stand for CT- series	£25.00
CS-P professional stand for CT-series	£27.00
SP-1 sustain pedal for CT- series	£12.00
VP-1 volume pedal for CT- series	£25.00
AD-1E mains adaptor for M-10/MT-30	£5.00
AD 4160 mains adaptor for VL-1	£5.00
HC-2 hard case for CT-301	£44.00
HC-3 hard case for CT-202	£44.00
HC-5 hard case for CT-101/403	
PC-1 hard case for MT-30	£9.95

PRICE includes VAT and P&P. Send your company order, cheque, PO or phone your Access or Barclaycard number to

TEMPUS

LEADING CASIO DISTRIBUTOR

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Telephone: 0223 312866

ORDER FORM back page

NEW PACE RUNNER

J-100
RRP
£22.95

ONLY
£19.95

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

NEW

World's most versatile watch

10 alternative displays - over 60 useful functions

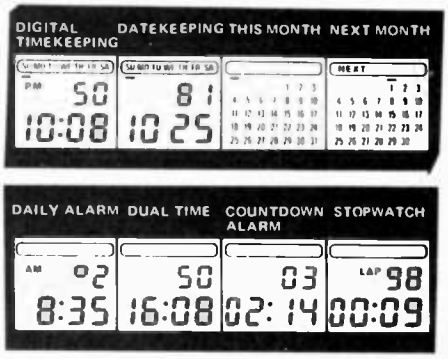
AX-210 Specification

Analog Display

CASIO AX-210 (RRP £34.95) ONLY £29.95

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.



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

NEW

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.

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. £8.95. 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

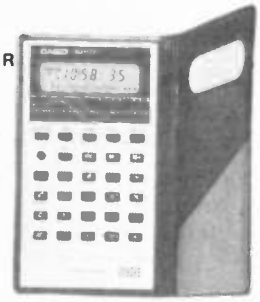
FT-7

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



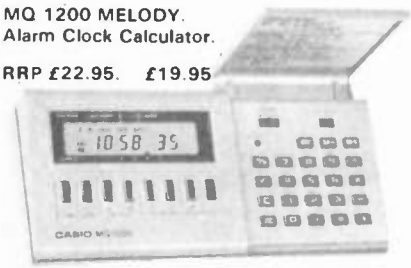
Calendar, two alarms, countdown alarm, stop-watch, time memory, three date memories, date and **BIORHYTHM CALCULATIONS**.
¼ x 2-7/16 x 4⅜"

RRP £18.95 **£16.95**

MQ 1200 MELODY.

Alarm Clock Calculator.

RRP £22.95. **£19.95**



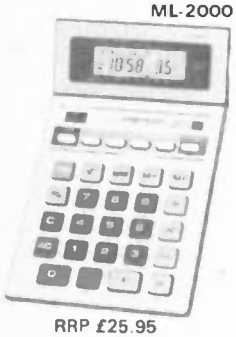
12 Melodies, 2 alarms, date memories, anniversary memories, calendar, night light. 1-9/16 x 6 x 2¾ inches. 7 ounces.

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

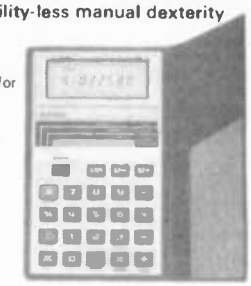
Mozart No. 40 or Buzzer.
Hourly chimes.
Snooze facility
1¾ x 4½ x 3in.

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 %

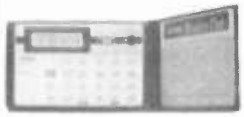
RRP £12.95
ONLY £10.95

MG-880 DIGITAL INVADERS

Our best selling calculator last Christmas.

MG-880

MG-770 Card Size



RRP £14.95. **£12.95**

RRP £12.95 **£10.95**

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

UC-365 MELODY

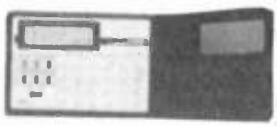
Alarm Clock Calculator.

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



UC-3000

RRP £21.95 **£19.95.**

Specifications as UC-365 above

RRP £30.95
£27.95

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

GENERAL SPECIFICATIONS

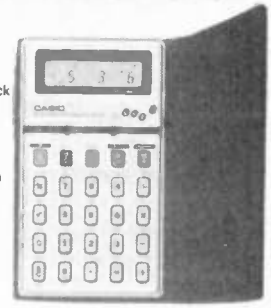
All casio calculators listed have liquid crystal displays for long battery life and a (minimum) 8 digits, with floating decimal point.
Alarm clock calculators all have a one year battery life, pre-programmed automatic calendar adjustment* and hourly time signals. (*Except FX-6100).

NEW

INSTANT MUSICIAN!

Electronic Musical Instrument and Calculator

VL-80

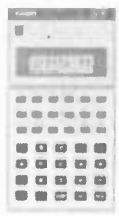


Records and plays back notes as a melody.
ONE KEY PLAY
AUTO PLAY
Manual play
Melody demonstration
Vibrato effect
8.5 x 68 x 118.5mm

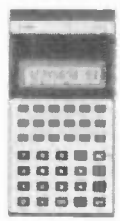
Price/delivery on application.

SCIENTIFICS at discount prices.

FX-81



FX-100



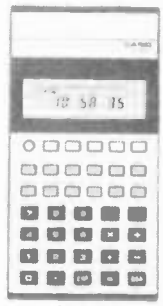
FX-550

£12.95 **£16.95** **£19.95**

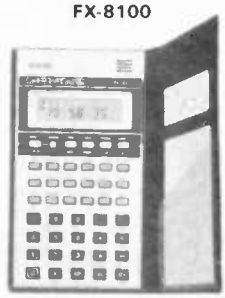
FX-81 8 digits, 30 scientific functions. 2x AA batteries last 4,000 hours. ⅜ x 3 x 5⅛"
FX-100. 10d. 44 sc.f, otherwise as FX-81
FX-550. 50 sc.f. 1,300 hour lithium battery. 5/16 x 2⅞ x 5¼". Wallet.

WITH CLOCK AND ALARM

FX-6100



FX-8100

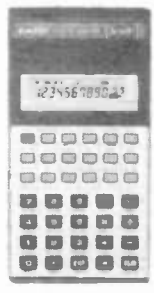


£14.95 **£24.95**

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. ⅜ x 3 x 5⅛".
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



FX-3600

£19.95 **£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 5⅛".
FX-3600P. Wallet version of above with hyperbolics and 1,300 hour lithium battery. 9/32 x 2⅞ x 5¼"

"BASIC" POCKET COMPUTER

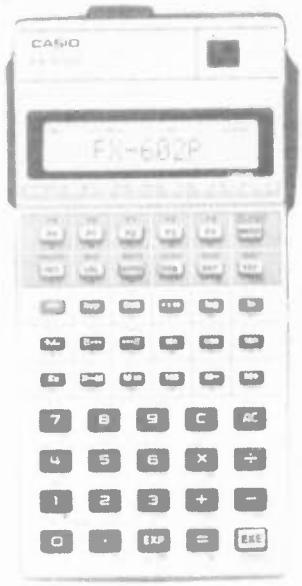
FX-702P

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:

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The Beaumont Centre, 164-167 East Road, Cambridge CB1 1DB. Telephone 0223 312866

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

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

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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

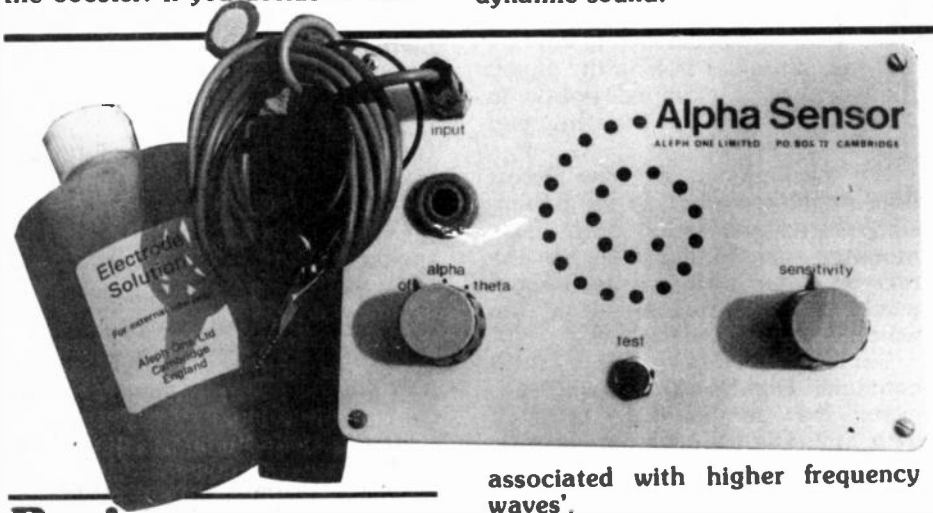
Listening to the speakers under test it was of no surprise to find, with speakers of this size, that bass response was limited and power handling capacity was lower compared with door-mounting types. However, they have the advantage of being easier to fit than door-mounted speakers, and, played within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

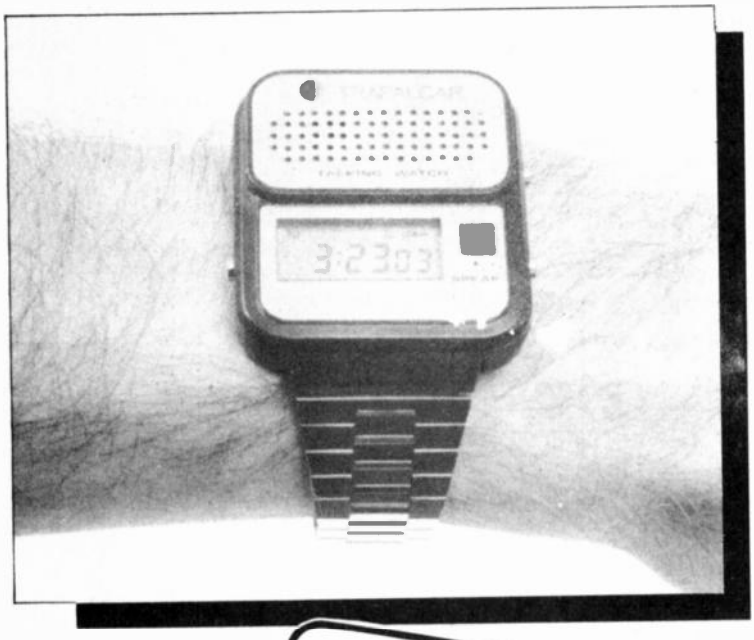
Now you can settle back, relax and close your eyes. If you can remain quiet but alert and free from distraction, you should soon hear the characteristic tone associated with alpha waves. With practice it should become easier to produce them and the sensitivity control can be turned down to decrease noise.

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

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.

COMPUTER COMPONENTS

TTLs by TEXAS

7400	11p	74368	55p	4015	60p	LINEAR I.Cs	
7401	11p	74390	100p	4016	30p	AN103	200p
7402	12p	74393	100p	4017	45p	AY1-0212	600p
7403	14p	74490	120p	4018	60p	AY1-1313	668p
7404	14p	74LS SERIES		4019	32p	AY1-1320	320p
7405	18p	74LS00	12p	4020	60p	AY1-5050	140p
7406	27p	74LS01	14p	4021	65p	AY3-8910	700p
7407	27p	74LS02	14p	4022	70p	AY3-8912	650p
7408	16p	74LS03	14p	4023	20p	AY5-1224A	240p
7409	16p	74LS04	15p	4024	40p	AY5-1315	600p
7410	15p	74LS05	15p	4025	20p	AY5-4007D	520p
7411	20p	74LS08	16p	4026	130p	CA3028A	120p
7412	20p	74LS09	15p	4027	32p	CA3019	80p
7413	25p	74LS10	15p	4028	60p	CA3046	70p
7414	35p	74LS11	15p	4029	75p	CA3048	225p
74C14	60p	74LS13	25p	4030	40p	CA3080E	72p
7416	25p	74LS14	45p	4031	170p	CA3086	48p
7417	25p	74LS20	15p	4034	160p	CA3089	225p
7420	17p	74LS21	15p	4035	80p	CA3090AQ	375p
7421	30p	74LS22	20p	4036	295p	CA3130E	90p
7422	20p	74LS26	20p	4039	295p	CA3140	50p
7423	22p	74LS27	18p	4040	55p	CA3160E	100p
7425	28p	74LS30	15p	4041	70p	CA3161E	140p
7426	30p	74LS32	16p	4042	55p	CA3162	450p
7427	25p	74LS37	16p	4043	60p	CA3189E	300p
7428	30p	74LS38	16p	4044	70p	CA3240	120p
7430	15p	74LS42	40p	4046	70p	CA3280G	200p
7432	25p	74LS47	40p	4047	75p	DAC1408-8	200p
7433	27p	74LS51	15p	4048	55p	HA1388	270p
7437	27p	74LS55	30p	4049	27p	ICL7106	850p
7438	30p	74LS73	25p	4050	27p	ICL8038	300p
7440	17p	74LS74	20p	4051	60p	ICM7555	80p
7441	70p	74LS75	28p	4052	80p	LC7120	600p
7442A	50p	74LS76	20p	4053	60p	LC7130	475p
7445	60p	74LS83	45p	4054	130p	LF347	160p
7446A	93p	74LS85	65p	4055	125p	LF351	48p
7447A	45p	74LS86	24p	4056	120p	LF353	100p
7448	45p	74LS90	35p	4059	500p	LF356P	95p
7450	17p	74LS92	40p	4060	90p	LF357	120p
7451	17p	74LS93	35p	4063	100p	LM10C	425p
7453	17p	74LS95	45p	4066	35p	LM301A	27p
7454	17p	74LS96	110p	4067	400p	LM311	75p
7460	17p	74LS107	45p	4068	18p	LM318	200p
7470	36p	74LS109	30p	4069	18p	LM319	225p
7472	30p	74LS112	34p	4070	18p	LM324	45p
7473	30p	74LS113	30p	4071	18p	LM335Z	140p
7474	23p	74LS114	30p	4072	18p	LM339	65p
7475	38p	74LS122	42p	4073	20p	LM348	75p
7476	30p	74LS123	50p	4075	20p	LM358P	75p
7480	50p	74LS124	120p	4076	60p	LM377	175p
7481	100p	74LS125	30p	4081	16p	LM380	75p
7482	70p	74LS126	30p	4082	20p	LM381AN	180p
7483A	45p	74LS132	45p	4086	72p	LM382	120p
7484	100p	74LS133	30p	4089	150p	LM386	95p
7485	90p	74LS136	30p	4093	40p	LM387	120p
7486	25p	74LS138	36p	4094	150p	LM389	95p
7489	210p	74LS139	36p	4095	95p	LM393	100p
7490A	30p	74LS145	75p	4096	95p	LM709	36p
7491	60p	74LS147	160p	4097	340p	LM710	50p
7492A	30p	74LS148	90p	4098	90p	LM725	350p
7493A	30p	74LS151	70p	4099	120p	LM733	100p
7494	50p	74LS153	60p	40085	90p	LM741	18p
7495A	50p	74LS154	200p	40097	£120p	LM747	70p
7496	45p	74LS155	40p	40098	120p	LM748	36p
7497	120p	74LS156	40p	40102	180p	LM2917	200p
74100	85p	74LS157	35p	40103	180p	LM3302	140p
74107	30p	74LS158	36p	40106	50p	LM3900	66p
74109	40p	74LS160	40p	40109	100p	LM3909	95p
74116	90p	74LS161	40p	40163	100p	LM3911	130p
74118	75p	74LS162	40p	40173	120p	LM3914	210p
74119	90p	74LS163	40p	40174	90p	LM3915	225p
74120	70p	74LS164	48p	40175	100p	LM3916	225p
74121	30p	74LS165	100p	40193	120p	LM13600	125p
74122	45p	74LS166	90p	40257	160p	M51513L	300p
74123	48p	74LS170	120p	4502	75p	M51516L	400p
74125	40p	74LS173	70p	4503	50p	M83712	200p
74126	40p	74LS174	60p	4507	40p		
74128	40p	74LS175	50p	4508	200p		
74132	45p	74LS181	140p	4510	65p		
74136	32p	74LS190	50p	4511	50p		
74141	65p	74LS191	50p	4512	65p		
74142	200p	74LS193	60p	4514	150p		
74145	70p	74LS195	50p	4515	150p		
74147	100p	74LS196	60p	4516	75p		
74148	75p	74LS197	65p	4518	45p		
74150	80p	74LS221	60p	4520	70p		
74151A	45p	74LS240	90p	4521	150p		
74153	45p	74LS241	90p	4526	75p		
74154	70p	74LS242	80p	4527	90p		
74155	50p	74LS243	80p	4528	75p		
74156	50p	74LS244	80p	4532	90p		
74157	50p	74LS245	90p	4534	500p		
74159	100p	74LS247	70p	4536	300p		
74160	60p	74LS251	40p	4538	120p		
74161	60p	74LS253	40p	4539	110p		
74162	60p	74LS257	45p	4543	100p		
74163	60p	74LS258	45p	4553	290p		
74164	65p	74LS259	90p	4555	50p		
74165	60p	74LS266	25p	4556	60p		
74166	70p	74LS273	90p	4560	180p		
74170	160p	74LS279	45p	4569	180p		
74172	300p	74LS283	45p	4572	30p		
74173	75p	74LS298	160p	4583	100p		
74174	70p	74LS323	250p	4584	45p		
74175	70p	74LS324	150p	4585	100p		
74176	50p	74LS348	150p	4724	150p		
74177	70p	74LS352	100p	14411	700p		
74178	100p	74LS353	100p	14412	900p		
74180	60p	74LS365	36p	14599	290p		
74181	160p	74LS367	36p				
74182	90p	74LS368	50p				
74184A	90p	74LS373	80p				
74185	120p	74LS374	80p				
74186	500p	74LS375	50p				
74188	325p	74LS377	90p				
74190	70p	74LS378	70p				
74191	70p	74LS390	55p				
74192	70p	74LS393	50p				
74193	70p	74LS399	200p				
74194	70p	74LS540	135p				
74195	60p	74LS541	135p				
74196	60p	74LS670	170p				
74197	60p						
74198	100p						
74199	100p						
74221	75	4000 SERIES					
74251	70p	4000	12p				
74278	150p	4001	14p				
74279	80p	4002	16p				
74283	75p	4006	65p				
74284	200p	4007	16p				
74285	200p	4008	60p				
74290	100p	4009	35p				
74293	100p	4010	40p				
74298	100p	4011	14p				
74365	55p	4012	16p				
74366	55p	4013	35p				
74367	55p	4014	60p				

MC1310P	150p
MC1458	40p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3403	120p
MK50398	750p
ML920	800p
MM57160	620p
NE531	150p
NE555	20p
NE556	50p
NE564	420p
NE565	130p
NE566	155p
NE567	140p
NE571	425p
NE5634A	250p
PLL02A	500p
RC4136	70p
RC4151	200p
S566B	260p
SAD1024A	1250p
SFF96364	800p
SL490	350p
SN76477	175p
SP8515	750p
TA7205	250p
TAA621	275p
TBA641B11	300p
T87120	200p
TA7204	250p
TA7222	200p
TA7310	200p
TAA621	275p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	300p
TCA220	350p
TCA940	175p
TDA1004A	300p
TDA1008	320p
TDA1010	225p
TDA1022	600p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2020	320p
TL071/81	45p
TL072/82	75p
TL074	130p
TL084	110p
TL094	200p
TL170	50p
TL430C	70p
UAA170	170p
UA2240	300p
UDN6118	320p
UDN6184	320p
ULN2003	100p
UPC575	400p
UPC592H	200p
UPC1156H	300p
XR2206	300p
XR2207	400p
XR2211	600p
XR2216	675p
ZN414	90p
ZN419C	225p
ZN423E	150p
ZN424E	135p
ZN425E	350p
ZN427E	625p
ZN1034E	200p

VOLTAGE REGULATORS
FIXED PLASTIC

	+ ve		− ve	
1A				
5V 1A	7805	50p	7905	55p
12V 1A	7812	50p	7912	55p
15V 1A	7815	56p	7915	60p
18V 1A	7818	56p	7918	60p
24V 1A	7824	56p	7924	60p
5V 100mA	78L05	30p	79L05	65p
12V 100mA	78L12	30p	79L12	70p
15V 100mA	78L15	30p	79L15	70p

OTHER REGULATORS			
LM309K 1A 5V	135p	78HGKC	600p
LM317K	326p	78HOSKC	550p
LM317T 1A Adj	200p	78MGT2C	140p
LM337T	225p	78GUIC	200p
LM323K 3A 5V	500p	79GUIC	225p
LM723 150mA Adj	37p	79HGKC	700p
TL494	400p	TL497	300p
78S40	300p	LM305AH	250p

OPTO-ELECTRONICS			
2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	56p

OPTO ISOLATORS			
ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL113	90p
ILQ74	240p	TIL116	90p

LEDS			
0.125"		0.2"	
TIL32	55p	TIL220 Red	15p
TIL209 Red	13p	TIL222 Gr	15p
TIL211 Gr	18p	TIL228 Yel	22p
TIL212 Ye	18p	Rectangular	
TIL216 Red	18p	LEDs (R, G, Y)	30p
		NSB5881	670p
DISPLAYS		TIL311	600p
3015F	200p	TIL312/3	110p
DL704	140p	TIL321/2	130p
DL707 Red	140p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	DRIVERS	
FND507	90p	9368	250p
MAN3640	175p	9370	300p
MAN4640	200p	UDN6118	320p
		UDN6184	320p

COUNTERS

74C925	550p
74C9280	600p
MK50398	£8
ZN1040E	£7

TTL & ECL

MC4024	325p
MC4044	325p
10116	70p
10231	350p

CPUs

1802CE	750p
2650A	£12
6502	450p
6502A	650p
6800	370p
6802	500p
6809	£10
6809E	£15
8035	750p
8039	860p
8080A	350p
8085A	550p
INS8050	£11
TMS9980	£20
Z80	370p
Z80A	480p
8088	£19

SUPPORT DEVICES

3242	800p
3245	450p
6522	500p
6532	775p
6821	160p
6845	£10
6847	£10
6850	180p
6852	370p
6875	600p
8154	950p
8155	800p
8205	320p
8212	180p
8216	180p
8224	250p
8226	280p
8228	250p
8243	450p
8250	850p
8251	375p
8253	800p
8255	375p
8257	800p
8259	800p
8279	950p
TMS9918	£60
Z80PIO	350p
Z80APID	400p
Z80CTC	350p
Z80ACTC	400p
Z80ADART	800p
Z80ADMA	£12
Z80S10-1	£20

MEMORIES

2101A	400p
2102-2L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	160p
2114-4L	130p
4027-3	300p
4044-45	700p
4116-15	200p
4116-20	200p
4118-3	500p
4118-4	450p
4164-2	£10
5101	300p
6116P-3	900p
6514-45	400p
6810	200p
7489	210p
74S189	325p
74S201	350p
74S289	325p

ROMs/PROMs

74S188	325p
74S287	308p
74S288	226p
74S387	325p
74S471	650p
74S473	850p
74S474	650p
74S570	650p
74S571	850p
74S573	950p

EPROMs

1702A	500p
2708	300p
2716 (+ 5V)	300p
2564	£8
2516 (+ 5V)	300p
2532	600p
2732	600p

UARTs

AY-3-1015P	350p
AY-5-1013P	350p
IM6402	450p

CHARACTER GENERATORS

RO-3-2513UC	750p
RO-3-2513LC	700p
SN74S262AN	£10

INTERFACE ICs

AD558CJ	775p
AD561J	£14
AM25S10	350p
AM26LS31	160p
AM26LS32	190p
DAC80	£20
DM8131	375p
DP8304	450p
DS8832	250p
DS8833	225p
LF13201	450p
MC1488	65p
MC1489	65p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC4024	325p
MC4044	325p
MM58174	£12
ULN2003A	100p
ULN2004A	100p
75107	160p
75110	160p
75112	160p
75114	160p
75115	160p
75150P	140p
75154	140p
75182	230p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	70p
8T26	120p
8T28	140p
8T95	140p
8T97	140p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p

DISC CONTROL

FD1771	£20
FD1791	£30
WD1691	£15
WD2143	560p

CRYSTALS

32.768KHz	250p
100KHz	300p
200KHz	370p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	250p
2.00MHz	250p
2.45760MHz	250p
3.728MHz	250p
3.5795MHz	175p
4.00MHz	290p
4.194MHz	250p
4.43MHz	125p
5.0MHz	250p
6.0MHz	250p
6.144MHz	250p
7.0MHz	250p
7.168MHz	250p
8.00MHz	250p
8.86MHz	250p
10.00MHz	250p
10.7MHz	250p
1p.0MHz	350p
18.00MHz	250p
18.00MHz	250p
18.432	250p
19.968MHz	390p
26.690MHz	300p
27.145MHz	250p
38.6667MHz	350p
48.0MHz	300p
65.5MHz	400p
110MHz	350p

KEYBOARD ENCODER

AY-5-2376	700p
74C922	500p

UHF MODULATORS

6MHz	375p
8MHz	450p

OIL SWITCHES

4 Way	90p
6 Way	105p
8 Way	120p
10 Way	150p

ZERO INSERTION FORCE SOCKETS

24 Pin	600p
40 Pin	£11

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	28p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

TRANSISTORS

AD161/2	45p
BC107/8	11p
BC109	11p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC192/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	18p
BC461	25p
BC477/8	30p
BC516/7	40p
BC547B	18p
BC548C	9p
BC549C	18p
BC557B	18p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	64p
BD139	58p
BD140	60p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	36p
BFR39	25p
BFR40/1	25p
BFR79	25p
BFR80/1	25p
BFX29	40p
BFX30	34p
BFX84/8	40p
BFX86/7	30p
BFX88	30p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	80p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	220p
BU205	200p
BU208	200p
BU406	145p
BUY69C	350p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	60p
MJE2955	100p
MJE3055	70p
MPF102	45p
MPF103/4	40p
MPF105	40p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MSPU06	83p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	62p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	130p
TIP147	130p
TIP2955	78p
TIP4055	70p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX1502	18p
ZTX504	30p
VN66	80p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	25p
2N2484	30p
2N2648	45p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	8p
2N3053	40p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5194	90p
2N5245	40p
2N5298	65p
2N5401	60p
2N5457/8	40p
2N5459	40p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1172	150p
2SC1306	150p
2SC1307	220p
2SC1957	90p
2SC1969	195p
2SC2028	120p
2SC2029	250p
2SC2078	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

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BYX36.300	20p
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OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
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16A 400V	110p
16A 500V	130p
T2800D	130p

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1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
BT106	110p
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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?

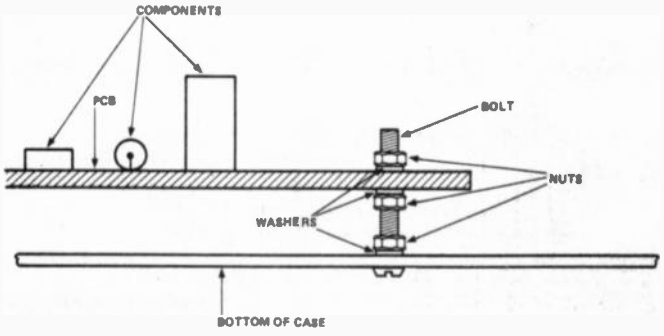

Figure 1. A method of fixing a PCB to a project case, using nuts, washers and bolts

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.

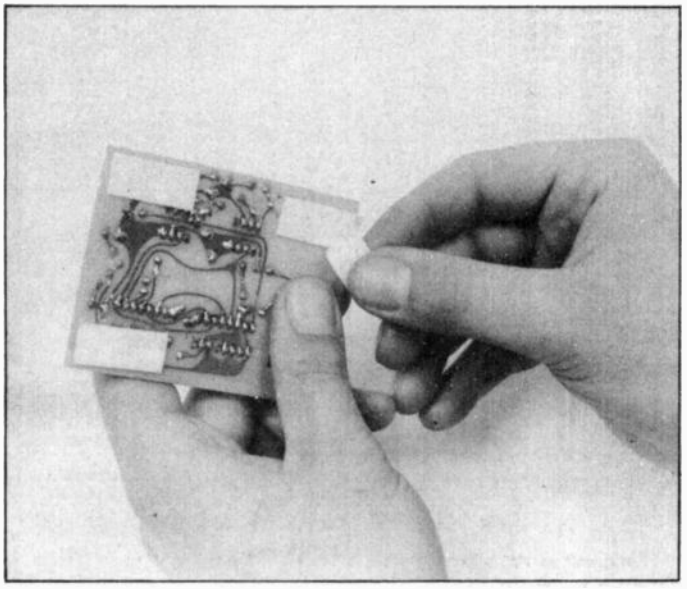

Figure 2. Using double-sided adhesive pads to hold down a PCB

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.

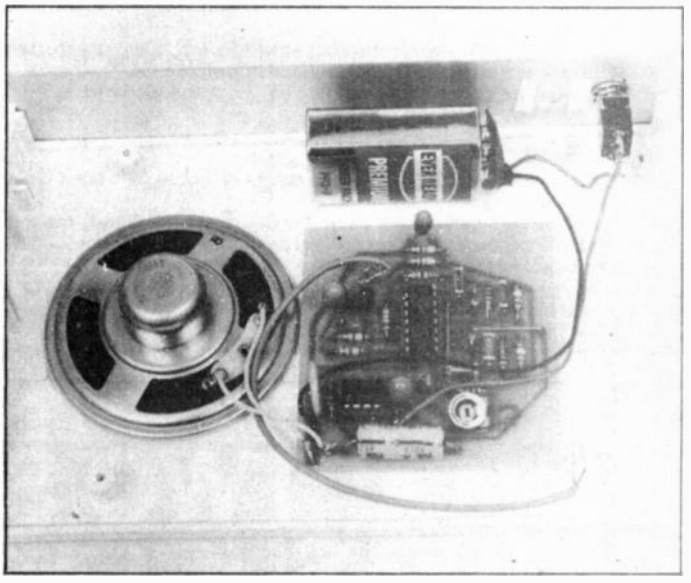

Figure 3. Double-sided adhesive pads are ideal for holding batteries in position

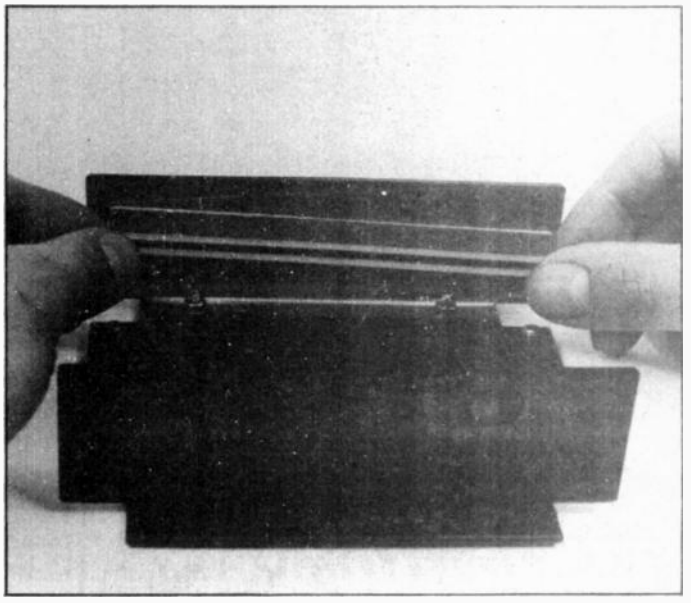

Figure 4. PCB guide-rails make an easy method of positioning and holding circuit boards

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

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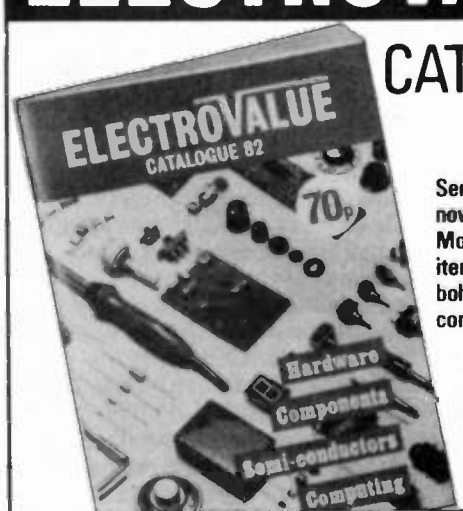

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Competition Results

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

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.**

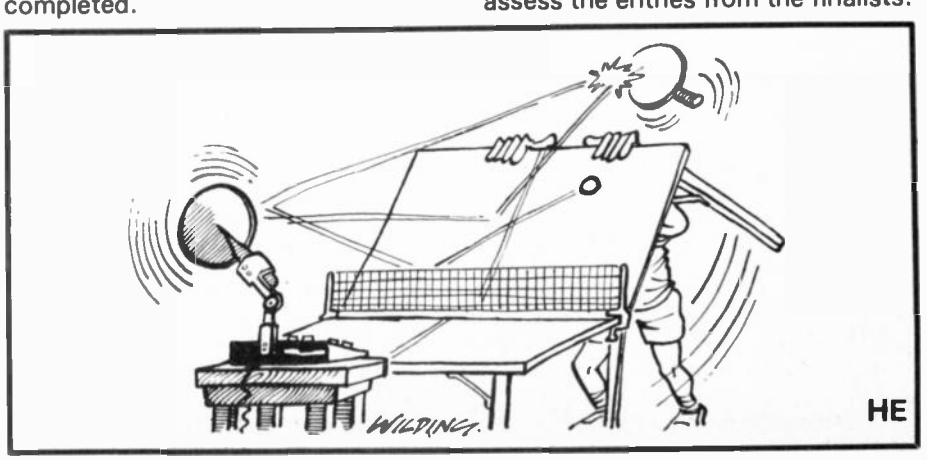
★Consolation Prize No. 2

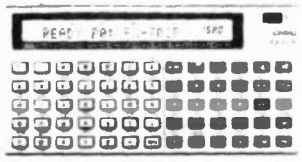
— **Galaxy Invader 1000 hand-held space battle game** — went to John L.Wigley, of Bourne End, Buckinghamshire, for his **Low-cost Communicator** for the disabled.

● 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.





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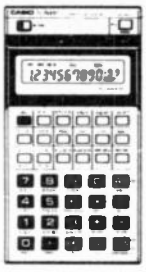

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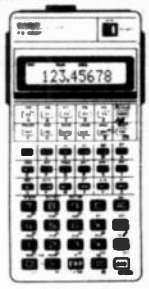

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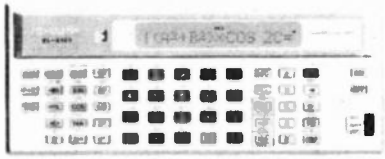

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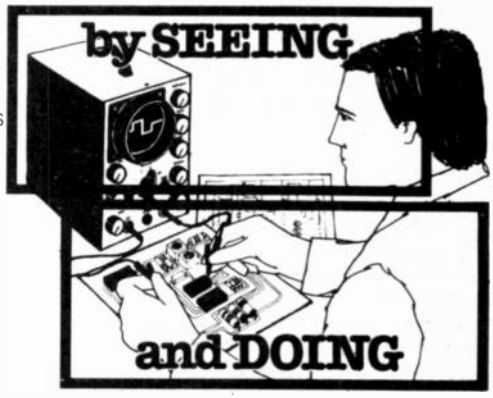

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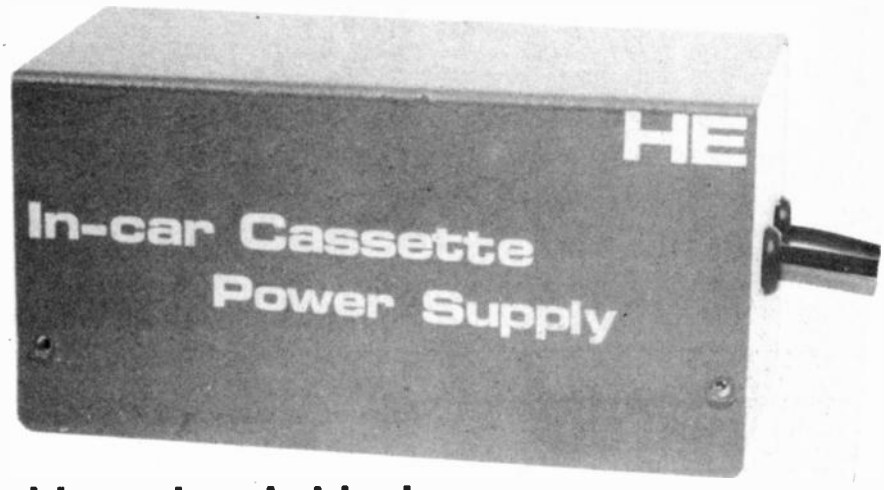
In-car Cassette Power Supply



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.

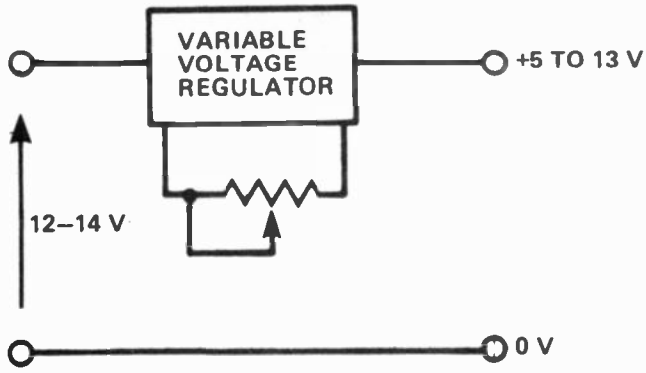
Push circuit board pins into the board where off-board connections are to be made. Now solder the pins in.

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.



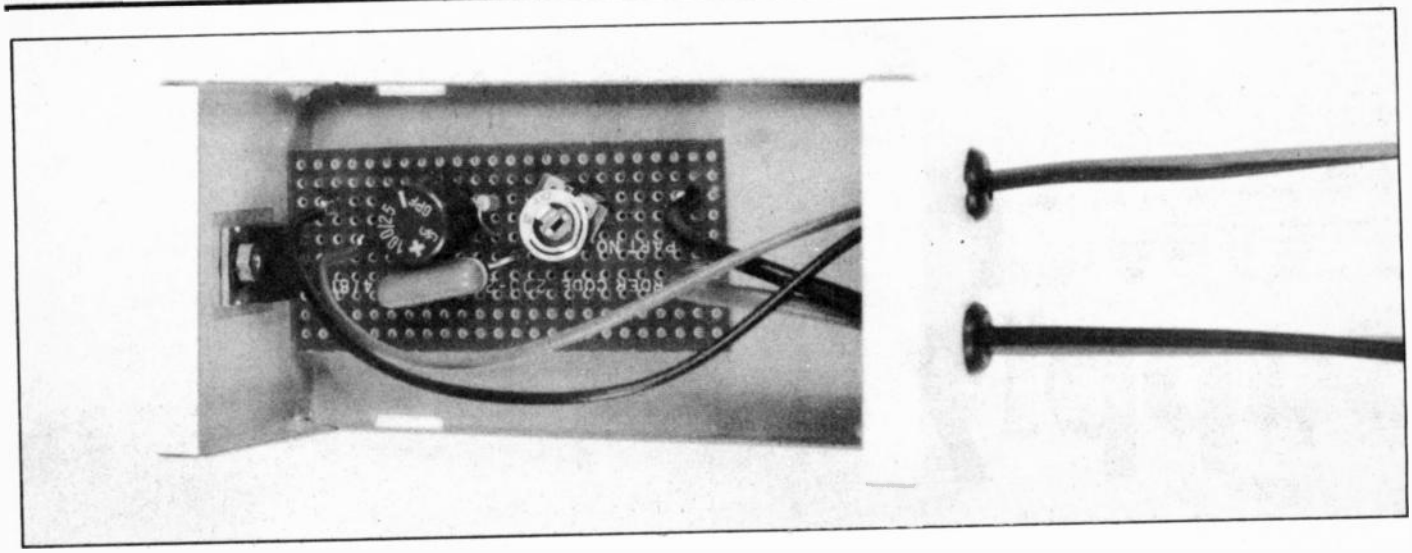
Integrated circuit IC1 is a fixed-voltage regulator which develops and holds the output voltage at 5 VDC. A typical circuit using the IC would have its common connection directly connected to the earth rail (0 V). The IC's output, in such a circuit, is at a voltage of exactly 5 V above earth. However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

SEMICONDUCTOR
IC1 7805, 5 V voltage regulator

MISCELLANEOUS
Veroboard, 10 strip x 24 hole
Case to suit

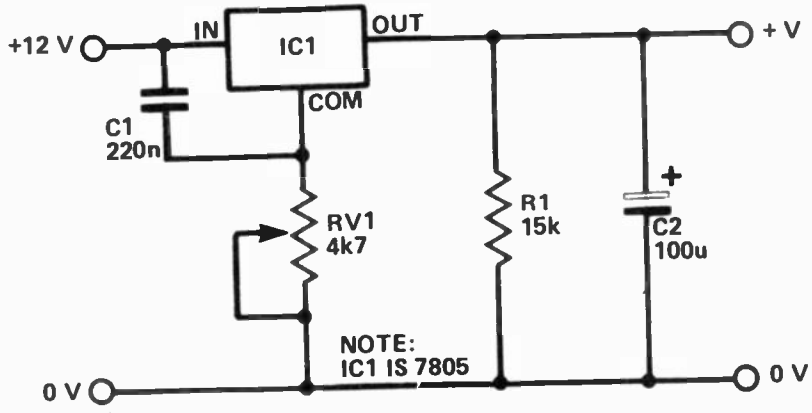


Figure 1. Circuit of the HE In-car Cassette Power Supply

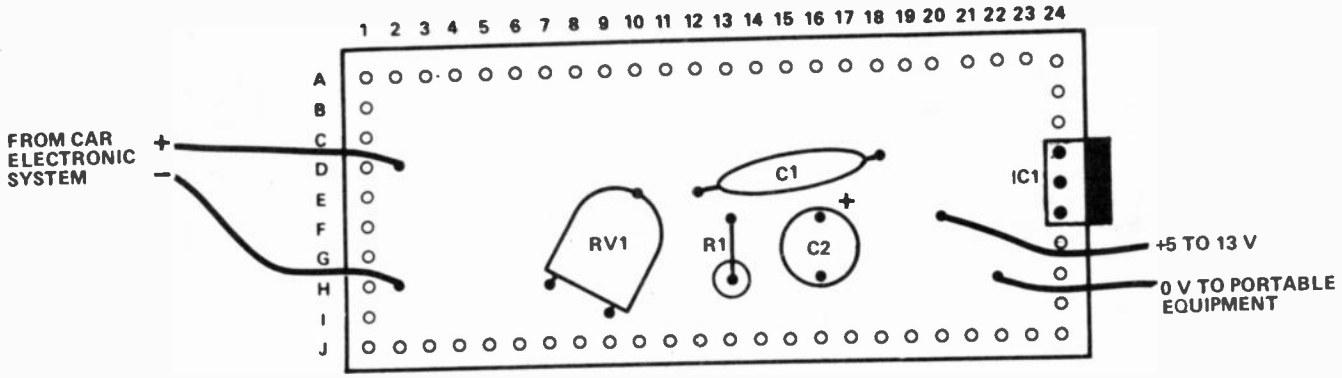
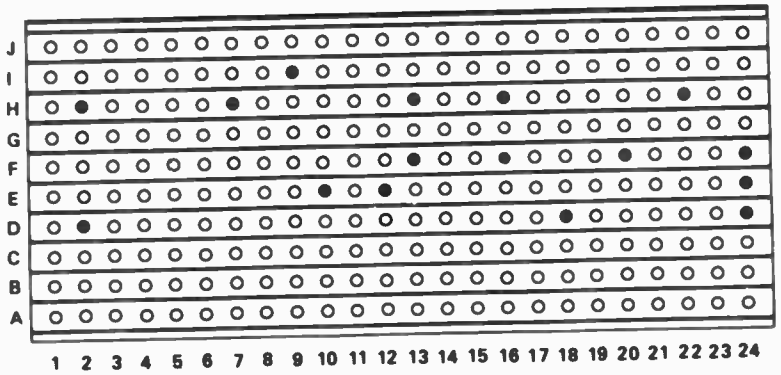


Figure 2. Veroboard layout, showing component locations along with connection details of the project. Note that there are no track breaks to make



Buylines

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

HE

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,
I
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

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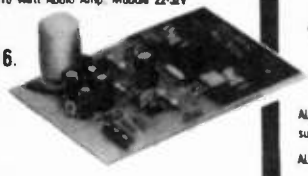
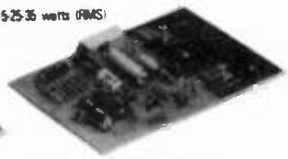


AUDIO AMPLIFIERS

15-25-35 watts (RMS)



AL60 15-25 watt Audio Amp Module 30-50v supply **£5.15.**

AL80 35 watt Audio Amp Module **£8.07**

AUDIO AMPLIFIER

Audio Amplifier, 50W R.M.S., with integral heat sink and short circuit protection.

Introduced to fulfill the demand for a fully protected power amp., capable to driving high quality speaker systems at up to 50w with distortion levels below .05%. Ideal for domestic use, Discos, P.A., systems, electronic organs, etc. The generously rated components ensure continuous operation at high output levels. AL120 50 watt Audio Amp Module 50-70v supply

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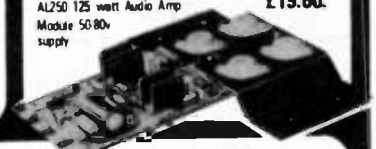
125 watts (RMS). AL250.

A power amplifier providing an output of up to 125w RMS, into a 4 ohm load. Four 115w transistors in the output stage makes it extremely rugged while damage from incorrect or short circuit loads is prevented by a four transistor protection circuit. For use in many applications such as disco units, sound re-inforcement systems, background music players etc.

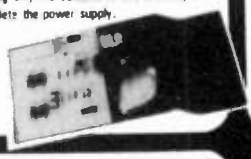
AL250 125 watt Audio Amp Module 50-80v supply **£19.60.**



POWER SUPPLIES

SPM120 is a fixed voltage stabiliser with an output voltage of either 45v, 55v, or 85v. Designed for use in audio applications, the stabiliser which provides output currents up to 2.5A operates direct from a mains transformer requiring only the addition of two Electrolytic capacitors to complete the power supply.

PS12 24v Supply Suit: 2 x AL10 2 x AL20 2 x AL30 & PA12/S453 **£1.86.** SPM80 33v Stabilised supply Suit: 2 x AL60 PA100 to 15 watts **£4.04.** SPM120/45 45v Stabilised supply Suit: 2 x AL60 PA100 to 25 watts **£8.38.** SPM120/55 55v Stabilised supply Suit: 2 x AL80 PA200 **£8.38.** SPM120/85 85v Stabilised supply Suit: 2 x AL120 PA200 1 x AL250 **£8.38.** SG30 15-0-15 Stabilised power supply for 2 x GE100 MKII **£3.00.**



STEREO PRE-AMPLIFIERS

PA12 Supply voltage 22-32v input sensitivity 300mv Suit: AL10/AL20/AL30 **£8.56.** PA100 Supply voltage 30-55v inputs Tape Tuner Mag P.U. Suit: AL60/AL80 **£17.86.** PA200 Supply voltage 35-70v inputs Tape Tuner Mag P.U. Suit: AL80/AL120/AL250 **£18.24.**

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STEREO 30 Complete 7 watt per channel Stereo amp board – includes amps, pre-amp, power supply, front panel, knobs etc. – requires 2039 Transformer **£19.88.**

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The MM100 and MM100G mono pre-amplifiers are compatible with the AL60, AL80, AL120 and AL250 power amplifiers and their associated power supplies.

MM100 Supply voltage 40-65v inputs Tape Mag P.U. Microphone Max output 500mv **£12.43.** MM100G Supply voltage 40-65v inputs 2 Guitars, Microphones Max output 500mv

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GE100 MKII

10 Channel Monographic Equaliser.

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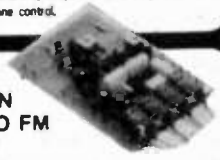
GE100 MKII 10 Channel mono-graphic Equaliser with sliders & Knobs **£20.00.**

PUSH BUTTON STEREO FM TUNER



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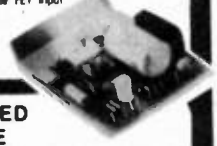

Transformers are not included with power supplies. SPM120 Range also require reservoir and output capacitors

TRANSFORMERS

2034 1.7 amp 35v suit SPM80 **£4.98.** 2035 2 amp 55v **£6.86.** 2036 750mA 17v Suit PS12 **£2.86.** 2040 1.5 amp 0-45v-55v Suit SPM120/45, SPM120/55v **£6.46.** 2041 2 amp 0-55v-85v Suit SPM120/55 SPM120/85v **£8.48.** 2039 1 amp 0-20v Suit Stereo 30 **£3.50.** 2043 150mA 15-0-15v Suit SG30 **£1.60.**

ACCESSORIES

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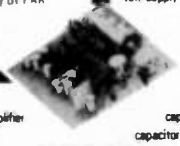

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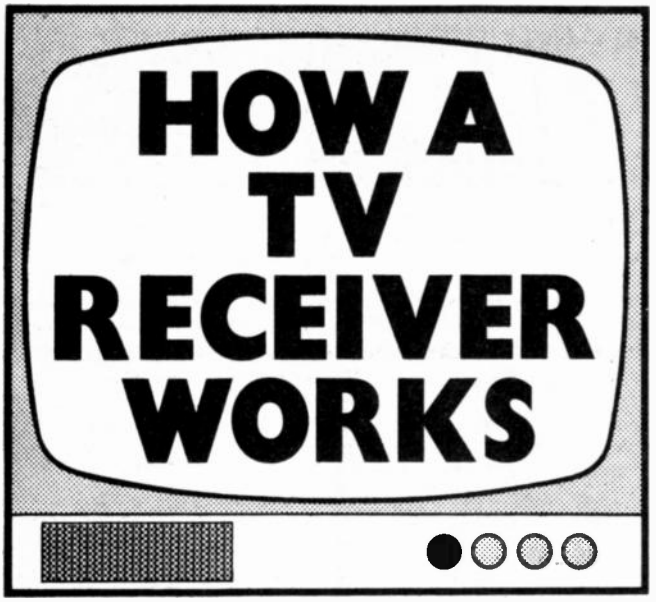

Hour after hour we watch that box (even described by one headmaster several years ago as a 'fool's lantern'). It's entertaining, it can be annoying but how does it work? Derek Jenkins explains, in simple terms, the operation of a black-and-white TV receiver

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 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.

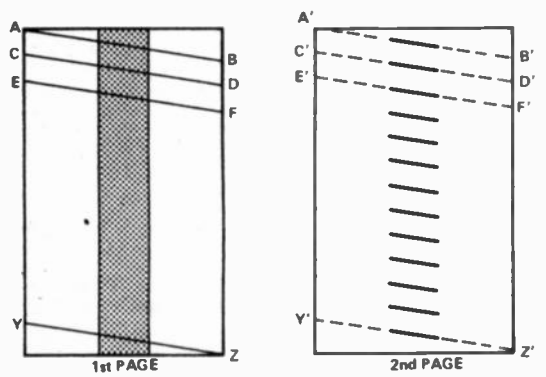

Figure 1. Transferring an image accurately from one sheet of paper to another. Light and dark areas on the first sheet are 'scanned' with a pointer and this information is transferred with a pen, line by line, to the second sheet. The pen must move in exact step with the pointer and only delivers ink 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

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.

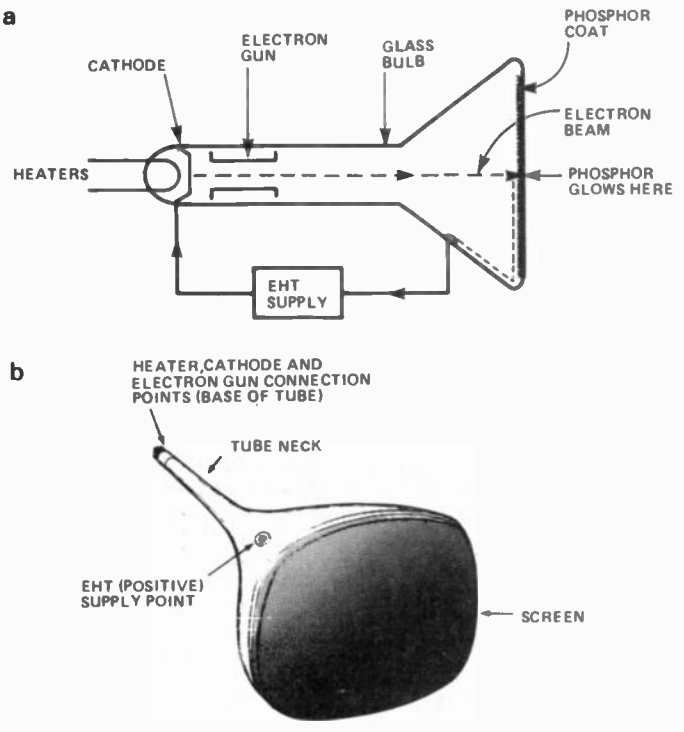

Figure 2. TV picture tube: a) main component parts and connections to EHT supply, b) outside view of picture tube

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.

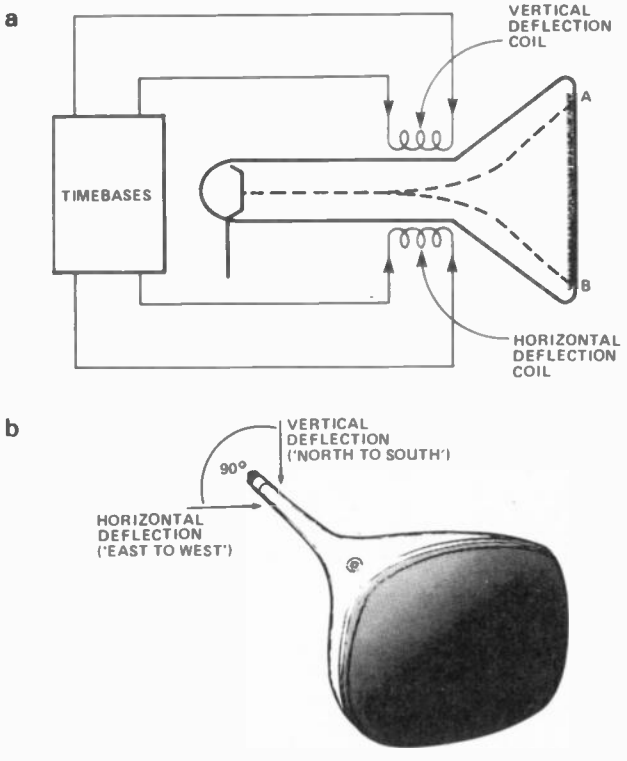

Figure 3. Position of deflection coils on neck of a TV picture tube: a) connections to timebase circuits, b) orientation of magnetic fields from coils

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.

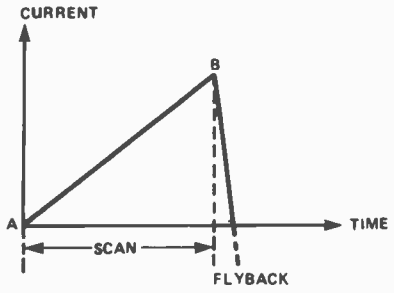

Figure 4. Shape of current waveform in deflection coils. This is known as a 'sawtooth' waveform because of its shape

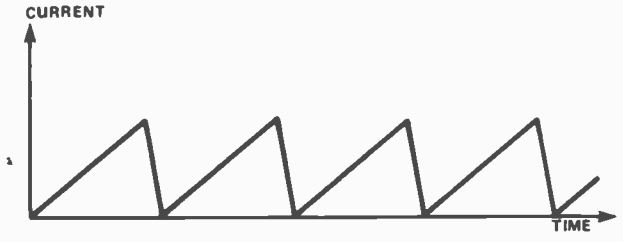

Figure 5. Because the scanning of lines on the picture tube is repetitive the current waveform is a continuous stream of sawtooth waveforms such as those shown in Fig.4. This is the picture you would expect to see on an oscilloscope connected to each coil in turn

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

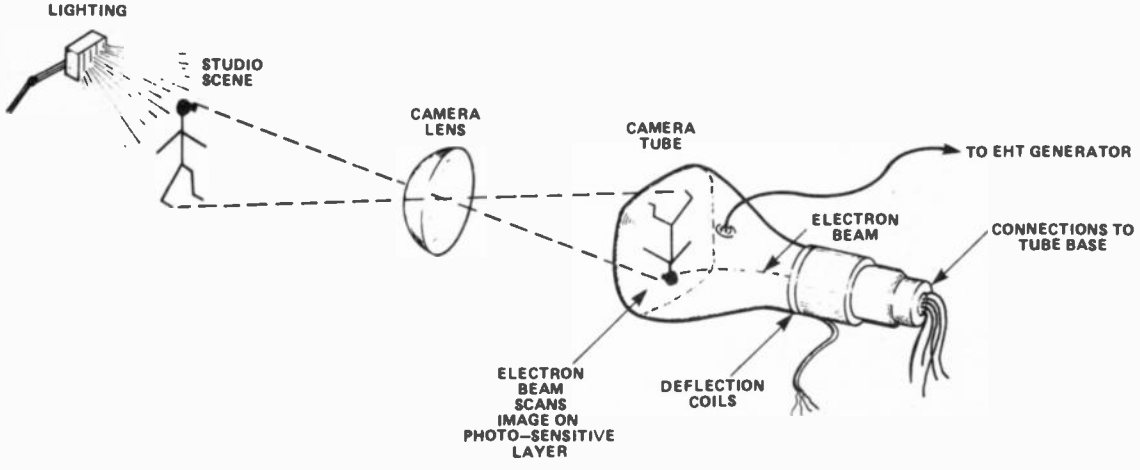

Figure 6. Greatly simplified operation of a TV camera. The illuminated studio scene is focused, through the lens system, onto the light-sensitive screen of the camera tube. (You'll notice that because a single lens is used in my example, the image on the tube screen is upside-down.) The tube has been 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.

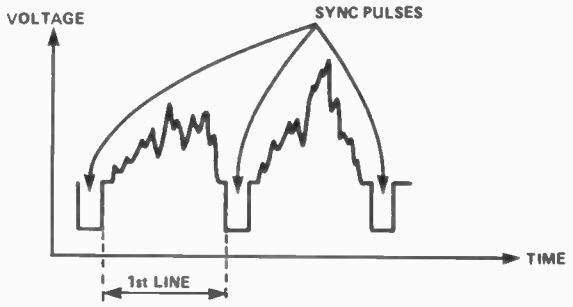

Figure 7. Waveform of signal transmitted from the studio to your TV receiver. It contains two kinds of information: regular 'sync' pulses which lock the horizontal and vertical deflection timebase circuits precisely to those in the camera, and voltage variations corresponding to the brightness information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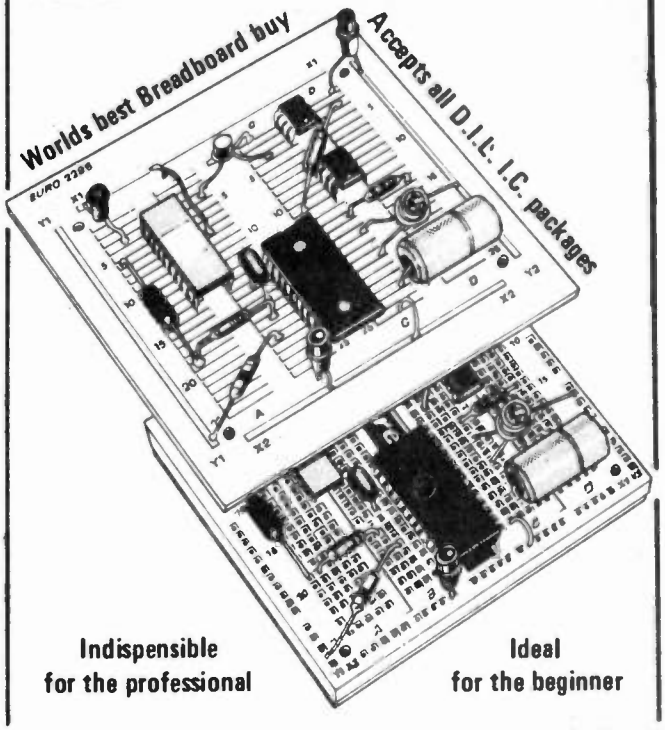

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DOORCHIME

A simple-to-build battery-powered project which is not expensive and is available as a kit

BEFORE WE START, let's get one thing clear — the circuit for this project *does not contain a 555!*

Gasp — stand back in amazement!

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.

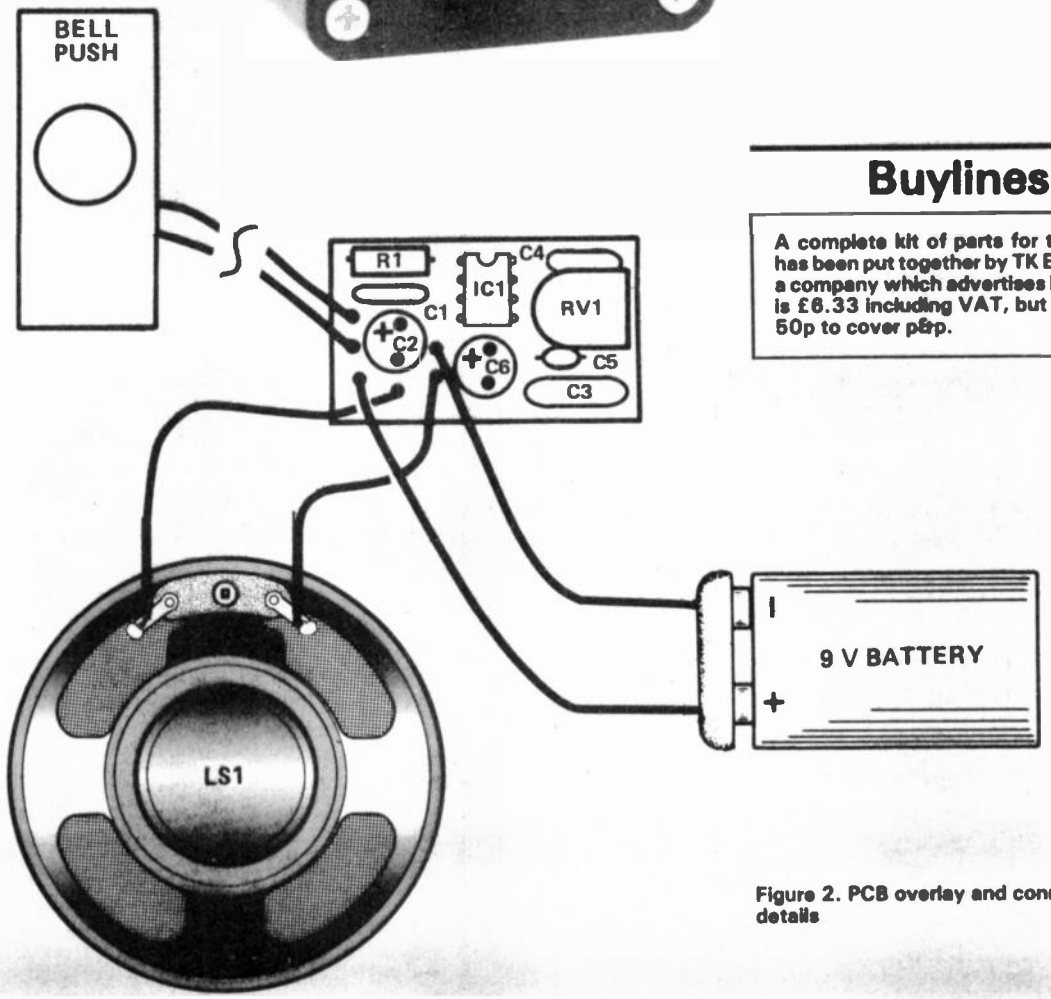


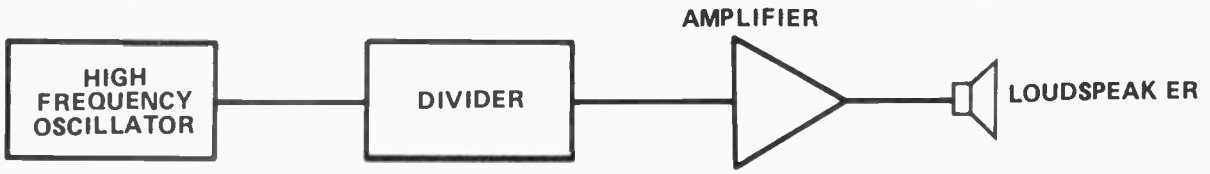
Figure 2. PCB overlay and connection details

Buylines

A complete kit of parts for this project has been put together by TK Electronics, a company which advertises in HE. Price is £6.33 including VAT, but please add 50p to cover p&p.

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

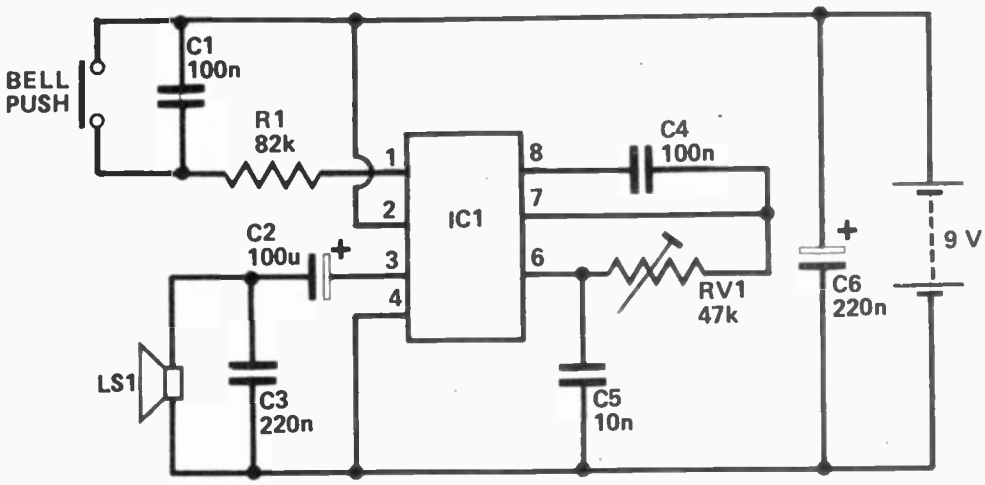
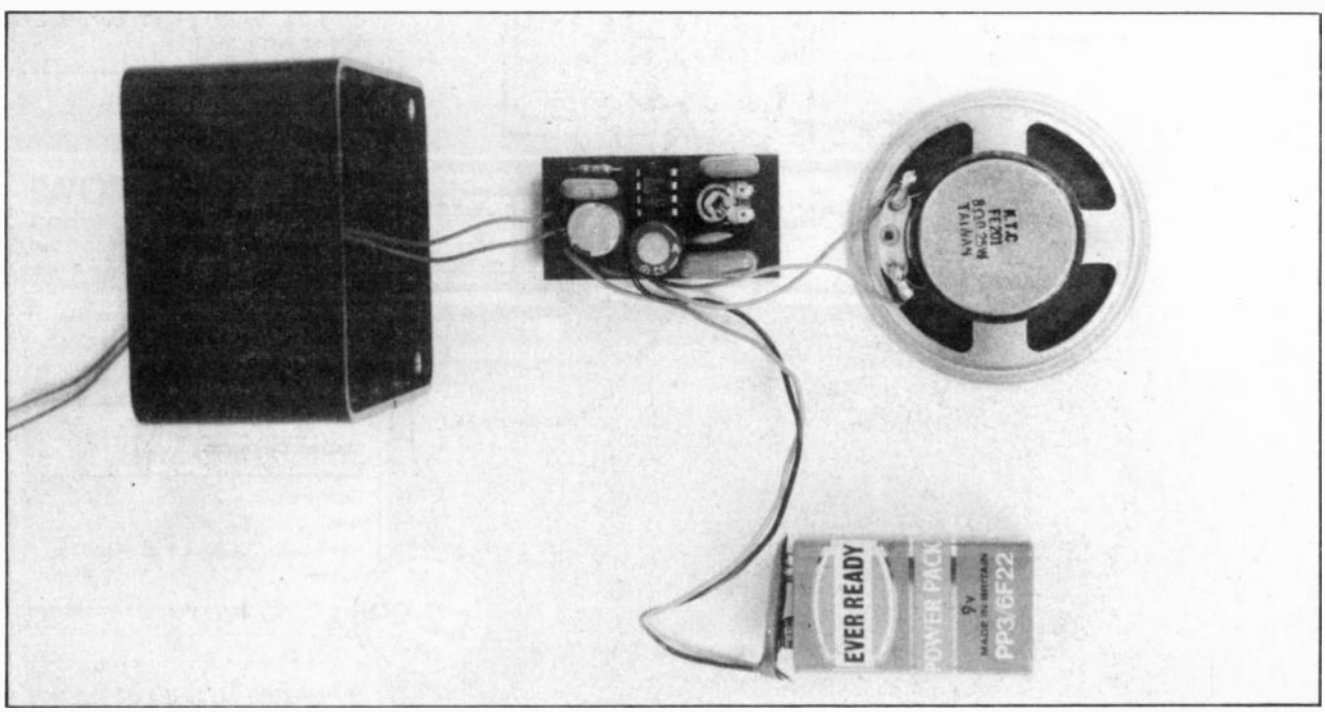


Figure 1. Circuit of the HE Doorchime



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 mo nitoring all but impossible. Fair enough, the antenna length li mit which says that no antenna shall be longer than 1.5 m is n io real problem on mobile installations but to try and impose the same limitations on base stations will ensure that any moni toring station will effectively be half deaf.

Second, the licensing conditions: they're too la x! For instance, no provision is made for maintenance and rep air of faulty equipment. In theory, a two-year-old with a scre wdriver is quite entitled to fiddle around inside a rig: it can hapj pen and it will happen. The result? A lot of rigs will end up transn nitting 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 sa ived and people will have the opportunity to talk to one anoth ier again (without the assistance, or hindrance, of the Post Offic e) and in this day and age that can't be a bad thing.

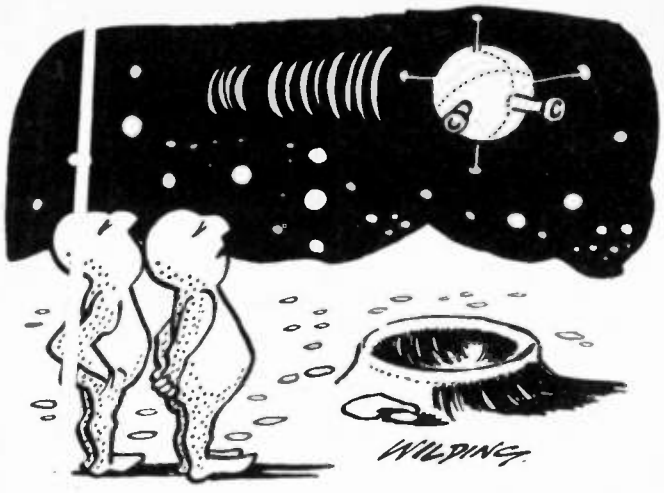
It's much too early to say whether or not the systen n will be allowed to work, and a lot of people have state d quite categorically that they're out to upset UK CB. These morons will try very hard to ruin CB for others: hopefully their interest will be short-lived, as is often proved to be true of such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

The Fight's Not Over Yet

It has been a long fight — regular readers may rememb ber our very first feature on CB back in early 1979, and I sin cerely believe that it has all been worth it. There were times w hen it seemed that the Government would never sanction CB. T hat's not to say I'm congratulating them now, I think they s hould have done it two years ago and avoided all this misery. Bu t 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 a erial restrictions.

In the meantime, CB is here and you have the opportunit y to participate in a great experiment, not least the demonstra tion that the British public can use two-way radio in a respons ible manner. It shows that laws can be changed, where there 's a will. Now, about those cordless telephones, wouldn't it be n ice if.....?

HE



"NO, IT'S THAT ELECTRONICS BLOKE FROM SUFFOLK, AGAIN!"

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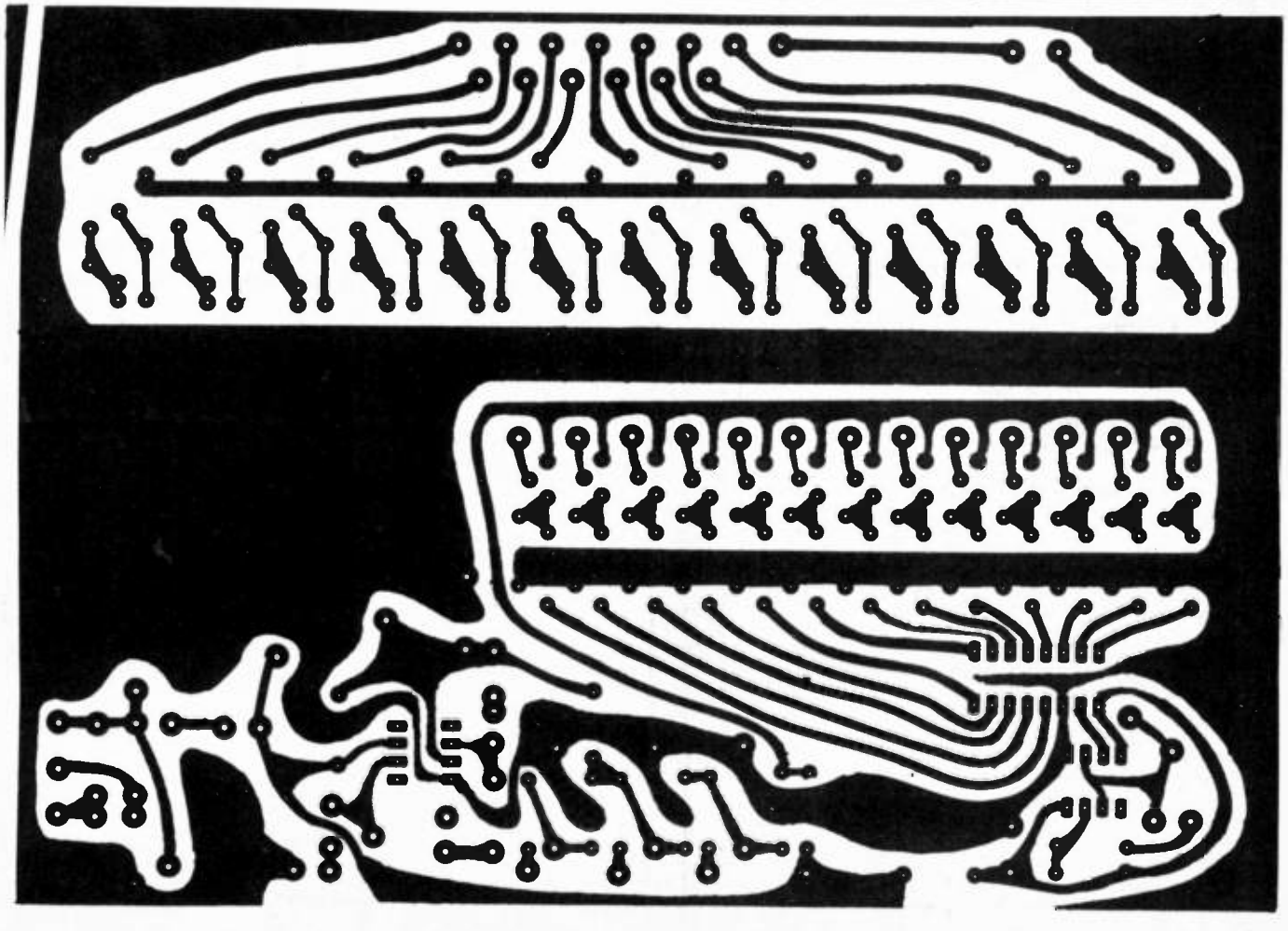
Below: The PCB foil pattern of the HE Pedalboard Organ project



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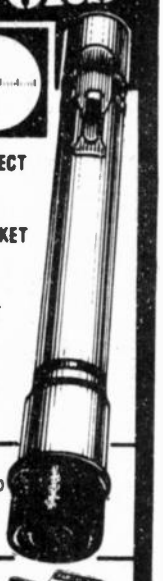

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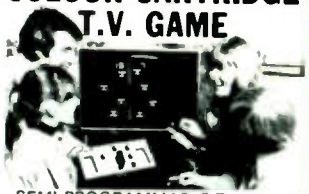

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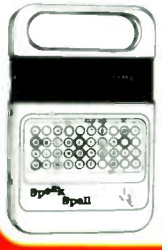

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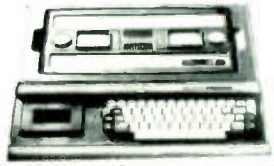

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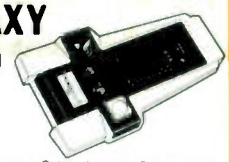

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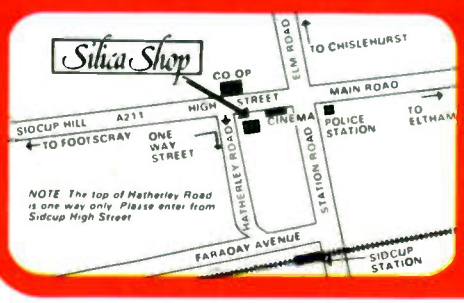

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