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Everyday ELECTRONICS

OCT. 82
80p

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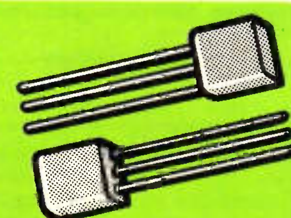
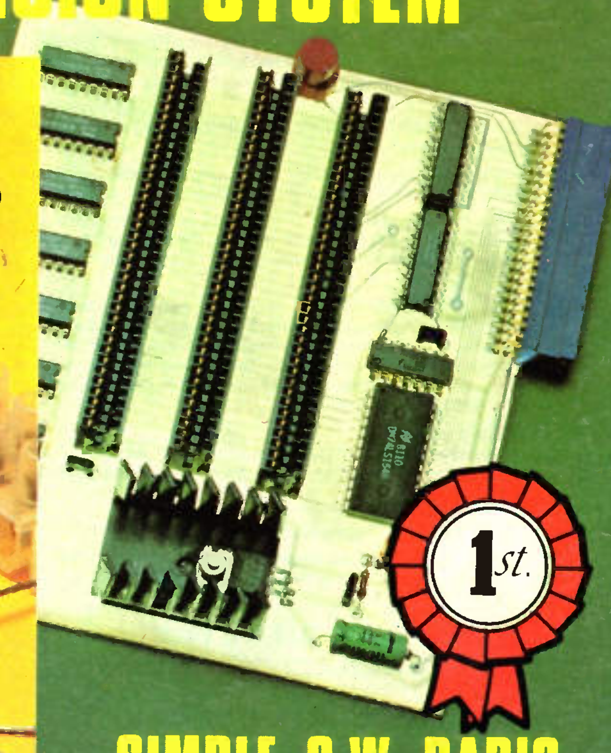
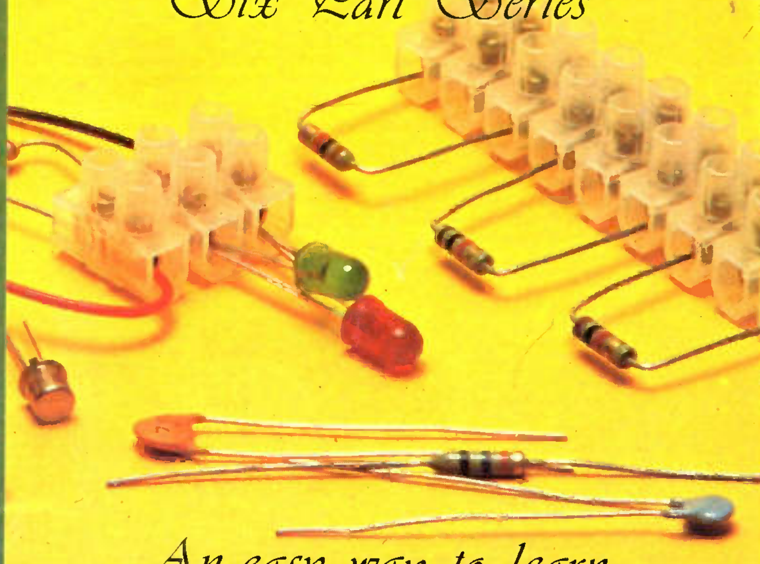


SEDAC Prize Winning Project
COMPUTER EXPANSION SYSTEM



INTRODUCING ELECTRONICS
Six Part Series



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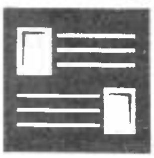
Everyday ELECTRONICS

VOL. 11 NO. 10 OCTOBER 1982

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .



YOUR FREE TRANSISTORS

See pages 628 and 632

START NOW

Our policy is to make electronics an easy to follow and enjoyable hobby. First steps can be difficult, and so in presenting a new six-part series **Introducing Electronics,** we have deliberately eliminated the business of soldering. Just a screwdriver and wire cutters are required to start off on practical work, because all connections between components are made by means of screw-terminal blocks. And with the longer evenings coming, what could be a better time to start studying electronics than now?

SCHOOLS
Electronic Design Award
COMPETITION

CALLING ALL SCHOOLS

The second Schools Electronic Design Award Competition (SEDAC) is announced in this issue. Please turn to page 647 for full details.

Our November issue will be published on Friday, October 15. See page 641 for details.

PROJECTS

SERIES

FEATURES

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4009U8	0.25	4518	0.35	74LS12	0.12	74LS145	1.20
4010	0.30	4520	0.60	74LS13	0.20	74LS151	0.30
4011	0.11	4521	1.30	74LS14	0.30	74LS153	0.27
4012	0.14	4522	0.89	74LS20	0.12	74LS154	0.99
4013	0.25	4526	0.60	74LS21	0.12	74LS155	0.35
4016	0.22	4527	0.80	74LS22	0.12	74LS156	0.37
4017	0.40	4528	0.65	74LS26	0.14	74LS157	0.30
4019	0.38	4529	0.70	74LS27	0.12	74LS158	0.30
4020	0.55	4531	0.65	74LS28	0.15	74LS160	0.37
4021	0.55	4532	0.80	74LS30	0.12	74LS161	0.37
4022	0.55	4534	4.00	74LS32	0.12	74LS162	0.37
4023	0.15	4536	2.50	74LS33	0.15	74LS163	0.37
4024	0.33	4538	0.85	74LS38	0.14	74LS164	0.40
4025	0.15	4539	0.80	74LS40	0.13	74LS165	0.60
4027	0.26	4543	0.80	74LS42	0.30	74LS168	0.70
4030	0.35	4549	3.50	74LS47	0.35	74LS169	0.85
4043	0.50	4553	2.70	74LS48	0.45	74LS170	0.90
4044	0.60	4554	1.20	74LS49	0.55	74LS173	0.60
4046	0.60	4555	0.35	74LS51	0.13	74LS174	0.40
4049U8	0.24	4556	0.40	74LS54	0.14	74LS175	0.40
4050	0.24	4557	2.30	74LS55	0.14	74LS181	1.05
4051	0.55	4558	0.80	74LS73	0.21	74LS190	0.60
4060	0.75	4559	3.50	74LS74	0.16	74LS191	0.60
4066	0.30	4560	2.50	74LS75	0.22	74LS192	0.45
4068	0.16	4561	1.00	74LS76	0.20	74LS193	0.42
4069U8	0.14	4562	2.50	74LS78	0.19	74LS194	0.35
4070	0.16	4566	1.20	74LS83	0.40	74LS195	0.35
4071	0.16	4568	1.45	74LS85	0.60	74LS196	0.55
4072	0.16	4569	1.70	74LS86	0.14	74LS221	0.50
4073	0.16	4581	0.18	74LS90	0.28	74LS240	0.80
4075	0.16	4572UB	0.22	74LS92	0.31	74LS241	0.80
4076	0.55	4580	3.25	74LS93	0.31	74LS242	0.70
4077	0.18	4581	1.40	74LS95	0.40	74LS243	0.70
4078	0.18	4582	0.70	74LS96	1.20	74LS244	0.60
4081	0.12	4583	0.80	74LS107	0.25	74LS245	0.80
4093	0.30	4584	0.27	74LS109	0.20	74LS257	0.40
4175	0.80	4585	0.45	74LS112	0.20	74LS258	0.37
4502	0.60	40174	1.05	74LS113	0.20	74LS260	0.50
4503	0.50	40195	1.08	74LS114	0.19	74LS266	0.22
4506	0.70	74LS00	0.10	74LS122	0.35	74LS273	0.70
4507	0.37	74LS01	0.10	74LS124	1.80	74LS279	0.35
4508	1.50	74LS02	0.11	74LS123	0.35	74LS365	0.32
4510	0.55	74LS03	0.11	74LS125	0.24	74LS366	0.34
4511	0.45	74LS04	0.12	74LS126	0.24	74LS367	0.32
4512	0.55	74LS05	0.13	74LS132	0.42	74LS368	0.35
4514	1.25	74LS08	0.12	74LS133	0.24	74LS373	0.70

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1	100	9p
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3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	14p
100	25	18p
100	40	22p
100	63	25p
100	100	30p
220	10	18p
220	16	17p
220	25	22p
220	40	30p
220	63	36p
220	100	40p
330	16	25p
330	25	22p
330	63	36p
470	16	25p
470	25	28p
470	40	38p
470	63	43p
470	100	60p
1000	16	30p
1000	25	32p
1000	40	44p
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22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
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2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3468 1.00
2N3512 1.06
2N3553 2.30
2N3632 9.88
2N3638 35p
2N3638A 37p
2N3694 30p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2.00
2N3713 1.38
2N3714 2.98
2N3715 3.31
2N3716 3.60
2N3819 21p
2N3820 38p
2N3821 1.38
2N3822 80p
2N3823 45p
2N3824 1.70
2N3860 31p
2N3866 90p
2N3877A 38p
2N3902 6.88
2N3903 16p
2N3904 16p
2N3905 16p
2N3906 16p
2N4030 66p
2N4031 55p
2N4032 66p
2N4036 58p
2N4037 43p
2N4239 1.00
2N4240 3.00
2N4347 2.26
2N4351 1.18
2N4400 15p
2N4401 27p
2N4402 20p
2N4403 20p
2N4409 38p
2N4410 42p
2N4427 75p
2N4440 12.58
2N4870 80p
2N4871 56p
2N4888 92p
2N4898 1.29
2N4901 1.80
2N4902 3.52
2N4903 3.24
2N4904 2.75
2N4905 3.25
2N4906 3.42
2N4907 3.20
2N4908 3.70
2N4909 2.90
2N4918 95p
2N4919 1.28
2N4920 1.34
2N4921 56p
2N4922 68p
2N4923 80p
2N5086 36p
2N5087 36p
2N5088 37p
2N5089 37p
2N5190 80p
2N5191 70p
2N5193 80p
2N5194 79p
2N5209 24p
2N5245 37p
2N5246 40p
2N5247 45p
2N5248 40p
2N5249 48p
2N5266 2.88
2N5293 98p
2N5294 1.28
2N5295 1.37

2N5401 35p
2N5415 1.10
2N5416 1.54
2N5447 16p
2N5448 19p
2N5449 21p
2N5450 23p
2N5451 25p
2N5457 29p
2N5458 29p
2N5459 29p
2N5460 72p
2N5543 5.00
2N5551 37p
2N6082 11.99
2N6121 54p
2N6122 56p
2N6123 59p
2N6124 56p
2N6125 59p
2N6126 71p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.14
2N6134 1.36
2N6253 1.45
2N6254 1.55
2SC1306 96p
2SC1444 2.50
2SC2078 1.70
2SJ49 3.98
2SK134 3.98
3N128 1.12
3N138 3.50
3N139 3.30
3N140 2.37
3N143 2.85
3N152 3.00
3N153 2.47
3N154 2.56
3N200 6.93
3N201 2.98
40360 60p
40361 67p
40362 67p
40363 2.22
40406 1.39
40407 75p
40408 1.59
40410 1.80
40411 2.85
40412 90p
40673 83p
40822 1.80
40871 86p
40872 86p
AC125 35p
AC126 25p
AC127 25p
AC128 25p
AC132 39p
AC151 51p
AC152 45p
AC153 55p
AC153K 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 39p
AC188 25p
AC188K 40p
ACY17 70p
AF239 1.24
AF240 1.00
AF279B 75p
AF279G 75p
AL102 3.40
AU110 2.20
AU113 2.30
BC107 10p
BC107A 12p
BC107B 12p
BC108 10p
BC108A 12p
BC108B 12p
BC108C 12p
BC109 10p
BC109B 12p
BC109C 12p
BC140 29p
BC141 37p
BC142 29p
BC143 34p
BC147 10p
BC147A 12p
BC147B 12p
BC147C 12p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 14p
BC149C 13p
BC152 35p
BC153 23p
BC154 27p
BC157 11p
BC157A 12p
BC157B 14p
BC158 10p
BC158A 11p
BC158B 12p
BC159 11p
BC159A 12p
BC159B 13p
BC159C 13p
BC160 42p
BC161 48p
BC167 10p
BC167A 10p
BC167B 10p
BC168 10p
BC168B 10p
BC168C 10p
BC169 10p
BC169B 10p
BC169C 10p
BC177 25p
BC177A 18p
BC177B 18p
BC178 16p
BC178A 24p
BC178B 16p
BC179 25p
BC179A 25p
BC179B 27p
BC179C 27p
BC182 10p
BC182A 12p
BC182B 12p
BC182L 10p
BC182LA 12p
BC182LB 12p
BC183 10p
BC183A 12p
BC183B 12p
BC183C 12p
BC183L 10p
BC183LA 10p
BC183LB 13p
BC183LC 13p
BC184 10p
BC184B 12p
BC184C 14p
BC184L 10p
BC184LB 12p
BC184LC 14p
BC186 24p
BC187 24p

BC212 10p
BC212A 12p
BC212B 12p
BC212L 10p
BC212LA 13p
BC212LB 14p
BC213 10p
BC213A 11p
BC213B 12p
BC213C 13p
BC213L 10p
BC213LA 13p
BC213LB 13p
BC213LC 14p
BC214 10p
BC214B 12p
BC214C 13p
BC214L 10p
BC214LB 14p
BC214LC 14p
BC237 16p
BC237A 16p
BC237B 17p
BC237C 18p
BC238 16p
BC238A 15p
BC238B 16p
BC238C 17p
BC239 15p
BC239A 16p
BC239B 17p
BC239C 16p
BC300 45p
BC301 44p
BC302 43p
BC303 47p
BC327 16p
BC328 14p
BC337 15p
BC338 15p
BC440 32p
BC441 33p
BC460 32p
BC461 33p
BC516 40p
BC517 40p
BC547 13p
BC547A 14p
BC547B 14p
BC548 14p
BC548A 13p
BC548B 14p
BC548C 15p
BC549 13p
BC549B 14p
BC549C 15p
BC550 30p
BC550C 33p
BC557 15p
BC557A 16p
BC557B 16p
BC558 15p
BC558A 15p
BC558B 16p
BC558C 17p
BC559 15p
BC559B 16p
BC559C 17p
BC560 32p
BC560C 34p
BCY70 16p
BCY71 16p
BCY72 16p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 39p
BD237 40p
BD238 38p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 70p
BD241A 61p
BD241C 67p
BD242A 65p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.00
BD245C 1.30
BD246A 1.20
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.00
BD250C 2.44
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 93p
BD442 93p
BD529 1.20
BD530 1.30
BD535 75p
BD536 75p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 1.10
BD540C 1.20
BD675 72p
BD676 77p
BD677 77p
BD678 83p
BD711 1.32
BD712 1.32
BDX14 1.30
BDX18 1.49
BDX32 3.47
BDY54 1.70
BDY55 1.75
BDY56 1.80
BDY57 1.80
BDY58 6.15
BF194 12p
BF195 12p
BF196 12p
BF197 12p
BF198 15p
BF199 15p
BF200 1.46
BF224J 32p
BF225J 30p
BF240 33p
BF241 36p
BF244A 36p
BF244B 35p
BF245A 35p
BF245B 35p
BF246 40p
BF246A 42p
BF246B 53p
BF247A 55p
BF247B 58p
BF254 55p
BF255 42p
BF256A 45p
BF256B 45p
BF256C 62p
BF257 30p
BF258 32p
BF259 35p

BF457 46p
BF458 56p
BF459 62p
BF469 86p
BF470 86p
BFR39 25p
BFR40 25p
BFR41 25p
BFR79 25p
BFR80 25p
BFR81 25p
BFR90 2.11
BFS28 2.95
BFS61 1.00
BFS98 1.10
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 24p
BSX21 24p
BU104 2.22
BU105 1.70
BU109 3.29
BU126 1.47
BU204 2.25
BU205 1.75
BU206 1.88
BU208 1.98
BU326S 2.35
BU406 1.45
BU407 1.45
BU408 1.35
BU500 2.95
BUV20 11.00
BUV21 10.90
BUV23 13.60
BUV24 12.10
BUV25 15.00
BUX20 17.00
BUY18S 3.85
E430 5.60
J300 1.80
J310 53p
MJ802 3.99
MJ900 2.90
MJ901 3.10
MJ1000 2.50
MJ1001 3.00
MJ1800 3.60
MJ2500 2.19
MJ2501 2.25
MJ2955 1.00
MJ3000 2.19
MJ3001 2.25
MJ3701 2.35
MJ4502 3.98
MJ15003 4.85
MJ15004 5.56
MJ15015 2.45
MJ15016 3.34
MJE340 53p
MJE350 1.50
MJE2955 99p
MJE3055 69p
MPSA05 23p
MPSA06 25p
MPSA10 28p
MPSA12 29p
MPSA13 48p
MPSA14 48p
MPSA16 38p
MPSA18 65p
MPSA20 48p
MPSA42 48p
MPSA43 48p
MPSA55 28p
MPSA56 28p
MPSA65 48p
MPSA66 48p
MPSA70 45p
MPSA92 38p
MPSA93 38p
MPSL01 42p
MPSL51 38p
MPSU01 84p
MPSU04 1.32
MPSU05 55p
MPSU06 58p
MPSU07 75p
MPSU51 80p
MPSU55 98p
MPSU56 88p
MPSU57 1.20
OC20 2.30
OC22 2.00
OC23 2.00
OC25 2.00
OC28 1.70
OC29 2.36
OC35 2.36
OC41 80p
OC43 70p
OC44 80p
OC70 80p
OC71 60p
OC72 50p
OC82 50p
OC82D 50p
OC83 70p
TIP29A 42p
TIP29C 50p
TIP30A 36p
TIP30C 50p
TIP31A 38p
TIP31C 38p
TIP32A 38p
TIP32C 42p
TIP33A 65p
TIP33C 76p
TIP34A 74p
TIP34C 80p
TIP35A 1.20
TIP35C 1.29
TIP36A 1.29
TIP36C 1.30
TIP41A 40p
TIP41C 50p
TIP42A 50p
TIP42C 56p
TIP49 1.20
TIP50 1.40
TIP53 1.57
TIP54 1.58
TIP110 74p
TIP112 90p
TIP115 81p
TIP117 94p
TIP120 80p
TIP122 73p
TIP125 1.20
TIP127 1.27
TIP130 1.50
TIP132 1.60
TIP135 1.60
TIP137 1.80
TIP140 1.04
TIP142 1.04
TIP145 1.19
TIP147 1.19
TIP2955 77p
TIP3055 70p
TIS43 40p
TIS45 64p
TIS46 64p
TIS47 45p
TIS88A 62p

VN10KM 60p
VN46AF 84p
VN66AF 85p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 35p
ZTX311 32p
ZTX312 35p
ZTX313 36p
ZTX314 24p
ZTX320 35p
ZTX330 35p
ZTX341 28p
ZTX500 14p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 34p
ZTX530 24p
ZTX531 25p

DIODES
1N34A 30p
1N821 70p
1N823 80p
1N914 08p
1N916 10p
1N1190 1.47
1N4001 4p
1N4002 4½p
1N4003 5p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 6p
1N4150 18p
1N4448 22p
1N4517 22p
1N5172 30p
1N5176 94p
1N5400 12p
1N5401 12p
1N5402 14p
1N5403 15p
1N5404 16p
1N5405 17p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1N5625 60p
1N5626 62p
1N5627 68p
1S44 10p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA144 30p
BA155 15p
BA156 38p
BA157 25p
BA158 30p
BA159 32p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 25p
BA318 30p
BAV10 18p
BAV19 15p
BAV20 15p
BAX13 10p
BAX16 11p
BY126 20p
BY127 22p
BY134 26p
BY182 1.26
BY188A 65p
BY206 38p
BY207 38p
BY223 1.56
BY297 48p
BY299 60p
MZ2361 1.80
OA10 70p
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p

DIACS
BR100 40p
ST2 25p

THYRISTORS 4, 8 & 12 Amps Texas TO220
Suffix: A = 100V, B = 200V, C = 300V, D = 400V, M = 600V
4A: TIC106A 44p, TIC106B 47p, TIC106C 48p, TIC106D 59p, TIC106M 68p
8A: TIC116A 64p, TIC116B 68p, TIC116C 71p, TIC116D 73p, TIC116M 80p
2A: TIC126A 72p, TIC126B 72p, TIC126C 73p, TIC126D 77p, TIC126M 96p

TRIACS Texas 400V TO220 Case
TIC206D(4A) 64p
TIC225D(6A) 74p
TIC226D(8A) 88p
TIC236D(12A) 1.16
TIC246D(16A) 1.22
TIC253D(20A) 1.90
TIC263D(25A) 2.11

BRIDGE RECTIFIERS (PIV shown in brackets)
1 amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40
Proprietory Bridges
B40C1500 1.20
B80C3700 1.80
BY164 55p
BY179 92p

ZENER DIODES 400-500mW E24 Series 2.4-47V 8p
1.3 Watt E24 Series 3.3-82V 15p
2.5 Watt E24 Series 7.5-75V 1.10

NEW OPTO DEVICES
New LEDs Now in stock. R = red, G = green, Y = yellow

Large diffused	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p
Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0.1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri-colour flat RGY8	83p	78p

LINEAR ICs
AN103 2.20
AY1 0212 6.60
AY3-0215 7.95
AY1 1320 2.20
AY1 5050 95p
AY1 1270 7.25
AY3 8910 5.39
AY3 8912 5.59
CA3048 2.99
CA3049 3.21
CA3059 2.80
CA3060 4.08
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.00
CA3140E 48p
CA3140T 1.00
HA1366W 2.40
HA1388 2.54
LC7120 3.20
LC7130 3.20
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.08
LM348N 62p
LM349N 1.16
LM350K 4.60
LM379S 4.79
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386N1 88p
LM386N4 1.20
LM388N 1.00
LM391N60 1.70
LM391N80 1.93
LM723CH 1.21
LM723CN 40p
LM725CH 3.40
LM725CN 3.19
LM733 69p
LM741CH 96p
LM741CN 15p
LM741CN14 80p
LM747CN 69p
LM748CH 60p
LM748CN 35p
LM1303N 1.20
LM1304N 2.50
LM1305N 3.10
LM1307N 2.75
LM1310N 1.45
LM1330N 2.25
LM1871 4.39
LM1872 4.38
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.89
LM2917N 1.89
NE531N 1.38
NE543N 2.50
NE544N 1.80
NE555 16p
NE556 45p
NE558 1.80
NE560 3.25
NE562 4.08
NE565 1.18
NE566 1.49
NE567 1.37
NE570 3.75
NE571 3.75
NE5534A 1.25
PLL02A 4.95
PLL03A 12.75
RC413F 58p
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.55
TBA530Q 2.79
TBA540 2.72
TBA540Q 2.74
TBA550 3.26
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TCA910 2.19
TCA940 1.88
TDA1002 3.38
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.85
TDA1024 1.19
TDA2610 3.90
TDA2611A 2.50
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.65
UPC1156 2.75
XR2206 2.82
ZN414 79p
ZN419 2.25
ZN1034 1.99
ZN1040 6.69
ZTK22 89p
ZTK33 89p

CPUs
1802 7.00
2650A 11.99
6502 3.24
6800 2.74
6802 2.80
6809 8.50
8035 3.40
8060 10.90
8080A 2.79
8085A 3.49
8900 57.75
9980 21.00
SCMP1 17.66
Z80A 2.96

LOGIC ICs including COMPUTER SUPPORT
ADC0800 22.50
ADC0816 14.90
ADC0817 10.06
AY5-2376 5.90
ICM7555 80p
INS1671 20.00
INS1771 20.00
RO2513LC 6.90
RO2513UC 7.50
SAA5000 3.00
SAA5010 7.10
SAA5012 7.10
SAA5020 5.50
SAA5030 9.00
SAA5040 15.00
SAA5041 15.00
SAA5050 8.50
SAA5052 8.50
TMS6011 3.65
8T26 1.35
8T28 1.35
8T95 1.35
8T97 1.35
81LS95 90p
81LS96 90p
81LS97 90p
81LS98 1.20
6522 3.19
6532 6.95
8154 9.42
8155 3.60
Z80ACTC 2.65
Z80ADART 8.00
Z80ADMA 10.00
Z80APIO 2.80
ZN425E8 3.38

VOLTAGE REGULATORS
– Positive – 100mA
78L05A 30p
78L12A 30p
78L15A 30p
78L24A 30p
1 Amp TO220
7805T 38p
7812T 38p
7815T 38p
7824T 38p
– Negative – 100mA T092
79L05 58p
79L12 58p
79L15 58p
1 Amp TO220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZERO INSERTION DIL SOCKETS
24 pin 4.99
40 pin 5.30

40 CMOS
4000 10p
4001 10p
4002 11p
4006 40p
4007 15p
4008 32p
4009 24p
4010 10p
4011 10p
4012 15p
4013 20p
4014 48p
4015 58p
4016 20p
4017 32p
4018 45p
4019 28p
4020 44p
4021 38p
4022 48p
4023 12p
4024 20p
4025 12p
4026 79p
4027 20p
4028 28p
4029 25p
4030 14p
4031 1.19
4032 80p
4033 1.20
4034 1.29
4035 58p
4036 2.48
4037 1.30
4038 90p
4039 2.80
4040 48p
4041 40p
4042 39p
4043 41p
4044 39p
4045 99p
4046 44p
4047 39p
4048 32p
4049 22p
4050 20p
4051 44p
4052 44p
4053 44p
4054 79p
4055 85p
4056 80p
4059 4.35
4060 42p
4063 79p
4066 22p
4067 2.48
4068 14p
4069 13p
4070 13p
4071 13p
4072 13p
4073 13p
4075 13p
4076 45p
4077 13p
4078 13p
4081 12p
4082 12p
4085 48p
4086 48p
4089 1.50
4093 20p
4094 65p
4095 60p
4096 90p
4097 2.88
4098 74p
4099 90p
For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS
4502 50p
4503 29p
4507 33p
4508 1.19
4510 35p
4511 40p
4512 48p
4514 1.17
4515 1.17
4516 45p
4518 36p
4519 29p
4520 40p
4521 99p
4526 50p
4527 58p
4528 45p
4532 55p
4534 4.20
4536 2.80
4538 55p
4539 48p
4543 48p
4553 2.20
4555 30p
4556 36p
4560 1.48
4566 1.48
4569 1.50
4584 36p
4585 79p

MEMORIES
1702A 3.50
2101 4.00
2102AL2 1.36
2111-1 3.00
2114 (200ns) 1.80
2532 3.90
2708 2.28
2716 (5V) 2.11
4027 3.00
4044 7.00
4060 9.50
4116 (200ns) 75p
4118-3 3.25
4164 4.50
5204 7.50
6116 3.30
6514 3.30
6810 1.15
7489 4.20
74189 4.00
74LS289 3.25
74LS188 2.25
74LS287 3.00
74LS288 2.25

TTL
7400 10½p
7401 11p
7402 11p
7403 12p
7404 12p
7405 15p
7406 20p
7407 20p
7408 14p
7409 18p
7410 15p
7411 16p
7412 18p
7413 18p
7414 25p
7416 20p
7417 20p
7420 15p
7421 20p
7422 20p
7423 20p
7425 20p
7426 22p
7427 22p
7428 26p
7430 14p
7432 22p
7433 22p
7437 25p
7438 25p
7440 15p
7441 65p
7442 32p
7443 90p
7444 90p
7445 50p
7446 60p
7447 44p
7448 55p
7450 15p
7451 15p
7453 15p
7454 15p
7460 15p
7470 34p
7472 25p
7473 25p
7474 25p
7475 28p
7476 28p
7480 48p
7481 1.19
7482 68p
7483 38p
7484 69p
7485 60p
7486 20p
7489 2.20
7490 20p
7491 25p
7492 25p
7493 25p
7494 30p
7495 35p
7496 40p
7497 1.20
74100 80p
74104 50p
74105 50p
74107 22p
74109 25p
74110 35p
74116 1.10
74118 58p
74119 80p
74120 55p
74121 25p
74122 40p
74123 42p
74125 35p
74126 34p
74128 40p
74132 29p
74136 45p
74141 35p
74142 1.99
74143 2.48
74144 2.10
74145 50p
74147 50p
74148 65p
74150 60p
74151 35p
74153 35p
74154 45p
74155 45p
74156 45p
74157 50p
74159 60p
74160 50p
74161 50p
74162 50p
74163 50p
74164 50p
74165 50p
74166 50p
74170 1.25
74172 2.75
74173 60p
74174 54p
74175 40p
74176 40p
74177 40p
74178 70p
74180 60p
74181 1.15
74182 50p
74184 98p
74185 98p
74186 4.60
74188 2.50
74190 48p
74191 48p
74192 45p
74193 48p
74194 45p
74195 45p
74196 38p
74197 45p
74198 85p
74199 83p
74221 53p

74H TTL
74H00 1.45
74H01 1.45
74H04 1.55
74H05 1.55
74H10 1.45
74H11 1.45
74H20 1.45
74H21 1.45
74H30 1.45
74H40 1.55
74H51 1.75
74H53 1.65
74H54 1.45

74LS TTL
74LS00 11p
74LS01 11p
74LS02 11p
74LS03 12p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 19p
74LS14 30p
74LS15 12p
74LS20 12p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 12p
74LS32 13p
74LS33 14p
74LS37 14p
74LS38 15p
74LS40 13p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 20p
74LS76 20p
74LS78 18p
74LS80 1.20
74LS83 38p
74LS85 48p
74LS86 16p
74LS90 24p
74LS92 25p
74LS93 24p
74LS95
74LS96
74LS107 20p
74LS109 27p
74LS112 22p
74LS113 22p
74LS114 22p
74LS122 38p
74LS123 38p
74LS124 80p
74LS125 24p
74LS126 24p
74LS132 39p
74LS136 28p
74LS138 32p
74LS139 30p
74LS145 70p
74LS147 1.57
74LS148 75p
74LS151 38p
74LS153 30p
74LS154 79p
74LS155 29p
74LS156 35p
74LS157 27p
74LS158 35p
74LS160 35p
74LS161 35p
74LS162 35p
74LS163 35p
74LS164 40p
74LS165 60p
74LS166 50p
74LS168 84p
74LS169 85p
74LS170 70p
74LS173 55p
74LS174 45p
74LS175 39p
74LS181 79p
74LS183 1.70
74LS190 40p
74LS191 40p
74LS192 36p
74LS193 37p
74LS194 35p
74LS195 32p
74LS196 45p
74LS197 45p
74LS221 50p
74LS240 55p
74LS241 55p
74LS242 55p
74LS243 55p
74LS244 70p
74LS245 50p
74LS247 50p
74LS248 55p
74LS249 50p
74LS251 30p
74LS253 30p
74LS257 30p
74LS258 36p
74LS259 80p
74LS261 1.35
74LS266 18p
74LS273 60p
74LS275 2.25
74LS279 30p
74LS280 1.60
74LS283 38p
74LS289 4.70
74LS290 40p
74LS293 40p
74LS295 60p
74LS298 80p
74LS299 2.50
74LS323 1.75
74LS324 1.46
74LS325 2.38
74LS326 2.39
74LS327 2.38
74LS347 95p
74LS348 1.00
74LS352 70p
74LS353 70p
74LS362 7.25
74LS365 25p
74LS366 25p
74LS367 25p
74LS368 25p
74LS373 58p
74LS378 58p
74LS386 1.14
74LS390 40p
74LS393 42p
74LS395 80p
74LS396 1.80
74LS398 2.70
74LS399 1.50
74LS445 1.80
74LS490 2.20
74LS540 1.60
74LS541 1.60
74LS640 1.00
74LS641 1.00

Rapid Electronics

Tel: 0206 36412
Hill Farm Industrial Estate
Boxted
Colchester Essex CO4 5RD

BARCLAYCARD VISA

TRANSISTORS

				BC548	10	BFR40	23	TIP29A	40	★ZTX107	8	2N3053	23
				BC549	10	BFR80	25	TIP29B	55	★ZTX108	8	2N3054	55
AC125	35	BC157	10	BC558	10	BFX29	25	TIP29C	60	ZTX109	12	2N3055	50
AC126	25	BC158	10	BCY70	18	BFX84	25	TIP30A	45	ZTX300	14	2N3442	120
AC127	25	BC159	8	BCY71	18	BFX85	25	TIP30B	50	ZTX301	16	★2N3702	8
★AC128	20	BC160	45	BCY72	18	BFX86	28	TIP30C	60	ZTX302	15	2N3703	9
AC176	25	BC168C	10	BD115	80	BFX87	25	TIP31A	45	ZTX304	17	★2N3704	6
AC187	22	BC169C	10	BD131	35	BFX88	25	TIP31C	55	ZTX341	30	2N3705	9
AC188	22	BC170	8	BD132	35	BFY50	23	TIP32A	45	ZTX500	15	2N3706	9
AD142	120	BC171	10	BD133	50	BFY51	23	TIP32C	60	ZTX501	15	2N3707	10
AD149	80	BC172	8	BD135	30	BFY52	23	TIP33A	50	ZTX502	15	2N3708	10
AD161	40	BC177	18	BD136	30	BFY53	32	TIP33C	75	ZTX503	18	2N3709	10
AD162	40	BC178	18	BD137	30	BFY55	32	TIP34A	60	ZTX504	25	2N3772	190
AF124	60	BC179	18	BD138	30	BFY56	32	TIP34C	85	2N697	20	2N3773	210
AF126	50	BC182	10	BD139	35	BRY39	40	TIP35A	160	2N698	40	★2N3819	18
AF139	40	★BC182L	8	BD140	35	BSX20	20	TIP35C	180	2N706A	20	2N3820	40
AF186	70	BC183	10	BD204	110	BSX29	35	TIP36A	170	2N708	20	2N3823	65
AF239	45	BC183L	10	BD206	110	BSY95A	25	TIP36C	195	2N918	35	2N3866	90
BC107	10	BC184	10	BD222	85	BU205	160	TIP41A	60	2N1132	22	2N3903	10
BC107B	12	★BC184L	7	BF180	35	BU206	200	TIP42A	60	2N1613	30	2N3904	10
★BC108	9	BC212	10	BF182	35	BU208	170	TIP120	90	2N2218A	45	2N3905	6
BC108B	12	BC212L	10	BF184	25	MJ2955	99	TIP121	90	2N2219A	25	2N3906	10
BC108C	12	BC213	10	BF185	25	MJE340	50	TIP122	90	2N2221A	25	2N4037	45
★BC109	9	BC213L	10	BF194	12	MJE520	65	TIP141	120	2N2222A	20	2N4058	10
BC109C	12	BC214	10	BF195	12	MJE521	95	TIP142	120	2N2368	25	2N4060	10
BC114	22	★BC214L	8	BF196	12	MJE3055	70	TIP147	120	2N2369	16	2N4061	10
BC115	22	BC237	8	BF197	12	MPF102	40	TIP2955	60	2N2484	25	2N4062	10
BC117	22	BC238	14	BF198	10	MPF104	40	TIP3055	55	★2N2646	45	2N5457	38
BC119	35	BC308	15	BF199	14	MPSA05	22	TIS43	40	2N2904	20	2N5458	36
BC137	40	BC327	14	BF200	30	MPSA06	25	TIS44	45	2N2904A	20	2N5459	30
BC139	40	BC328	14	★BF244B	22	MPSA12	30	TIS45	45	2N2905	22	2N5485	36
BC140	30	BC337	14	BF245	30	MPSA55	30	TIS90	30	2N2905A	22	2N5777	45
BC141	30	BC338	14	BF256B	45	MPSA56	30	TIS91	30	2N2906	25	2N6027	30
BC142	25	BC477	30	BF257	32	MPSU05	55	★VN10KM	45	2N2906A	25	40360	40
BC143	25	BC478	30	BF258	25	MPSU06	55	VN46AF	75	2N2907	25	40361	50
BC147	8	BC479	30	BF259	35	MPSU55	60	VN66AF	85	2N2907A	25	40362	50
BC148	8	BC517	40	BF337	30	MPSU56	60	VN88AF	95	2N2926	9	40408	70
BC149	9	BC547	7										

LINEAR

		ICL7611	95	LM377	150	LM13600	120	NE570	400	TL071	30
★555CMOS	80	ICL7621	180	★LM380	65	MC1310	150	NE571	400	TL072	50
556 CMOS	150	ICL7622	180	LM381	120	MC1496	68	★RC4136	68	TL074	95
709	25	ICL8038	320	LM382	120	MC3340	135	★RC4558	60	★TL081	25
★741	14	ICL8211A	200	LM384	130	ML922	400	SL480	170	★TL082	45
748	35	ICM7224	785	LM386	65	ML924	195	SL490	250	★TL084	95
9400CJ	350	ICM7555	80	LM387	120	ML925	210	SN76018	150	TL170	50
AY-3-1270	840	LF351	45	LM393	100	ML926	140	SN76477	250	★UA2240	120
AY-3-8910	600	LF353	85	LM709	25	ML927	140	SP8629	250	ULN2003	85
AY-3-8912	625	LF356	90	LM725	350	ML928	140	TBA120S	70	ULN2004	90
CA3046	60	LM10	360	LM733	75	ML929	140	TBA800	80	★XR2206	300
CA3080	65	LM301A	25	LM741	14	MM5387A	465	TBA810	96	ZN414	100
CA3089	215	LM311	70	LM747	75	NE529	225	TBA820	80	ZN423	135
CA3090AQ	375	LM318	120	LM1458	40	NE531	150	TBA950	290	ZN424	135
CA3130E	90	LM324	40	LM2917	200	NE544	250	TDA1008	320	ZN425E	350
★CA3140E	45	LM334Z	100	LM3900	50	★NE555	16	TDA1022	525	ZN426E	330
CA3161E	100	LM335Z	125	★LM3909	70	★NE556	45	TDA1024	125	ZN427E	650
CA3189	290	LM339	50	LM3911	120	NE565	120	TL061	40	ZN428E	480
★CA3240E	110	LM348	65	LM3914	200	NE566	150	TL062	60	ZN459	285
ICL7106	790	LM358	50	LM3915	220	NE567	100	TL064	96	ZN1034E	200

CMOS

		★4017	38	4036	275	4055	95	4082	16	4502	60	4529	150
		4018	45	4039	290	4059	480	4085	65	4503	48	4532	80
4000	10	4019	25	4040	50	4060	85	4086	50	4507	38	4534	485
★4001	18	4020	50	4041	60	4063	85	4089	125	4508	150	4538	110
4002	12	4021	50	4042	45	★4066	30	★4093	30	4510	50	4543	100
4006	50	4022	50	4043	50	4067	295	4094	120	★4511	50	4549	360
4007	15	4023	18	4044	50	4068	16	4095	75	4512	50	4553	275
4008	48	4024	38	★4046	60	4069	16	4097	290	4514	120	4555	35
4009	24	4025	18	4047	60	4070	15	4098	75	4515	120	4556	35
4010	24	★4026	80	4048	40	4071	15	4099	90	4516	65	4559	390
★4011	11	4027	24	★4049	25	4072	15	40106	50	★4518	40	4560	175
4012	15	4028	50	★4050	25	4073	15	40109	118	4520	70	4584	45
★4013	25	4029	60	4051	45	4075	15	40163	100	4521	130	4585	60
4014	50	4030	30	4052	60	4076	50	40173	100	4526	70	4724	140
4015	50	4031	125	4053	60	4077	18	40175	100	4527	80		
4016	20	4034	140	4054	95	4081	14	40193	95	4528	70		

LS TTL

		LS21	12	LS76	18	LS125	26	LS161	37	LS221	54	LS365	30
		LS22	12	LS78	18	LS126	25	LS162	37	LS240	69	LS366	30
★LS00	11	LS26	14	LS83	40	LS132	42	LS163	37	LS241	69	LS367	30
LS01	11	LS27	12	LS85	52	LS136	26	LS164	43	LS242	75	LS368	35
LS02	11	LS30	11	LS86	19	★LS138	32	LS165	75	LS243	75	★LS373	65
LS03	12	LS32	13	★LS90	28	★LS139	32	LS166	75	★LS244	60	LS374	65
LS04	12	LS37	15	LS92	32	LS145	70	LS170	85	★LS245	70	LS375	45
LS05	13	LS38	15	★LS93	28	LS147	150	LS173	65	LS247	50	LS377	70
LS08	12	LS40	13	LS95	40	LS148	85	LS174	45	LS251	35	LS378	60
LS09	12	★LS42	32	LS96	95	LS151	38	LS175	45	LS257	35	LS390	55
LS10	12	★LS47	38	LS107	40	LS153	40	LS190	45	LS258	35	LS393	55
LS11	12	LS48	45	LS109	21	LS154	90	LS191	45	LS259	75	LS399	175
LS12	12	LS51	14	LS112	21	LS155	35	LS192	45	LS266	22	LS541	120
★LS13	22	LS55	14	LS113	21	LS156	36	LS193	45	LS273	68	LS670	150
LS14	38	LS73	18	LS114	22	★LS157	30	LS195	38	LS279	35		
LS15	12	★LS74	18	LS122	38	LS158	30	LS196	50	LS283	40		
LS20	12	LS75	22	LS123	38	LS160	37	LS197	60	LS353	88		

TTL

		★7413	18	7442	32	7480	48	74107	25	74155	40	74177	45
		7414	28	7444	90	7482	65	74109	25	74156	40	74179	80
★7400	11	7416	24	7446	65	7483	40	★74121	25	74157	30	74180	40
7401	11	7417	24	7447	40	7485	60	74122	40	74160	60	74181	115
7402	11	7420	15	7448	45	7486	20	74123	40	74161	50	74182	60
7403	12	7421	20	7450	16	7489	180	74125	35	74162	50	74190	50
7404	13	7422	20	7451	16	★7490	21	74126	38	74163	50	74191	50
7405	15	7427	22	7453	16	7491	45	74132	40	74164	50	74192	50
7406	24	7428	24	7454	16	7492	25	74141	40	74165	50	74193	45
7407	25	7430	14	7460	16	★7493	25	74145	50	74167	150	74194	50
7408	14	7432	20	7472	26	7494	38	74147	90	74170	125	74195	50
7409	14	7433	25	7473	26	7495	35	74148	70	74173	70	74196	50
7410	14	7437	25	★7474	20	7496	40	74150	55	74174	66	74197	50
7411	16	7438	25	7475	26	7497	95	74153	40	74175	55	74198	90
7412	18	7440	15	7476	30	74100	80	74154	55	74176	40	74199	90

CRYSTALS

100KHz	290	6·0M	200
200KHz	370	6·144M	180
1MHz	300	7·0M	250
1·008M	370	8·0M	170
1·8432	300	10·0M	180
2·0M	270	12·0M	200
2·4576M	220	16·0M	240
3·276M	240	18·0M	240
3·579M	120	18·432	220
4·0M	150	38·667	320
4·194M	150	48·0M	220
4·43M	125	116M	300
5·0M	240		

VERO

★ Verobloc 350p ★

Size 0·1 matrix	
2·5 × 1	22p
2·5 × 3·75	75p
2·5 × 5	85p
3·75 × 5	95p
VQ board	160p
Veropins per 100	
Single sided	50p
Double sided	60p
Spot face cutter	105p
Pin Insert. Tool	182p

SOCKETS

	Low profile	Wire-wrap
★8 pin	7p	25p
★14pin	9p	35p
★16 pin	10p	42p
18 pin	15p	52p
20 pin	18p	60p
22 pin	20p	70p
24 pin	22p	70p
28 pin	26p	80p
40 pin	32p	98p

Soldercon pins 60p/100.

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Our latest catalogue has just been released containing over 2000 stock lines all at extremely competitive prices backed by Rapids return of post service. Stocks include Denco coils, tools, Verocases, data sheets etc. etc. Send 45p for your copy now (sent free of charge with all orders over £10).

RESISTORS

¼W 5% Carbon film E12 series 4·7Ω-10M **1p** each. ½W 5% Carbon film E12 series 4·7Ω to 4M7, **2p** each. ¼W 1% Metal film. E24 series 10Ω-1M, **6p** each.

TRANSFORMERS

Please add carriage charges to our normal post charges

Miniature mains.
606V, 909V, 12012V all @ 100mA **100p** each.
PCB mounting. Miniature.
3VA 0-6, 0-6 @ 0·25A; 0-9, 0-9 @ 0·15A; 0-12, 0-12 @ 0·12A, **200p** each.
6VA 0-6, 0-6 @ 0·5A; 0-9, 0-9 @ 0·3A; 0-12, 0-12 @ 0·25A, **270p** each.
High quality. Split bobbin construction.
6VA 0-6, 0-6 @ 0·5A, 0-9, 0-9 @ 0·4A, 0-12, 0-12V @ 0·3A **220p** each.
12VA 0-6, 0-6 @ 1A, 0-9, 0-9 @ 0·8A, 0-12, 0-12 @ 0·5A, 0-15, 0-15 @ 0·4A. **295p** each (plus 40p carriage).
25VA 0-6, 0-6 @ 1·5A, 0-9, 0-9 @ 1·2A, 0-12, 0-12 @ 1A, 0-15, 0-15 @ 0·8A **330p** each (plus 60p carriage).
50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1·5A **440p** each (plus 75p carriage).

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices.

¼W 5% Resistor Kit. Contains 10 of each value from 4·7Ω to 1 Megohm (650 resistors) **480p**.

Ceramic Capacitor Kit. Contains 5 of each value from 22p to 0·01µ (135 caps.) **370p**.

Polyester Capacitor kit. Contains 5 of each value from 0·01 to 1µF (65 caps.) **575p** each.

Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets **425p** each.

Nut and Bolt Kit. Total 300 items. **180p.**

25 6BA ¼" bolts	25 4BA ¼" bolts
25 6BA ½" bolts	25 4BA ½" bolts
50 6BA nuts	50 4BA nuts
50 6BA washers	50 4BA washers

TRIACS

400V 4A	50
400V 8A	65
400V 16A	95
BR100	25

CABLES

20 metre pack single core connecting cable ten different colours	65p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2·5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m

HARDWARE

PP3 battery clips	6p
Red or Black crocodile clips	6p
Black pointer control knob	15p
Pr Ultrasonic transducers	350p
★6V Electronic buzzer	60p
★12V Electronic buzzer	85p
★PB2720 Piezo transducer	75p
★64mm 64 ohm speaker	70p
★64mm 8 ohm speaker	70p
20mm panel fuseholder	25p

DIODES

BY127	12	★1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	15
OA202	8	1N5404	16
1N914	4	1N5406	17
★1N4148	2	400mW zen	6

BZX61 Series zeners 1·3W 4V7 -39V **15p** each.

SWITCHES

Subminiature toggle
SPST **55p.** SPDT **60p.** DPDT **65p.**
Miniature toggle
SPDT **80p.** SPDT centre off **90p.**
DPDT **90p.** DPDT centre off **100p.**
Standard toggle SPST **35p.** DPDT **48p.**
Miniature DPDT slide switch **12p.**
Push to make **12p.** Push to break **22p.**
Rotary type adjustable stop
1P12W 2P6W 3P4W 4P3W all **55p** each
DIL switches
4 SPST **80p.** 6 SPST **80p.** 8SPST **100p.**

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All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/PO or Access/Visa number with your order. Please note new address. Callers most welcome—we are just 10 minutes from the centre of Colchester. Telephone orders welcome with Access and Visa. Official orders welcome from colleges and schools etc. Export orders no VAT but please add carriage. All components brand new + full spec.

CAPACITORS

Polyester. Radial leads. 250V, C280 type.
0·01, 0·015, 0·022, 0·033, **6p**; 0·047, 0·068, 0·1, **7p**; 0·15, 0·22, **9p**; 0·33, 0·47, **13p**; 0·68 **20p**; ·1µ **23p**.
Electrolytic, Radial or axial leads.
0·47/63V, 1/63V, 2·2/63V, 4·7/63V, 10/25V, **7p**; 22/25V, 47/25V, **8p**; 100/25V **9p**; 220/25V, **14p**; 470/25V, **22p**; 1000/25V, **30p**; 2200/25V, **50p.**
Tag end Power Supply Electrolytics.
2200/40V **110p**; 4700/40V **160p**; 2200/63V **140p**; 4700/63V **230p.**
Polyester. Miniature Siemens PCB.
1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, **7p**; 22n, 33n, 47n, 68n, **8p**; 100n, **9p**; 150n, **11p**; 220n, **13p**; 330n, **20p**; 470n, **26p**; 680n, **29p**; 1µ, **33p**; 2µ2, **50p.**
Tantalum bead.
0·1, 0·22, 0·33, 0·47, 1·0 @ 35V, **12p**; 2·2, 4·7, 10 @ 25V, **20p**; 15/16V, **30p**; 22/16V, **27p**; 33/16V, **45p**; 47/6V, **27p**; 47/16V, **70p**; 68/6V, **40p**; 100/10V, **90p.**
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Everyday ELECTRONICS

VOL. 11 NO. 10 OCTOBER 1982

WIDE CHOICE

ELECTRONICS appeals to all sorts of people, and it follows that constructors interests and needs vary, as does depth of knowledge and practical experience. Yet electronics offers something to all, for the possible applications are vast, and the level of technology employed can range from simple one- or two-transistor circuits, to involved systems based on microchips.

For examples it is necessary only to turn the following pages. The *General Purpose Pre-Amplifier* and the *Sine Wave Generator* come into the first category; what is more, the two transistors required in either design will be found mounted on the front cover of this month's issue. Higher technology is represented by the *Computer Expansion System*, winner of the Schools Electronics Design Award Competition; and the *Optical Tachometer*, which breaks new ground as an instrument for use with rotating mechanisms.

A useful car gadget and a simple short wave radio complete this month's complement of projects and underline the wide scope of home constructed electronics.

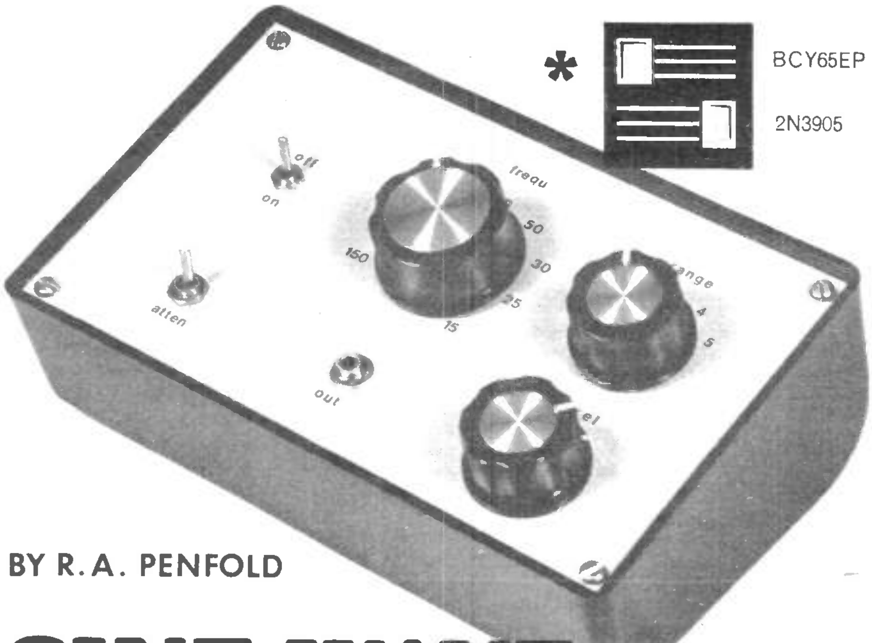
COME TO THE FAIR

Have a day out with the family at the first Electronics Hobby Fair. Alexandra Pavilion in north London is the venue for this new style exhibition sponsored by EVERYDAY ELECTRONICS and our associate journals *Practical Electronics* and *Practical Wireless*. The dates to remember are November 18-21.

Names long familiar to readers of our advertisements pages will materialise there as exhibitors; visitors will have the opportunity to browse around their stands, purchase their wares or just chat up the proprietors of businesses that year in and year out satisfy the needs of constructors and experimenters. The staff of EE, PE and PW will be in attendance and look forward to meeting their readers.

Other major attractions are laid on. The new Alexandra Pavilion—already dubbed "a palace of light"—will be an appropriate setting for this most enlightening of shows with its happy gathering of electronics enthusiasts, their families and friends, together with traders, professional organisations—in fact all who share some interest, be it great or small, in this exciting, ever expanding field of technology. Further details appear on page 657. Be seeing you.

Fred Bennett.



BY R. A. PENFOLD

SINE WAVE GENERATOR

**A GOOD USE FOR YOUR FREE TRANSISTORS*

THIS simple but extremely useful piece of test equipment gives a sinewave output of reasonable purity over an approximate frequency span of 15Hz to 1·5 MHz. It is ideal for applications such as frequency response and voltage gain measurement of audio circuits, and it can also be used in the alignment and testing of medium and longwave radios as the higher frequency ranges of the unit extend well into the radio frequency spectrum.

The five frequency ranges of the Sinewave Generator are nominally as follows:

Range 1 15Hz to 150Hz
Range 2 150Hz to 1·5kHz
Range 3 1·5kHz to 15kHz
Range 4 15kHz to 150kHz
Range 5 150kHz to 1·5MHz

The maximum output amplitude is approximately 1 volt r.m.s., and this can be continuously varied down to zero by means of two attenuator controls. The output level is accurately stabilised and there is no significant variation in the output level over the frequency range of the unit. circuit. This is really a simple form measurements since it is not necessary repeatedly to check that the output level of the unit is still correct when making measurements at various frequencies.

THE WIEN NETWORK

In common with most good quality sinewave generators, this one is based on a Wien network, and Fig. 1 shows the arrangement used in this type of circuit. This is really as simple form of $C-R$ bandpass filter which gives losses that are at a minimum at a frequency which can be calculated using the following formula:

$$f=\frac{1}{2RC}$$

This assumes that R1 and R2 are of equal value, and that C1 and C2 are also of the same value (which is invariably the case for practical designs). At this frequency of peak response there is zero phase shift through the network.

In order to use a Wien network in an oscillator it is merely necessary to use the network to provide positive feedback over an amplifier; but the losses through the network must be counteracted by the gain of the amplifier to a high degree of accuracy if a good quality sinewave output is to be obtained.

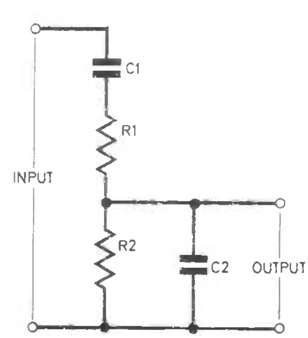


Fig. 1. The circuit of a Wien network.

NEED FOR AUTOMATIC GAIN CONTROL

Too much gain results in the circuit oscillating too strongly and the output becoming clipped and badly distorted. This results in strong harmonics (multiples of the fundamental frequency) on the output signal, which would give inaccurate results when using the generator for frequency response measurements.

Inadequate gain results in a failure of the circuit to oscillate.

In practice it is necessary to have some form of automatic gain control circuit which maintains the gain of the amplifier at just the right level, and compensates for factors such as changes in supply voltage and variations in loading of the output when necessary.

CIRCUIT DIAGRAM

The circuit diagram of the sinewave generator is shown in Fig. 2, and the amplifier used in the unit is a simple two-transistor complementary type. This gives a reasonably high input impedance so that there is negligible loading on the Wien network, and a fairly low output impedance so that the output level is not affected significantly with normal loading of the output. The input is to the base of TR1 and the output is taken from the collector of TR2 via d.c. blocking capacitor C14.

SWITCHED CAPACITORS

The Wien network has two sets of five switched capacitors (C3 to C7 and C9 to C13), and these give the unit its fives ranges. C3 has been given a value of only 82pF rather than the expected value of 100pF due to the input capacitance of the amplifier which effectively boosts the value of C3 to approximately the required capacitance of 100pF. This input capacitance is not high enough to have any significant effect on the other four ranges.

The two resistances in the Wien network are formed by R3 plus VR1a in series, and R7 plus VR1b in series. VR1 enables the oscillator to be tuned over the ranges quoted earlier. R1, R2, and C2 are used to bias the amplifier through part of the Wien network.

THERMISTOR STABILISING

Thermistor RTH1 is used to stabilise the gain of the amplifier at the correct level, and the R53 (or RA53) type thermistor used here is a special device which is contained in a vacuum in a glass encapsulation. This largely isolates it from the ambient temperature, and it instead responds to the current flowing through the component and the consequent heat produced.

At switch-on RTH1 will be at a relatively low temperature and will therefore have a fairly high resistance. RTH1 is connected so that it provides negative feedback from the output of the amplifier to the emitter of TR1, and with a high resistance through RTH1 there is little feedback and the amplifier has a high voltage gain. This results in strong oscillation.

The strong output signal results in a large current flow through RTH1, causing it to heat up and its resistance to fall. The gain of the circuit thus falls and gentle oscillation is produced.

RISE OR FALL IN OUTPUT

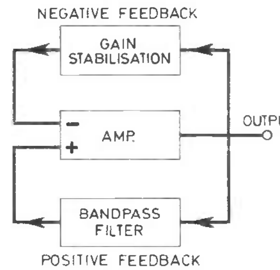
If the output signal level should fall for some reason, the current flow through RTH1 will decline and its temperature will reduce. This gives a rise in resistance, more voltage gain through the amplifier, and stronger oscillation which increases the output signal back to virtually its original level.

An increase in output has the opposite effect with RTH1 passing a stronger current so that its resistance decreases, the voltage gain of the amplifier is reduced, and the output signal is returned to almost its original level.

This method of stabilisation is very simple and only uses a single component, but it is very efficient and the output signal level is well stabilised.

HOW IT WORKS

The circuit is based on an amplifier which is made to oscillate by the application of frequency selective positive feedback, and the circuit oscillates at the frequency at which the most feedback is provided. This frequency can be varied over wide limits and the output frequency can be varied from sub-audio to high frequencies well into the radio frequency spectrum.



In order to obtain a reasonably pure sinewave output, or an output signal which contains just one frequency in other words, it is necessary to have the voltage gain of the amplifier at precisely the right level. This is achieved using a circuit that automatically sets the gain of the amplifier at the right level by applying a controlled amount of negative feedback over the amplifier.

OUTPUT ATTENUATOR

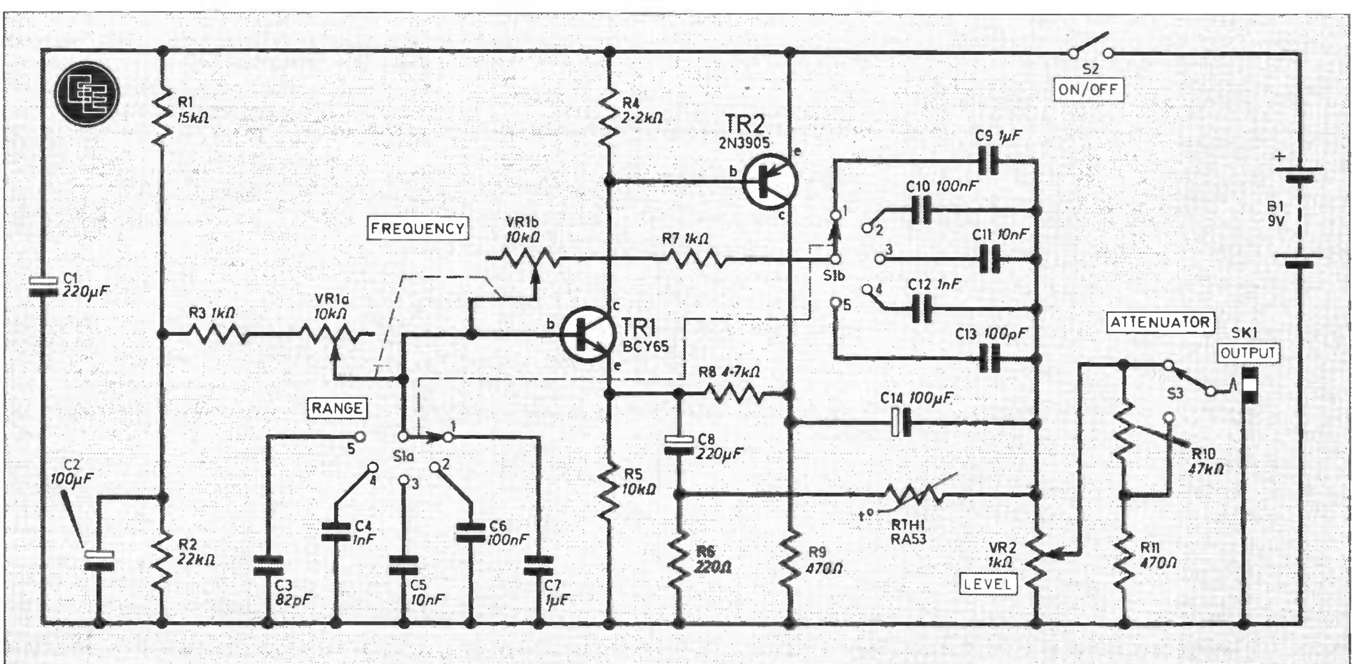
VR2 is a volume control type output attenuator which enables the output signal level to be set at any desired level between zero and the maximum output level of about 1 volt r.m.s.

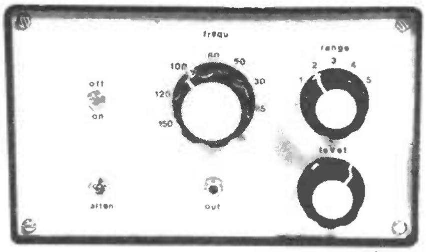
Adjusting the output level using VR2 can be rather awkward when very low signal levels are required, and an additional (final) attenuator which consists of R10 and R11 can be switched into circuit to reduce the output by about 40dB (by a factor of 100). VR2 then gives an output signal which can be varied from zero to about 10mV r.m.s, and output levels of under a millivolt can then be accurately and easily set.

Power is obtained from an ordinary PP3 size 9 volt battery, and the current drain of around 10mA gives a reasonable battery life.

COMPONENTS approximate cost £15·00

Fig. 2. Circuit diagram of the Sine Wave Generator.





SINE WAVE GENERATOR

COMPONENTS

Resistors
- R1 15kΩ
- R2 22kΩ
- R3, 7 1kΩ (2 off)
- R4 2·2kΩ
- R5 10kΩ
- R6 220Ω
- R8 4·7kΩ
- R9 470Ω
- R10 47kΩ
- R11 470Ω
- All $\frac{1}{3}$W 5% carbon

See **Shop Talk** page 635

Potentiometers
- VR1 10kΩ logarithmic dual-gang carbon
- VR2 1kΩ linear carbon

Capacitors
- C1, 8 220μF 10V elect (2 off)
- C2, 14 100μF 10V elect (2 off)
- C3 82pF polystyrene
- C4, 12 1nF polycarbonate (2 off)
- C5, 11 10nF polycarbonate (2 off)
- C6, 10 100nF polycarbonate (2 off)
- C7, 9 1μF polycarbonate (2 off)
- C13 100pF polystyrene

Semiconductors
- TR1 BCY65EP *npn* silicon
- TR2 2N3905 *pnp* silicon

Switches
- S1 6-way 2-pole rotary with adjustable end stop
- S2 s.p.s.t. miniature toggle
- S3 s.p.d.t. miniature toggle

Miscellaneous
- B1 9 volt PP3 size
- RTH1 thermistor, n.t.c. (RS type RA53 or R53)
- SK1 3·5mm jack
- Sloping front case (Maplin type M1005); 0·1 inch matrix stripboard 36 holes by 14 strips; battery connector; control knobs; Veropins; connecting wire; 6BA fixings; solder.

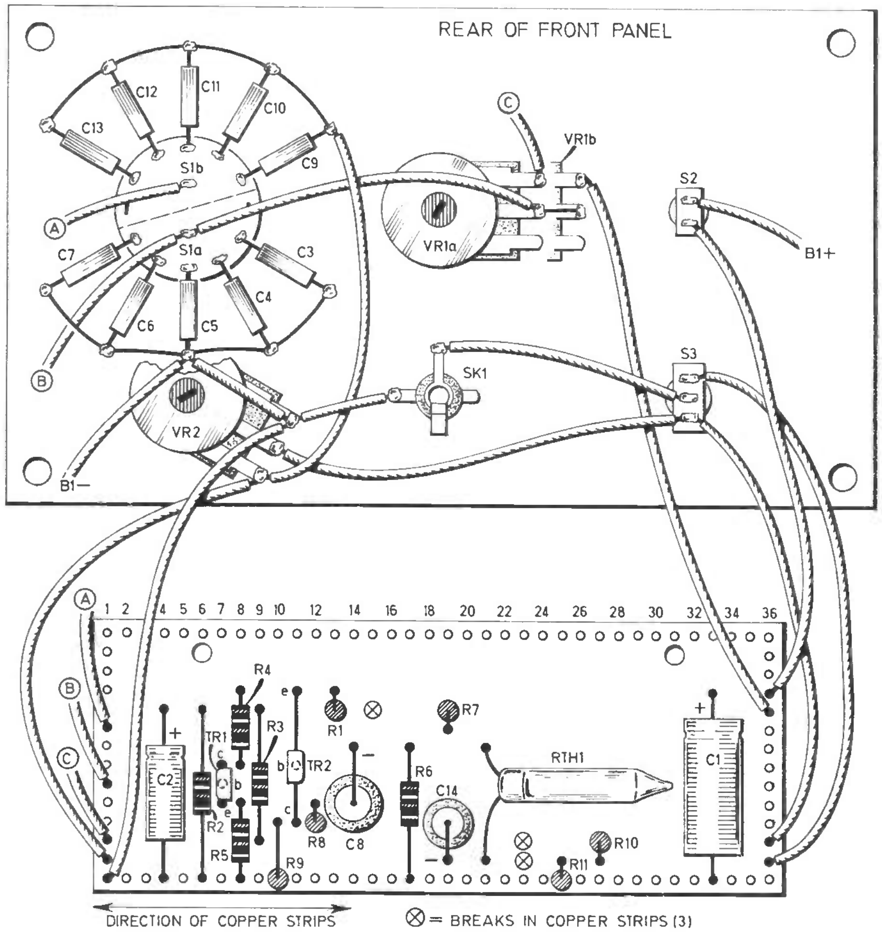
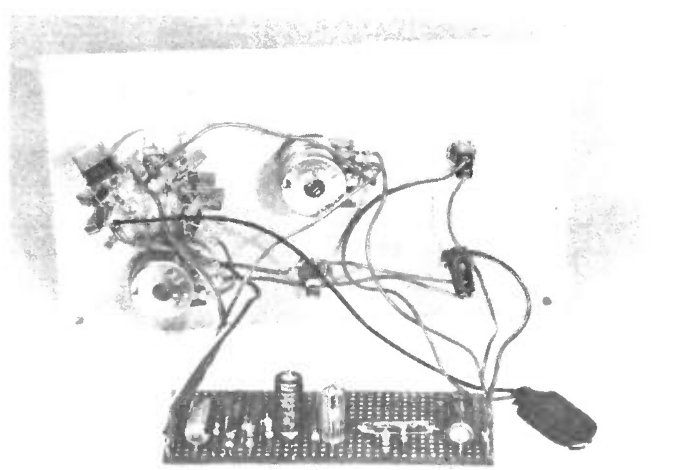
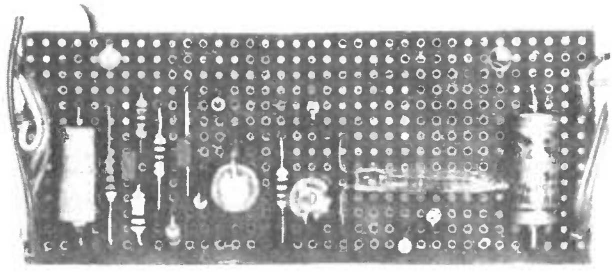


Fig. 3. The completed assembly, showing the front panel components and their interconnections to the circuit board. Note the breaks required in the copper strips as indicated on the top view of the circuit board.



The circuit board and (right) the complete assembly.



CONSTRUCTION starts here

CONSTRUCTION

A sloping front case measuring about 161×96×61mm is used for this project, although any case of about this size should be perfectly acceptable. The front panel layout used for the prototype can be seen from the photographs, and the unit will be easy to wire up and use if this general arrangement is copied.

The component panel is a 0·1 inch matrix stripboard having 36 holes 14 copper strips, and details of this are provided in Fig. 3. Construction of the board follows the normal pattern with a board of the specified size first being cut out using a hacksaw, the breaks in the copper strips and the two mountings then being made, after which the components are soldered into place and Veropins are fitted at points where connections to the off-board components will be made. The completed board is mounted on the base panel of the case, to the rear of the unit and on the left hand side.

This still leaves a substantial amount of wiring, to the off-board components, all of which is illustrated in Fig. 3.

OFF-BOARD COMPONENTS

C3 to C7 and C9 to C13 are mounted direct on S1, and these need to be physically small components if they are to fit comfortably into the available space. They also need to have a tolerance of 5 per cent or less, and this leaves little choice to polycarbonate capacitors for the higher value capacitors.

These kind of capacitors are really intended for printed circuit mounting, but they will fit readily onto the tags of S1 provided you do not bend the leadout wires (which could easily result in them becoming detached).

The other wiring is quite straight forward and is completed using multistrand p.v.c. insulated connecting wire.

CALIBRATION

To be of most use the unit should have a scale calibrated in terms of output frequency marked around the control knob of VR1. In order to give reasonably linear scaling VR1 is a logarithmic potentiometer used in reverse (i.e., clockwise adjustment of VR1 gives a reduction in output frequency).

The easiest way of calibrating the unit is to use a frequency meter of some kind to aid the location of the various calibration points. Note that it is only necessary to calibrate the unit on one range since switching from one range to the next increases the output frequency by a factor of ten.

Thus, for example, the point on the scale that corresponds to 100Hz on range 1 obviously corresponds to 1kHz on range 2, 10kHz on range 3, 100kHz on range 4, and 1MHz on range 5.

If access to a frequency meter is not possible an alternative method is to use another (ready calibrated) signal generator to provide tones of known frequency, with the outputs of the two signal generators being monitored using crystal earphones, high impedance headphones, or amplifiers and loudspeakers so that the generators can be tuned by ear to the same frequency.

Another method is to use an oscilloscope to measure the output frequency, and although this is not likely to be quite as accurate as using a frequency meter or accurately calibrated signal generator to calibrate the unit.

MUSICAL INSTRUMENTS AND AURAL TUNING

If no suitable test equipment for calibration purposes is available another method is to use a musical instrument to provide tones of known frequency. The output of the signal generator must be monitored using a crystal earpiece, headphones, or amplifier and loudspeaker, so that it can be tuned by ear to the same frequency as the reference note from the musical instrument.

The 'A' above middle C is at a frequency of 440Hz and this frequency doubles for each octave increase in pitch, and halves for each octave decrease in pitch. The 'B' below middle C is at approximately 250Hz (actually 246·94Hz), the 'G' below middle C at about 200Hz (196Hz to be exact), and the F below middle C is at approximately 175Hz (174·61 is the precise figure). Again, octaves above and below these notes can be used to provide further calibration points on the scale.

SETTLING DOWN PERIOD

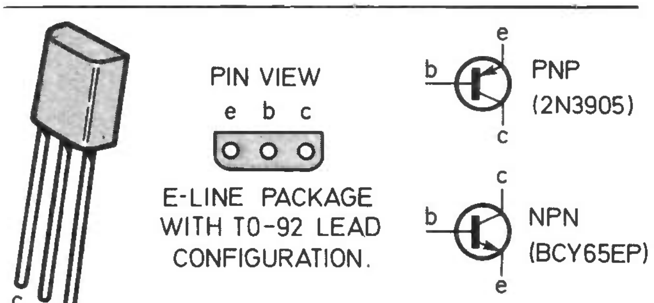
One final point to note is that the thermistor gain stabilisation circuit does not respond very rapidly to changes in loading, adjustments to the frequency controls, and so on.

After such changes, it therefore usually takes a second or two for the unit to settle down and give a good quality output of the correct amplitude, and the resultant momentary losses of output signal or signal purity are normal for this type of equipment and are not indicative of a fault.

✱ FREE TRANSISTORS ✱

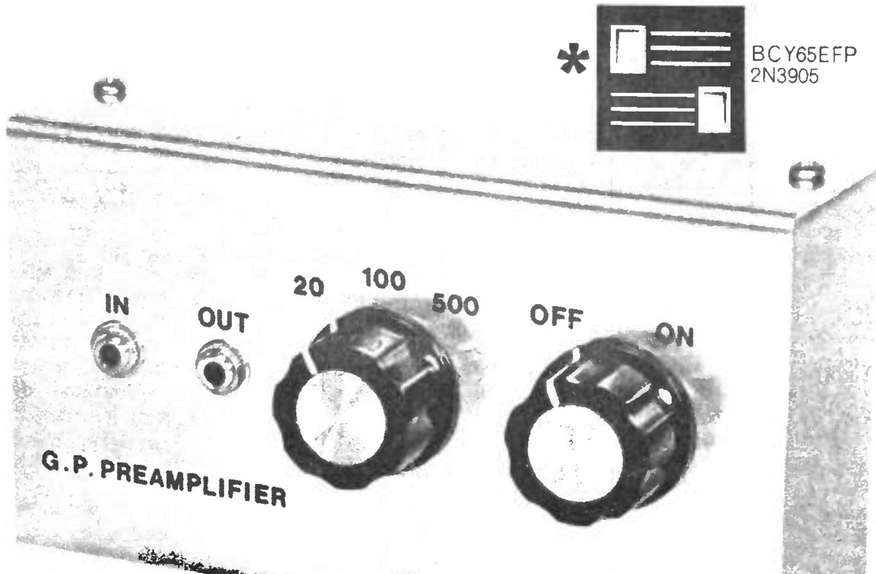
PARAMETERS AND OUTLINES

The 2N3905 and BCY65EP may be used to replace the transistor types listed in the table, but not all of these devices may be used as replacements for the 2N3905 and BCY65EP. You are advised to check with the relevant data sheet for circuits operating at high voltages.



CIRCUIT SYMBOLS

Parameter	2N3905	BCY65EP
Application	General purpose	Low noise amplifier
Construction	*PNP* Silicon	*NPN* Silicon
Case	E-Line (TO-92)	E-Line (TO-92)
V_{CB}	−40V	60V
V_{CE}	−40V	60V
V_{EB}	−5V	7V
I_C	−200mA	100mA
P_{TOT}	500mW @ 25°C amb 1·2W @ 25°C case	400mW @ 25°C amb 1W @ 45°C case
h_{FE}	50 to 150 $I_C = -10$mA $V_{CE} = -1$V	180 to 310 (250 typ.) $I_C = 2$mA $V_{CE} = 5$V
h_{fe} @ 1kHz	50 to 200 $I_C = -1$mA $V_{CE} = -10$V	175 to 350 (260 typ.) $I_C = 2$mA $V_{CE} = 5$V
f_T (min)	200MHz	125MHz
Suitable replacements for:	BC159, BC212, BC214, BC388, BC478, BC479, BC558, BFX85, 2N3702, 2N3906.	BC107, BC108, BC109, BC147 BC148, BC149, BFX95, ZTX107, ZTX108, ZTX109, 2N2926, 2N3702.



GENERAL PURPOSE PRE~AMPLIFIER

BY R.A.PENFOLD

* *A SIMPLE PROJECT FOR YOUR FREE TRANSISTORS*

ALTHOUGH there are a great many electrical and electronic standards there is no standard output level for items of audio equipment and musical instruments. Likewise there is no standard sensitivity for audio amplifiers of various types. This can lead to problems of incompatibility, however, with so many different types of signal source commonly available a single output level and input sensitivity for all types of audio frequency equipment is probably not practical.

Where an item of gear has an excessive output level for the equipment with which it is to be used there may well be no problem if the two units are coupled direct to one another, and a simple attenuator is all that is required if overloading should become evident. A more common problem is that of having a low level signal from (say) a microphone which is inadequate to drive the input of an amplifier.

In such cases the cure is to use a suitable preamplifier, and in most cases the versatile preamplifier described in this article should be capable of giving proper matching between the two items of equipment concerned.

SWITCHED GAIN LEVELS

The circuit provides three switched levels of voltage gain and these are approximately 26dB (20 times), 40dB (100 times), and 56dB (500 times). The input impedance of the unit is about 10 kilohms and the output impedance is reasonably low.

When used at the low gain setting the preamplifier is suitable for applications such as matching a low output electric guitar to an insensitive power amplifier, and in the higher gain settings it is able to boost low level signals such as those from a microphone to a high enough level to drive power amplifiers and musical effects units.

The signal to noise ratio of the unit is very good with an output noise level (input short circuited) of only about 400 microvolts on the highest gain seting, and less than this on the other gain settings. In most applications this will result in an unweighted signal-to-noise ratio of 60dB or better.

THE CIRCUIT

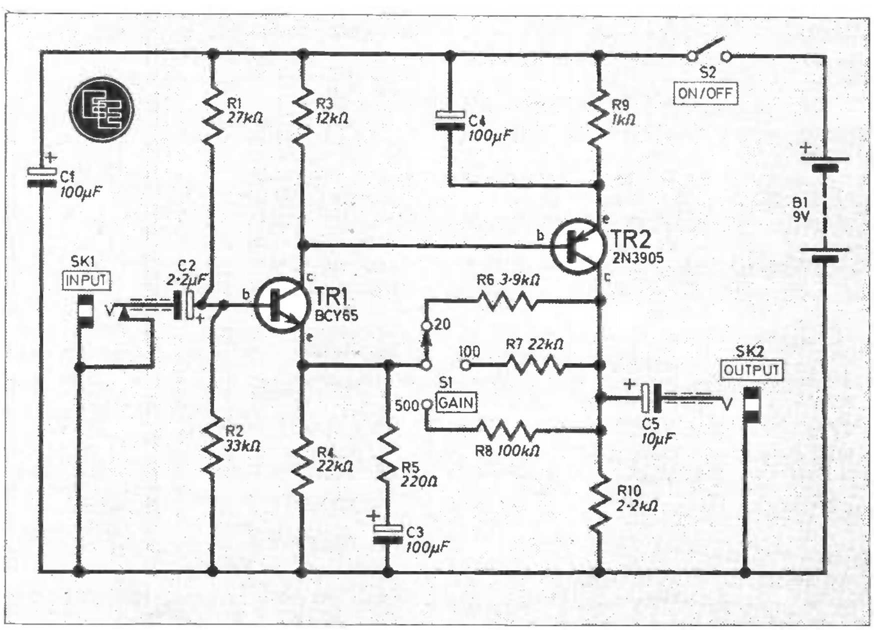
Fig. 1 shows the circuit diagram of the preamplifier, and a two-stage direct-coupled configuration is used.

The base of TR1 is biased to about half the supply potential by R1 and R2, and this gives a potential of a little under 4 volts at the emitter of TR1 due to the voltage drop of about 0·6 volts or so from the base to the emitter.

The collector and emitter currents of TR1 are virtually identical, and the voltage across R3 is therefore a little more than half that developed across R4 since it is a little more than half the value of R4. This results in TR1 being biased to give a collector potential of about 7 volts, and permits an unclipped voltage swing of approximately 4 volts peak-to-peak at the output of this stage. This is more than adequate for the input stage of a preamplifier.

TR1 is a low noise device and is operated at a collector current of only about 200μA in order to give the circuit a good signal-to-noise ratio.

Fig. 1. The circuit diagram of the General Purpose Pre-Amplifier.



SECOND STAGE

TR2 is used in a similar configuration to TR1, but this is a *pnp* type instead of an *npn* device, and it is biased from the output of TR1.

Due to the voltage drop from the base of TR2 to its emitter there is about 1·5 volts across R9, and thus about 3·3 volts across R10. This gives a maximum unclipped output voltage swing of approximately 6·6 volts which should be perfectly adequate, and is obviously approaching the maximum that can be attained using a 9 volt battery supply.

TR2 is run at a higher current than TR1 (about 1·5mA) in order to help give the circuit a fairly low output impedance.

R4 and R9 introduce a great deal of negative feedback and give the circuit a voltage gain of only about unity. This aids accurate biasing of the circuit, but it is necessary to decouple some of this feedback at audio frequencies in order to give the circuit a useful level of voltage gain at these frequencies. R5 and C3 remove most of the audio frequency feedback from TR1, and C4 eliminates the audio feedback over TR2.

This gives the circuit a high voltage gain of typically over 60dB (1,000 times), and this is too high for the majority of applications. The voltage gain of the circuit is reduced to the required level by using a resistor to couple negative feedback from the collector of TR2 to the emitter of TR1

COMPONENTS

Components
R1 27kΩ
R2 33kΩ
R3 12kΩ
R4, 7 22kΩ (2 off)
R5 220Ω
R6 3·9kΩ
R8 100kΩ
R9 1kΩ
R10 2·2kΩ
All ⅓W 5% carbon

See Shop Talk page 635

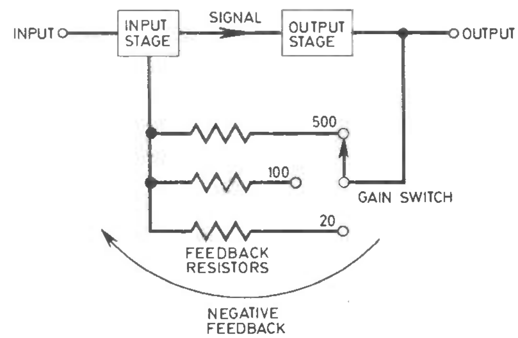
Capacitors
C1,3,4 100μF 10V elect (3 off)
C2 2·2μF 63V elect.
C5 10μF 25V elect.

Semiconductors
TR1 BCY65EP *npn* silicon
TR2 2N3905 *pnp* silicon

Miscellaneous
SK1,2 3·5mm jacks (2 off)
S1 3 way 4 pole rotary switch
S2 rotary on/off type switch
B1 9 volt PP3 type
Metal case; control knobs; battery connector; 0·1 inch stripboard 14 strips by 24 holes; 6BA fixings; wire; etc.

Approx. cost Guidance only £4·00

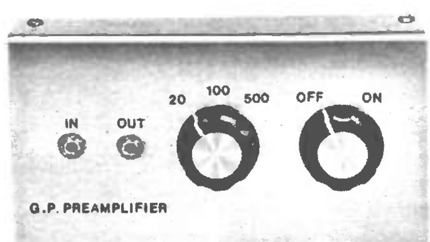
HOW IT WORKS



The circuit has two stages of amplification; a low noise input stage and an output stage that enables the unit to provide sufficient output voltage and current to drive most amplifiers, mixers, etc.

Both stages give a fairly high level of voltage gain, and the total gain of the amplifier is more than a thousand. This is higher than would normally be required, and the gain is reduced to the required level by coupling some of the output signal back to the input stage so that it has a cancelling effect on the input signal.

This is known as "negative feedback" and in addition to reducing the voltage gain of the circuit it also has the beneficial effects of reducing noise and distortion to a similar degree. There are three switched levels of feedback so that three levels of voltage gain are available from the preamplifier.



VOLTAGE GAIN CONTROL

The voltage gain of the circuit is approximately equal to the value of this feedback resistor divided by R5, plus one. Three feedback resistors are used with the required resistor being selected using S1. This gives the circuit its three levels of voltage gain, and the values of R6 to R8 have been chosen to give the approximate voltage gains specified earlier.

A break contact on input socket SK1 is used to short circuit the input of the amplifier when no input is connected to the unit. This minimises any noise at the output of the unit and eliminates the slight risk of instability when no signal source is connected to the unit.

The current consumption of the circuit is less than 2mA and a PP3 size 9 volt battery is an adequate power source for the preamplifier.

CONSTRUCTION starts here

METAL CASE

In order to minimise problems with stray pick-up it is recommended that a metal case is used for this project, and an inexpensive aluminium type measuring 133×70×38mm is ideal. The two controls and two sockets are mounted on the front panel, and apart from the battery and the three feedback resistors the components are all fitted on a 0·1 inch matrix stripboard having 24 holes by 14 strips.

CIRCUIT BOARD

Details of the component panel and all the other wiring are shown in Fig. 2. A stripboard of the specified size is not available and it is necessary to cut the board down to size using a hacksaw. There are just two breaks in the copper strips and a single link wire. Fit Veropins to the board at the points where connections to off-board components such as S1 and S2 will be made.

GENERAL PURPOSE PRE-AMPLIFIER

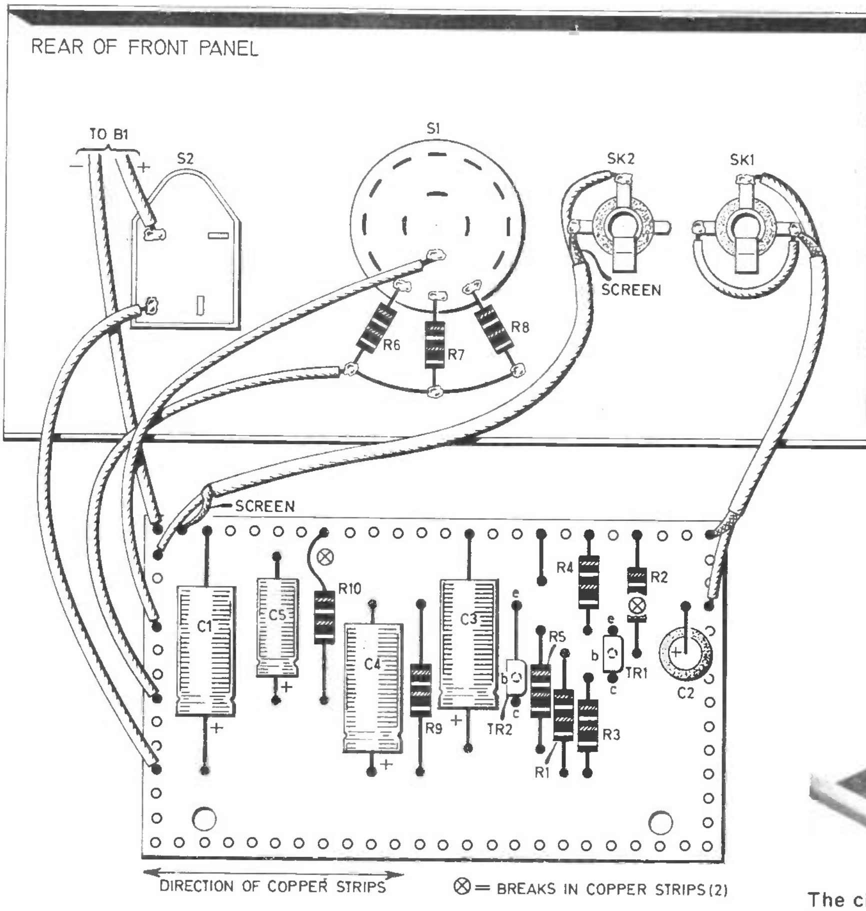
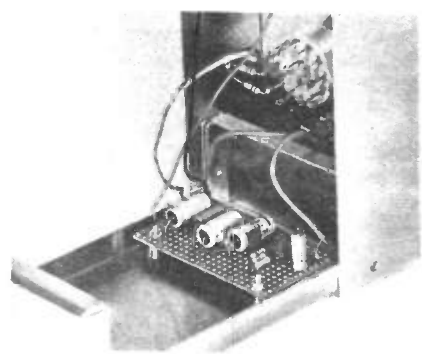
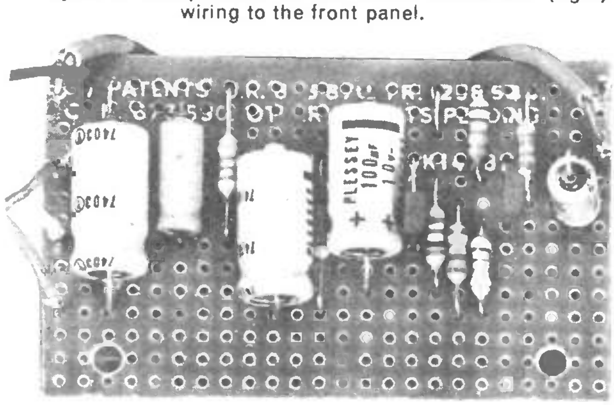


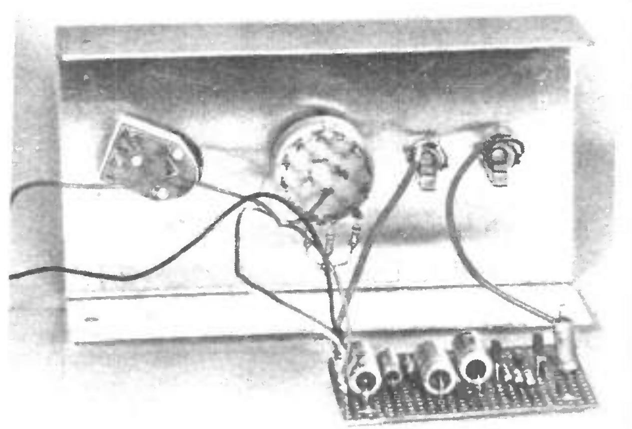
Fig. 2. Circuit board component layout and interwiring to the front panel components.



The circuit board mounted in position on spacers.

Layout of components on the circuit board and (right) wiring to the front panel.





Once the board has been finished and thoroughly checked it can be mounted on the rear panel of the case using 6BA fixings. Use 6·35mm spacers over the mounting screws to ensure that the soldered joints on the underside of the board are kept well clear of the metal case.

CRITICAL POINTS

Next the three feedback resistors are fitted onto S1 and the other wiring is added to complete the unit.

It is advisable to use screened leads for the connections from the component panel to SK1 and SK2 since the input and output of the amplifier are in-phase, and any stray feedback between the two is likely to result in instability.

For the same reason the component layout of the preamplifier is quite critical and it is not advisable to alter this in any way unless you are sure of what you are doing.

USING THE PREAMPLIFIER

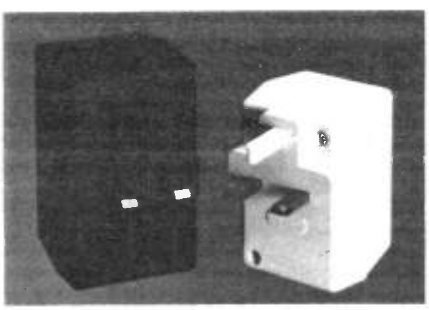
In use the preamplifier should be used on the lowest gain setting that gives satisfactory results as this minimises the risk of overloading and also gives the lowest levels of noise and distortion. The unit is not really suitable for use with high impedance signal sources such as crystal microphones, but as these are not in common use these days this is not really a major drawback. ⌑

By Dave Barrington

Case For Power

We have, over the past few months, published designs which have included separate circuits for a.c. mains to low voltage d.c. supplies. Even this month's article for a *Optical Tachometer* contains one such circuit.

West Hyde Developments are now marketing a range of cases specifically designed to house power supplies for low voltage equipment such as calculators, radios and games.



The case, available in two sizes, will accommodate the components of a power supply, including the transformer. It features a plastics earth pin and brass live and neutral pins to allow the unit to be plugged directly into a 13A mains socket. Safety, it is claimed, is assured with the inclusion of a special internal moulding which, as well as retaining the earth pin, separates the mains input from the low voltage output circuitry and transformer.

Stockists and prices can be obtained from West Hyde Developments Ltd., Dep EE, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET.

On The Move

We have just been informed that components supplier T. Powell has just moved premises to a more central London location.

They are now trading from 311 Edgware Road, London, W2.

CONSTRUCTIONAL PROJECTS

General Purpose Preamplifier

All components for the *General Purpose Preamplifier* should be readily available from most component suppliers. This project has been specially designed around the transistors given Free with this issue.

The on/off switch S2 used in the prototype was a mains rotary type and is listed by Rapid Electronics. This switch could be a common on/off toggle type.

Sinewave Generator

The *Sinewave Generator* is another project that has been specially designed around the transistors given Free with this issue.

The 6-way 2-pole rotary switch, with adjustable end-stop, is available from Watford Electronics. The sloping-front case called up in the components list is a Maplin M1005 type, although any plastics case with a metal front panel of similar dimensions can be used.

The thermistor used in this project is the RA53 from RS Components. Any *bona-fide* RS components supplier will be able to obtain this item and should be ordered as stock number 151-114.

This device is also stocked and listed as a R53 thermistor by some suppliers.

Simple Shortwave Radio

Except for the coils used in the *Simple Shortwave Radio* the rest of the components for this project should not cause any undue purchasing problems.

The coil used in the receiver is an old Wearite type which is no longer produced. However, we understand that T. Powell is producing a complete kit of parts, including coil, for this project.

Optical Tachometer

We do not expect any component buying problems for the *Optical Tachometer* project.

The most expensive item in this project is the sloping-front case. Once again, any case with similar or larger dimensions may be used.

ZX81 Expansion System

Several of the components listed in the *ZX81 Expansion System* are "specials" and are not "off-the-shelf" items.

The 37-way single-sided edge connectors will have to be cut from a larger version. This and the double sided 23-way wirewrap edge connector are available from Watford Electronics.

The designers used a 23 + 23 wirewrap connector, for pin lead length, and bent the pins to the required right-angle. Readers should enquire before purchase that it is possible to bend the pins, it has been found that on some types they may snap off.

The monolithic ceramic capacitors used for the decoupling capacitors are Siemens types. These are stocked by Electrovalue and have 5mm lead spacing. When ordering quote Ceramic B37449 and value.

Similar capacitors are held by Maplin, Bradley Marshalls and Cricklewood Electronics.

The miniature p.c.b. pushbutton switch is a RS type (No. 334-892) and available from any recognised RS Components supplier.

The double-sided printed circuit board is only available from Bytor Computers, Bright Street Works, Bright Street, Bury, Lancs BL9 6AQ, and cost £9·85, including postage and packing.

JACK PLUG & FAMILY...

BY DOUG BAKER

EXPANSION SYSTEM FOR THE ZX81

BY
M. LYSEJKO
A. HUDSON

WHEN the ZX81 Microcomputer was unveiled in early 1981, Sinclair Research, the designers of the computer, surprisingly announced that they would not be providing any add-on hardware for the ZX81 apart from a printer and a ram pack. They were leaving this to other firms to supply.

Since then a large number of small businesses have sprung up to supply a varied and useful range of accessories, memory packs, interfaces and so on, to readily convert the memory intensive machine for monitoring and control applications in the home and laboratory.

This project falls into this category and is believed to be unique in its overall capabilities: its provides an additional 4 kbytes of static RAM, and decoding to allow up to 11 more 1k blocks for memory, I/O or any device capable of supporting a bus. The decoding, address data and control busses are made available at three parallel expansion slots.

The ZX81 is a domestic computer which even novices are expected to find easy to use. This project has been designed to be compatible with this concept, but at the same time it has almost limitless capabilities for the more advanced user.

The Expansion System mates with the ZX81 to form a larger memory (5k total) monitoring and control capable system simply by easing its edge connector onto the ZX81 expansion slot.

The advantages of a larger memory system are manifold, such as allowing longer programs to be entered, larger data handling facilities, and a semi-memory mapped display, which will prove very useful for games programmers. You will also discover that LISTing and PRINTing are carried out much faster.

EXPANSION SLOTS

The expansion slots referred to above are three 37-pin single sided 0·1 inch pitch card edge connectors with a polarising key fitted at position 35. This aligns the socket contacts with the finger set (tracks) on the daughterboards to be plugged in. The use of single-sided sockets allows prototype circuitry constructed on 0·1 inch Veroboard to be plugged in and tested before committing to a p.c.b.

Using these slots, electronic devices can be readily interfaced with the ZX81. For example, an RS232 printer interface, extra memory, joysticks, sound generator, digital and analogue I/O devices. Some of these "daughterboards" are in an advanced state of development: RS232, Sound Generator, 5 kbytes memory. Full details of these may be obtained from the suppliers of the p.c.b.—see Shop Talk.

Table 1. Expansion bus details

Pin No.	Function	Pin No.	Function	Pin No.	Function
1	$\overline{RESET}$	13	$\overline{RD}$	25	$\overline{E1}$
2	$\overline{WAIT}$	14	$\overline{WR}$	26	$\overline{E2}$
3	A4	15	D5	27	$\overline{E3}$
4	A5	16	D6	28	$\overline{E4}$
5	A6	17	D2	29	$\overline{E5}$
6	A7	18	D4	30	$\overline{E10}$
7	A8	19	D3	31	$\overline{E9}$
8	A9	20	D1	32	$\overline{E8}$
9	A3	21	D0	33	$\overline{E7}$
10	A2	22	D7	34	$\overline{E6}$
11	A1	23	Ø	35	KEY
12	A0	24	$\overline{E0}$	36	+5V
				37	0V

8k RAM		0000–1FFF
Vacant 8k block		2000–3FFF
Internal 1k RAM		4000–43FF
1st additional 1k RAM		4400–47FF
2nd additional 1k RAM		4800–4BFF
3rd additional 1k RAM		4C00–4FFF
4th additional 1k RAM		5000–53FF
RAM ↓	$\overline{E0}$	5400–57FF
	$\overline{E1}$	5800–5BFF
	$\overline{E2}$	5C00–5FFF
	$\overline{E3}$	6000–63FF
	$\overline{E4}$	6400–67FF
	$\overline{E5}$	6800–6BFF
	$\overline{E6}$	6C00–6FFF
	$\overline{E7}$	7000–73FF
	$\overline{E8}$	7400–77FF
	$\overline{E9}$	7800–7BFF
I/O ↑	$\overline{E10}$	7C00–7FFF

Fig. 1. Memory map with Expansion System plugged in.

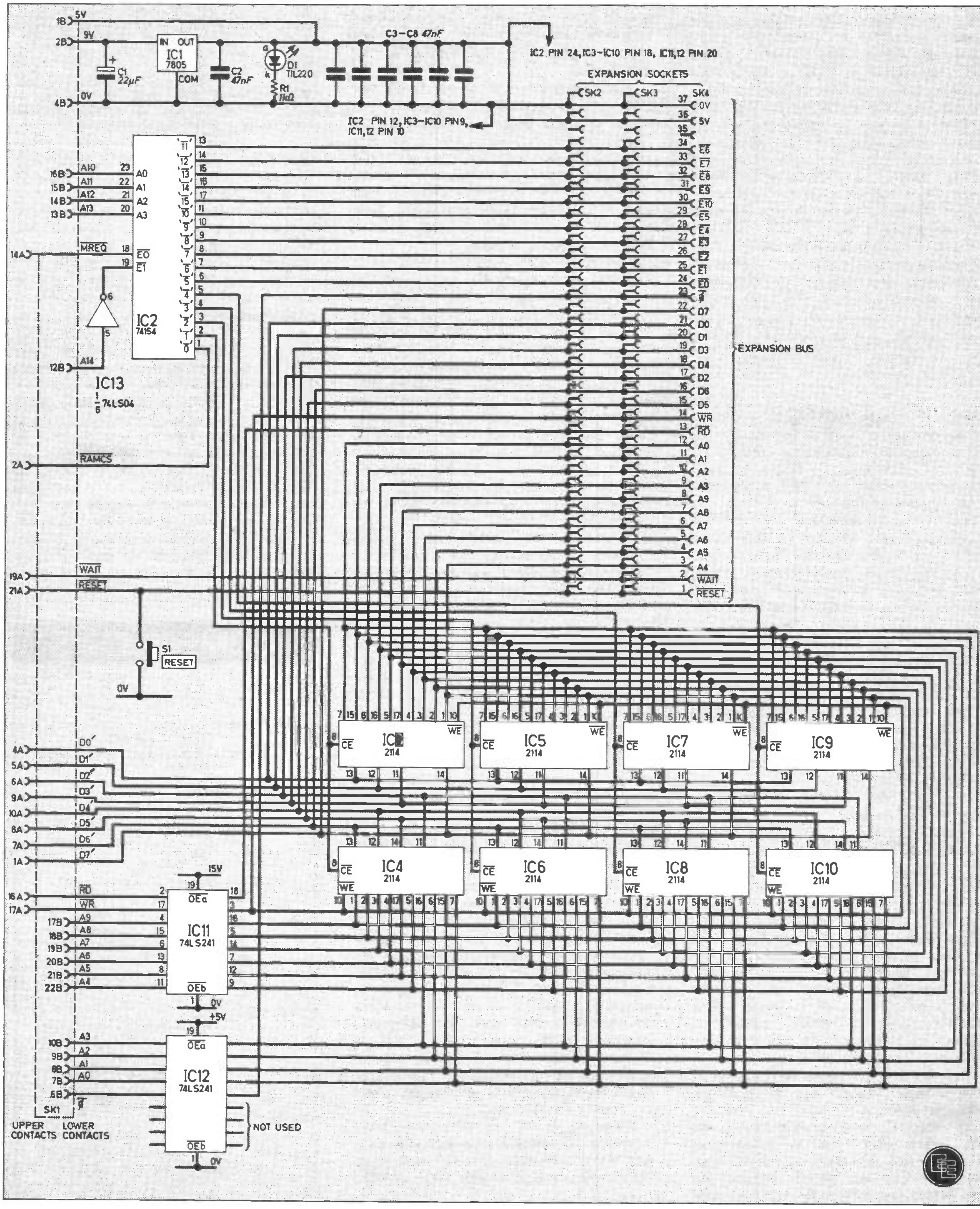


Fig. 2. The complete circuit diagram for the Expansion System for the ZX81.

EXPANSION BUS

The address lines A0 to A9, $\overline{RD}$, $\overline{WR}$ and $\overline{Ø}$ signals reach the expansion slots via buffers. The upper address lines A10 to A14 are decoded to yield 16 enable lines. The lower five are used for resident RAM with the remainder going to the expansion slots for user defined applications. The RAM is kept low in the memory map to ensure continuous RAM for BASIC.

All enable lines are active low, and enable blocks of 1024 memory locations. They can be used for RAM, ROM, EPROM and any other device capable of supporting a bus. $\overline{WAIT}$, $\overline{RESET}$, 0V and +5V complete the lines to the expansion slots to give the expansion bus shown in Table 1. The bars over the functions indicate they are active low.

The memory map with the Expansion System plugged into ZX81 is shown in Fig. 1.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Expansion System is shown in Fig. 2. It contains 12 digital i.c.s, a voltage regulator i.c. and a handful of discrete components.

IC1 is a monolithic 5V voltage regulator. Input voltage to this i.c. is picked up from the 9V rail in the ZX81. This is the input voltage to the ZX81 from its power supply unit and will be in the range 7 to 11V. The resulting 5V output from IC1 is coupled to the ZX81 internal supply so that the total system load is shared by IC1 and the regulator already in the ZX81.

The function of the regulator is to supply a steady 5V at up to 1A. If the input is 9V, then IC1 must dissipate 4 watts when supplying 1A, hence the inclusion of the heatsink.

L.e.d. D1 is included to indicate that power is being supplied to the extension board. Decoupling capacitors C3 to C8 are distributed around the board to eliminate high frequency oscillations on the power supply lines.

IC2 is a 4-to-16 line decoder. This has two "enable" controls. When either or both are at logic 1, all outputs are at logic 1 regardless of the states of the four inputs (A0 to A3). The latter represents a four-bit binary number (16 states). This number specifies which output is turned on (at logic 0) with the remaining 15 outputs off (logic 1).

The logic 0 will only be present if both enable inputs are at logic 0. Address line A14, via an inverter IC13, controls one enable input, so only when the c.p.u. is addressing memory with A14 high (greater than 16k) will any one of the outputs go low. When memory is being addressed $\overline{MREQ}$ which controls the other enable input is at logic 0.

The outputs corresponding to the five lowest binary inputs (memory locations 4,000 to 53FF) act as chip enables ($\overline{CE}$) for each of the five 1k blocks of resident RAM. The remainder reach the expansion slots to allow up to a further 11 1k blocks to be accessed.

Address lines A0 to A9 from the ZX81 are buffered by permanently enabled tri-state buffers IC11 and IC12. These buffered lines are used for addressing the on-board 4k of static RAM and reach the expansion slots. $\overline{Ø}$, $\overline{RD}$, and $\overline{WR}$ lines are also buffered and run to the expansion slots. Buffered $\overline{WR}$ as explained later is used also for writing to RAM.

The data bus, which allows communication between the c.p.u. and the on-board RAM and any peripherals connected to the expansion slots is not buffered as this will be carried out on the individual daughterboards which plug into the expansion slots.

To effect a rest on the ZX81 the power supply input jack plug must be removed for a brief instant. To overcome this unsatisfactory arrangement, a RESET button has been built-in on the Expansion System. On pressing S1, the system is initialised. All memory is cleared and the ZX81 re-evaluates its system variable, Ramtop, which tells the ZX81 how much memory is available. If a software "bug" occurs which and the keyboard does not react, RESET may be used.

The RAM i.c.s chosen here are the readily available and inexpensive 2114 types. These are configured as 1024×4 bit locations. Two of these are needed to realise a 1024×8 bit arrangement (1k bytes) and four of these pairs, IC3/4, IC5/6, IC7/8, IC9/10 provide the 4k of additional RAM. Normally when using 2114 RAM, the high order nibble (D4-D7) is held in one i.c. with the low order nibble (D0-D3) in the other half of the pair. However, in this project, the data lines are shared differently.

The 2114 has ten address lines, A0 to A9, to uniquely select any one of its 1024 locations. Data input and output share the same pins. To select the chip, its $\overline{CE}$ pin must be placed at logic 0. If the $\overline{WE}$ pin is high with $\overline{CE}$ low, internal circuitry places the addressed data on the data bus (read mode). If now $\overline{WE}$ is made low, internal circuitry puts the information on the data bus into the addressed location (write mode). When $\overline{CE}$ is high, the data pins are put in a third state known as the high impedance state, and effectively disconnects the i.c. from the data bus.

Thus A0 to A9 selects a particular location, $\overline{CE}$ selects a specific i.c. pair and data is written into or read from the i.c. depending on the state of $\overline{WE}$.

PRINTED CIRCUIT BOARD

All the components are mounted on a single printed circuit board. The

CONSTRUCTION starts here

board is a very special type which has not to date appeared in EE. It is a double-sided board with plated through holes. This means that there is a copper track pattern on each side of the board. The two patterns are accurately aligned and joined together at the appropriate places by a copper lining on the surface of each hole which connects the copper pads on each side of the hole. This requires a complex and special technique and equipment not available to the home constructor. For this reason no p.c.b. master patterns have been given, but a supplier for this p.c.b. is given in Shop Talk.

The layout of the components on the topside of the board is shown in Fig. 3. As the board is plated through, only the component leads on the board underside need to be soldered.

Carefully position and solder all the i.c.s paying attention to their orientation. There is a notch at pin 1 body end. Next fit the resistor and capa-

COMPONENTS

Resistor
R1 1kΩ ¼W carbon ±5%

Capacitors
C1 22µF 16V elect.
C2-C9 47nF monolithic ceramic (8 off)

Semiconductors
D1 TIL220 red l.e.d.
IC1 7805 5V 1A voltage regulator i.c. (To-220 case)
IC2 74154 TTL 4-to-16 line decoder
IC3-10 2114LC-1 static RAM, 1024 × 4 bit (8 off)
IC11, 12 74LS241 TTL low power Schottky octal buffer, tri-state (2 off)
IC13 74LS04 TTL low power Schottky hex inverting buffer

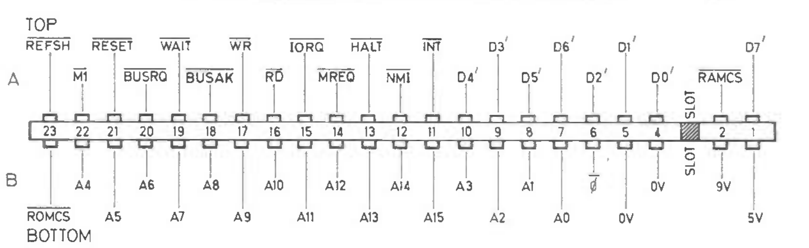
Miscellaneous
S1 miniature p.c.b. switch
SK1 23+23 way 0·1 inch pitch edge connector with wire-wrap pins
SK2-SK3 37-way 0·1 inch pitch edge connector (3 off)
Printed circuit board: double-sided plated through holes size 145 × 130mm; heatsink 10·5°C/W type TV2; 6BA nut, bolt and washer; self adhesive feet 5·6mm high (2 off)

Guidance only Approx. cost £36 including p.c.b.

citors followed by the l.e.d. Note that the l.e.d. has a flat on its body alongside the cathode (k) lead. The three sockets SK2-SK4 should have a polarising key fitted at position 35. A piece of stripboard may be used for this, glued in place. Solder the sockets in place.

SK1 needs to have angled pins. This type may be difficult to locate and is more expensive than the straight pin versions. However, types with miniwrap wire-wrapping pins may easily be bent to the required shape by bending the two rows through 90 degrees. A piece of 0·1 inch stripboard may be used for this purpose, using the holes closest to one end.

This socket should also be fitted with a polarising key at position 3. The pins and track wipers may need to be removed to fit this. A small piece of stripboard can be used as the "key" and glued in place.



Connection details of the ZX81 expansion slot viewed from the rear.

You should check with the supplier of the straight pin socket to find out that the leads may be bent without causing the pin to fracture. With one particular socket tried (manufacturer unknown) the pins snapped off when they were bent.

Next bend the leads on IC1 so that when positioned on the board the fixing hole in its tab aligns with the hole in the p.c.b. Apply some heat-sink compound to the underside of IC1 so as to make good thermal contact with the heatsink. Position the heatsink on the board and bolt IC1 to the board through the heatsink using a 10mm long bolt, nut and shakeproof washer. Solder IC1 to the board. Finally position and solder S1 to complete the construction.

Thoroughly inspect the board construction, checking for component

Fig. 3. Layout of the components on the topside of the p.t.h. printed circuit board.

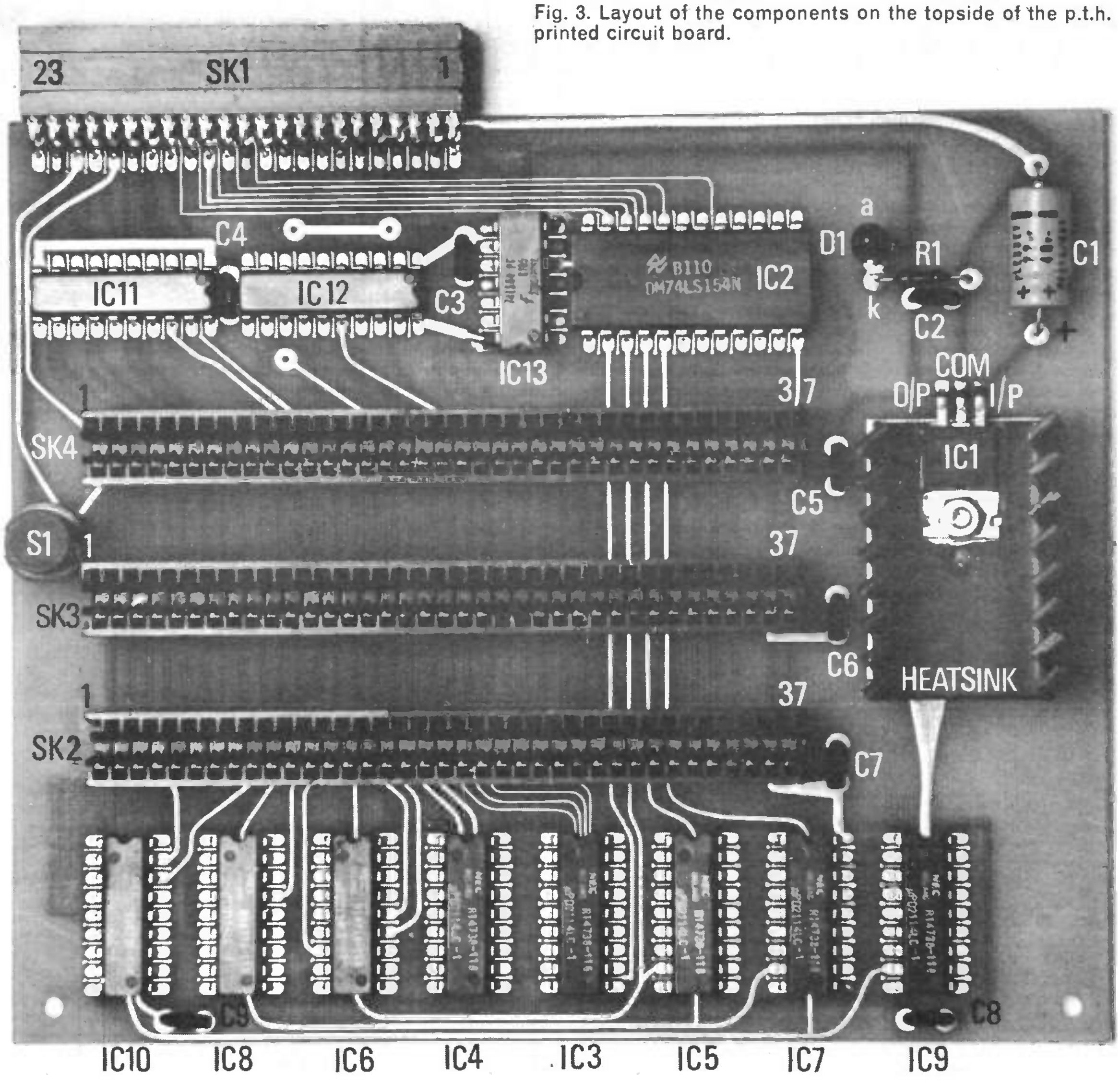


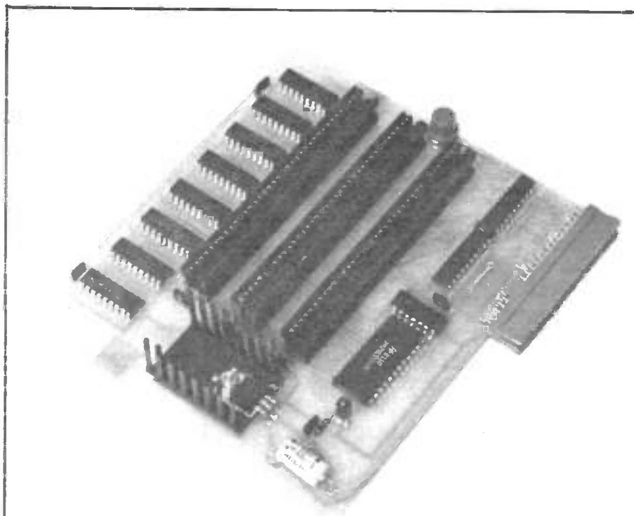
Table 2. IC2 decoding check table

Pin No.	13B	14B	15B	16B	IC2 pin no. reading 0V, remainder 5V	Expansion slot no.
Function	A13	A12	A11	A10		
	0	0	0	0	1	—
	0	0	0	1	2	—
	0	0	1	0	3	—
	0	0	1	1	4	—
	0	1	0	0	5	—
	0	1	0	1	6	24
	0	1	1	0	7	25
	0	1	1	1	8	26
	1	0	0	0	9	27
	1	0	0	1	10	28
	1	0	1	0	11	29
	1	0	1	1	13	34
	1	1	0	0	14	33
	1	1	0	1	15	32
	1	1	1	0	16	31
	1	1	1	1	17	30

Conditions

12B=5V
14A=0V

12B	14A	Output
A14	MREQ	State
0	0	All high
0	1	All high
1	0	As Tbl.
1	1	All high



The completed and ready to use Expansion System for your ZX81.

position, orientation and that all component leads have been soldered. Make sure that there are no solder bridges between the tracks and pads.

Fit the specified rubber feet. These will hold the board at the correct height to align with the ZX81 expansion slot. The unit may then be plugged into the ZX81 and tested.

TESTING

The Expansion System must always be inserted before the ZX81 power supply is connected, and removed after the supply has been disconnected.

On connecting the power supply, the l.e.d. D1 should illuminate. A Ramtop test should yield 21504 which will indicate that a large part of the construction is functioning satisfactorily, since RAM read and write will have been carried out. Press RESET to initialise and test the reset switch.

Disconnect the ZX81 power supply and remove the board. To check the remainder of the circuitry you will need a 9V supply. A PP9 battery will be suitable. Connect this across C1. This can be done easily by fitting a battery connector with miniature crocodile clips.

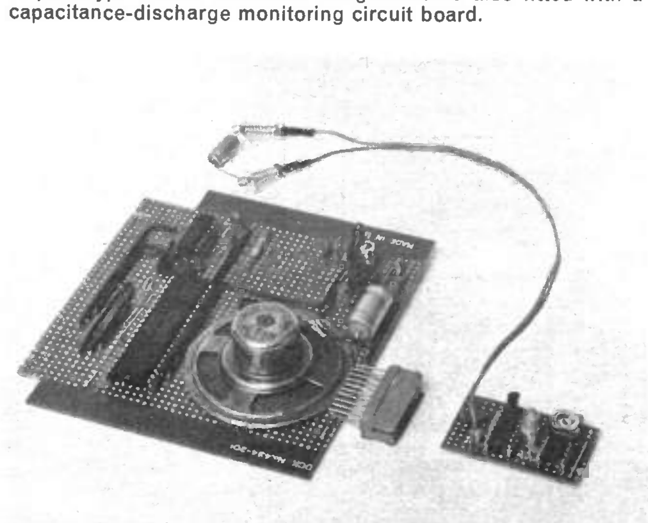
Connect the negative probe of a voltmeter set to read 10V d.c. to the −ve side of C1. Place the +ve probe on the output pin of IC1. You should read 5V. Touch the +ve probe onto each of the V_{CC} pins of all the i.c.s on board. You should read 5V in all cases. Check also that the 5V is available at expansion slot position 36. Also connect the probe to expansion slot positions 24 to 34 to read 5V in all positions. Pins 1 to 5 on IC2 should also give a reading of 5V.

To check the decoding of IC2 you will need to make up some means of connecting a voltage level to some of the pins on SK1, namely 1B, 4B, 12B, 13B, 14B, 15B and 16B, and 14A. A piece of 0·1 inch pitch stripboard, 5 strips wide by about 10 holes long with flying leads attached to one end can be used for 12B to 16B. For pin 14A on SK1, a miniature crocodile clip or hook probe fitted with a flying lead can be fitted to the pin at its point of entry into the body of SK1.

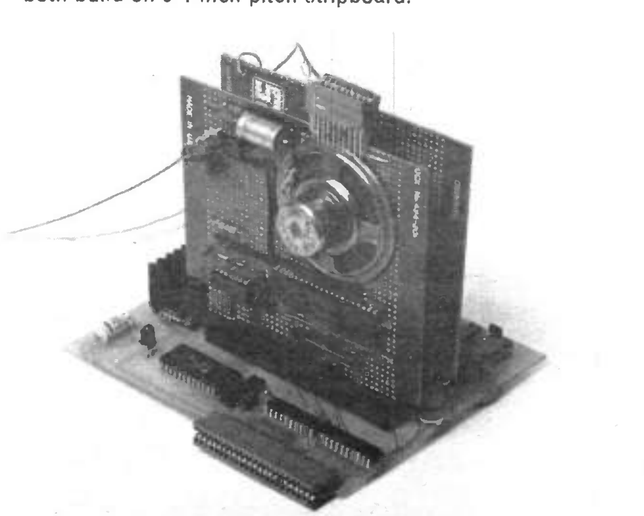
A 4-strip wide piece of stripboard, same length as before, fitted with flying leads at strip positions 1 and 4 (position 3 slotted) will provide the logic level source for the inputs to IC2. A solderless breadboard will be found most useful for connecting the inputs as required, otherwise the lead ends will have to be twisted together. The 5V lead from 1B will be used for logic 1, the 0V from 4B for logic 0. Use Table 2 to check the operation of IC2.

If the above tests have all been satisfactorily completed, the Expansion System is ready for use, to give one immediate additional 4k bytes of memory and the necessary signals to communicate with daughterboards of your design. ⌑

A prototype Sound Generator daughterboard also fitted with a capacitance-discharge monitoring circuit board.



The Expansion System fitted with two prototype daughterboards, both build on 0·1 inch pitch stripboard.



Everyday ELECTRONICS

NOVEMBER ISSUE ON SALE FRIDAY, OCTOBER 15

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Baffled by this "new" technology? This important series of articles sets out to explain the various electronic techniques involved and how they will fit together, in combinations of varying size and complexity, to meet the demands of commerce, industry, public services and ordinary individuals for rapid access to information and data of all kinds, as well as computing facilities, in the years immediately ahead.

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THE NOVEMBER ISSUE ALSO FEATURES

DIGITAL METRONOME

Provides direct readout of pulses per minute, updated automatically to register changes in tempo as selected by user. Mains operated. Easy to calibrate. Always accurate. An essential instrument for the professional music teacher, this Digital Metronome will also be a most valuable aid for musicians of all classes. Also fitted with switchable audible/visual output.

OSCILLOSCOPE COMPANION

SEDAC PRIZE WINNING PROJECT

This unit will convert a single beam c.r.o. with external sync. input to a dual beam version and provides additional features permitting accurate measurement of voltage and current.

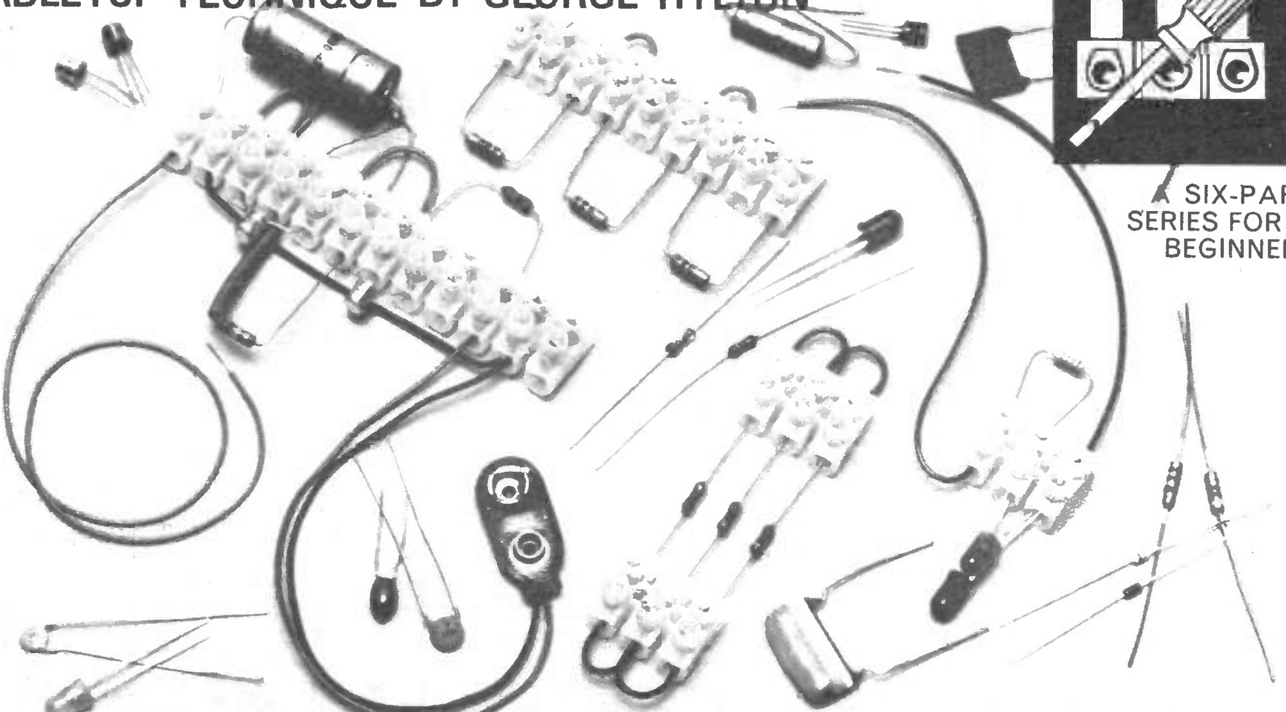
COMBINATION LOCK

Self-contained, battery operated. Selection of correct 5-digit number actuates relay which can be used to operate electro mechanical lock or other mechanism. The number sequence is entered by means of a single rotary dial. The combination may be easily altered.

ZX TAPE CONTROLLER

Designed for use in conjunction with the ZX81 *or* Spectrum micro-computer and a standard cassette recorder. Allows "load" and "save" operations to be carried out without need to unplug cassette leads. Contains microphone and loudspeaker; also a tape erase facility.

A NEW SERIES FEATURING A TEARLESS TABLETOP TECHNIQUE BY GEORGE HYLTON



A SIX-PART SERIES FOR THE BEGINNER

INTRODUCING ELECTRONICS

Part 1 FROM ELECTRONS TO ELECTRONICS

IN 1899, J. J. Thompson made experiments with a cathode-ray tube which may be said to mark the beginnning of electronics. He showed that the mysterious "cathode rays" which travelled through the tube under the influence of an electric field were in reality little bits of matter, each with a definite mass and a definite electric charge. They were named "electrons". In giving them that name, a more precise and scientific meaning was given to a word which had been around for a very long time.

"Elektron" was the ancient Greek word for amber. Amber is a fossilised natural resin. Like the synthetic resins of today amber is a good insulator. Rubbed with dry cloth or fur it acquires an electric charge which attracts bits of dust and fluff. The Greeks knew this, but didn't follow it up,

When, in later ages, learned men discovered that other substances, such as wax and glass, have similar properties, they needed a word which meant amber-like to describe these properties. Being scholars, they used the Greek word to coin their new term: the new word, meaning amber-like, was "electric".

So in calling the particles of the cathode rays electrons, scientists were really harking back to the very beginnings of electrical science. Long before the discovery of the electron as a carrier of electric charge and therefore a vehicle for electric currents there were other pioneers, such as the American, Benjamin Franklin, who searched for some explanation of electrical phenomena. For many years they managed to explain the observed effects of "electricity" by assuming that matter was permeated by an invisible, weightless "electric fluid". If an object had more than the normal amount of electric fluid in it, it was said to be "charged" with electricity.

TWO KINDS OF ELECTRICITY

So far, so good. But it soon became apparent that there were two kinds of electricity, positive and negative. Were there two kinds of fluid? Not necessarily, since a deficiency of fluid could give one sort of charge (say negative) and an excess of fluid the other sort (positive). Quaint though the idea may seem, it had a lot going for it.

With our modern knowledge of matter whose every molecule contains electrons which can be made to hop from atom to atom under the influence of electric forces, the fluid idea can be seen as a pretty good guess. The only really unfortunate thing about it was that the early investigators guessed wrong about polarity. They assumed that the fluid flowed from positive to negative. When it was realised that electric currents were movements of negative charges carried by electrons, flowing from negative to positive, the "wrong" way, it was too late to do anything about it.

Fortunately things have got a little easier with the invention of transistors. Transistor physicists got into the habit of regarding the "gap" left in an atom by the departure of an electron as a real thing, a "positive hole".

A hole behaves in much the same way as a positive charge. Under the influence of the battery voltage it moves round a circuit from positive to negative, the "right" way. So by forgetting about the real electrons and thinking only of holes we can reconcile the conflict between electron flow and conventional current flow.

ELECTRIC CELL

Luckily there were no such problems in the 1820s, when an obscure German scientist, Georg Simon Ohm, set about the task of obtaining a better understanding of current flow. For his experiments he used a relatively new invention, the electric cell.

The cell had been developed by the Italian, Volta, following a chance discovery by his fellow-countryman, Galvani, in quite a different area—biology. Galvani noticed that under certain conditions the legs of a newly-killed frog twitched as if given an electric shock. Investigation showed what the essential conditions were: wet frogs' legs had to be in contact with two different metals.

Looked at with modern knowledge, the explanation is that the two metals form the electrodes (electric gateways) of an electric cell. The moisture forms the electrolyte (like the acid in a car battery). The resulting current, though feeble, is enough to trigger the nerves into activity and hence the muscles they control. The discovery led to the development of the "electrochemical cell", in which current is generated as a result of chemical changes.

In Ohm's day it wasn't certain that the kind of electricity produced by a "voltaic cell" was the same as the "frictional electricity" produced by rubbing an insulator. For this reason Ohm avoided the term and called his circuit a "galvanic chain".

The electric-fluid idea suggested comparisons with the flow of water. If, as it seemed, the electric fluid could flow freely through metal wires then surely these could be likened to water-pipes? The cell which provided the driving force must then be the equivalent of the elevated tank or reservoir which provides the head of water (the pressure), to drive water through the pipe when we turn on the tap.

RESISTANCE

Friction impedes the flow, so a thin or long pipe lets through less water than a thick or short one, with the same pressure. Does this apply to electric conductors? Ohm was able to show that it does. Thin wires allow less current flow than thick ones, for the same electric pressure (voltage). Long wires allow less than short ones.

It also turned out that different metals (iron, copper, silver, and so on) allow different currents to flow, even when they are the same length and thickness.

In a word, different conductors offer different degrees of *resistance* to the flow of current. The idea of resistance as something definite and measurable was Ohm's real contribution to electrical science. The idea had far-reaching implications, which is why even today it is in universal use in electronics.

The existence of resistance meant that the strengths of currents could be controlled and adjusted. Ohm's law (current increases in proportion to the driving voltage or "electromotive force" and decreases in proportion to the resistance in a circuit) paved the way to electrical engineering.

EXPERIMENTAL WORK

There were no ammeters in Ohm's day to indicate the strengths of currents. Like him, we'll do some practical work using only a very crude current indicator.

For the purpose of this series of articles we shall dispense with solder and join up our circuits with the aid of screw terminals. These can be bought in the form of electricians terminal blocks, made of plastic, and usually containing twelve double terminals. (They can be divided into smaller blocks by cutting them with a sharp knife.)

It is essential to use the smallest size of terminal block, known as a 2-amp block. Larger ones (5-amp and upwards) will not accept some of the

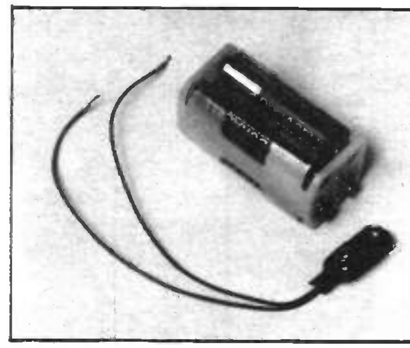


Fig. 1.1. A suitable battery holder with integral battery clip fitted with 4 × 1·5V (type AA) cells. Also shows battery clip with flying leads.

components we shall be using. You'll also need some ordinary electronic hookup wire and various components which will be specified as we go along.

POWER SUPPLY

For the power source we shall use a six-volt battery. The most convenient form is a plastic holder into which fit four small 1·5V dry cells of the HP7 type or equivalent. These are connected in series by the holder to yield 6V. Get a holder with a press stud connector as used in transistor portable radios and get a connector to fit, with flying leads. See Fig 1.1.

CURRENT INDICATOR

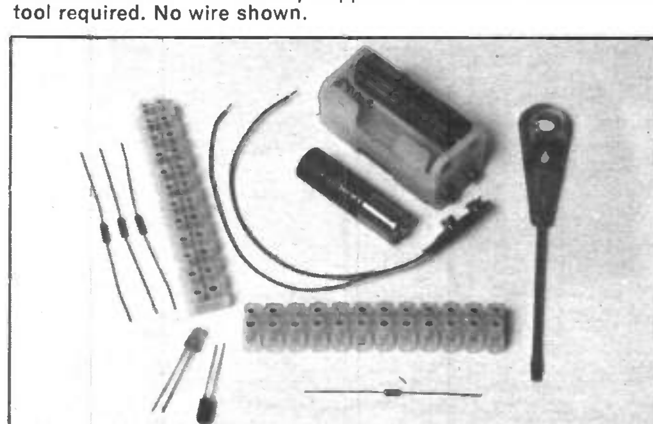
We shall use a lamp to indicate that current is flowing. Ordinary filament lamps need too much current so we'll make up a special indicator lamp using two l.e.d.s (light emitting diodes) one red, the other green. An l.e.d. lights up when current flows through it in a particular direction—in at its anode (entry gate) and out at its cathode (exit gate). The cathode leadout is usually marked by a small 'flat' next to it on the l.e.d. plastic case.

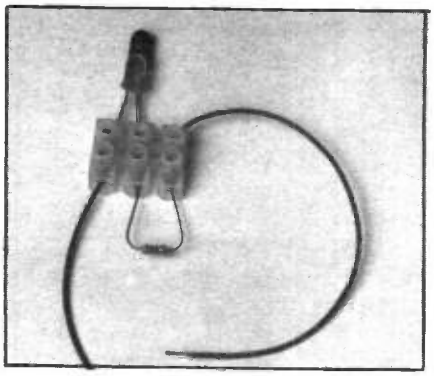
Unlike a resistance, an l.e.d. does not pass a current which rises smoothly as the applied voltage rises. Instead, it allows no current at all to flow at very low voltages, then, once

Components

Quantity	*Description*
4	2-amp 12-way screw terminal blocks (some for later use)
1	Battery holder to hold 4 × HP7 (type AA) batteries, with integral battery connector
4	HP7 (type AA) 1·5V batteries
3 metres	P.v.c. covered light duty stranded wire; selection of colours to make up 3 metres
1	Battery clip with flying leads to suit battery holder
1	220 ohm ¼W carbon ±5% tolerance resistor
3	1 kilohm ¼W carbon ±5% tolerance resistors
1	TIL220 red light emitting diode
1	TIL221 green light emitting diode

Shows the components used in this month's practical work. The screwdriver has a wire cutter/stripper in the handle and is the only tool required. No wire shown.





The assembled Current Indicator Lamp.

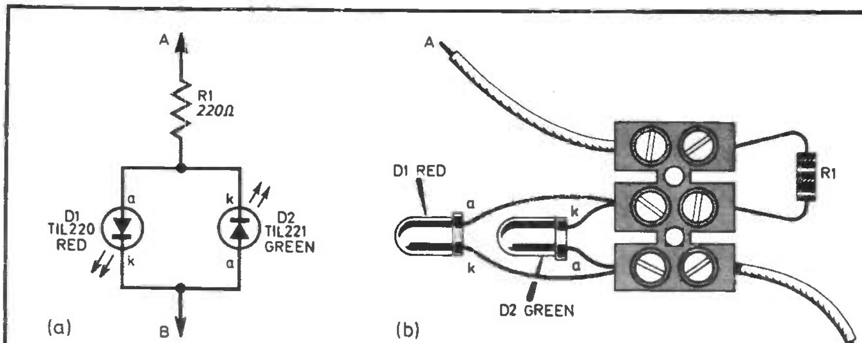
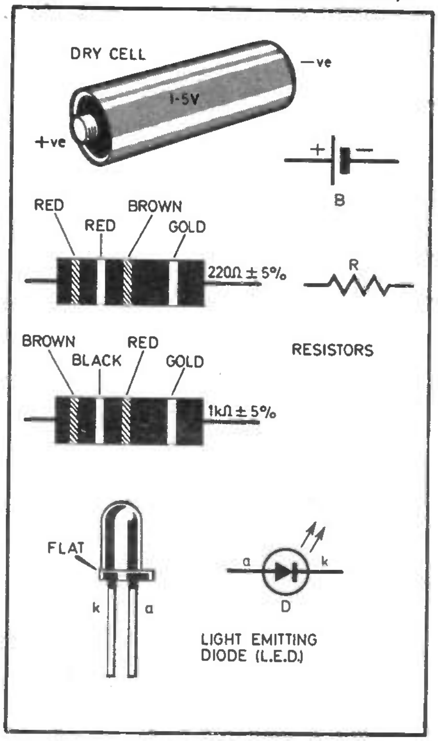


Fig. 1.2. Details of the Current Indicator Lamp (a) the circuit diagram (b) arrangement of the components on the screw terminal block in accordance with the circuit diagram. Use the layout diagram as a template.



Shows the physical representation of the components and their circuit symbols used this month. The resistors have their value printed on the body in the form of a Colour Code. The decoding for the two different values is provided for those unfamiliar with this system.

a certain voltage is reached, the current flow builds up very rapidly, a small additional increase in voltage then producing a large increase in current.

This "non-ohmic" behaviour makes it only too easy to destroy an l.e.d. by applying too much voltage. In practical l.e.d. circuits the designer always ensures that the current is limited to a safe amount. The easiest way is to connect a resistance so that the current must flow through this to get to the l.e.d., see Fig. 1.2a. If the resistance is large enough the current is not able to exceed the safe value. (This varies according to the type of l.e.d. but most will take 20 milliamps safely.)

For our Current Indicator Lamp we use two l.e.d.s, connected in parallel but "back to back". The red l.e.d. lights when current flows from *A* to *B* and the green l.e.d. when current flows from *B* to *A*. Fig. 1.2b indicates how the connections can be made using three terminals of a block. It will be convenient to cut off a strip of three connections so that the indicator forms a separate unit which can be moved around as required.

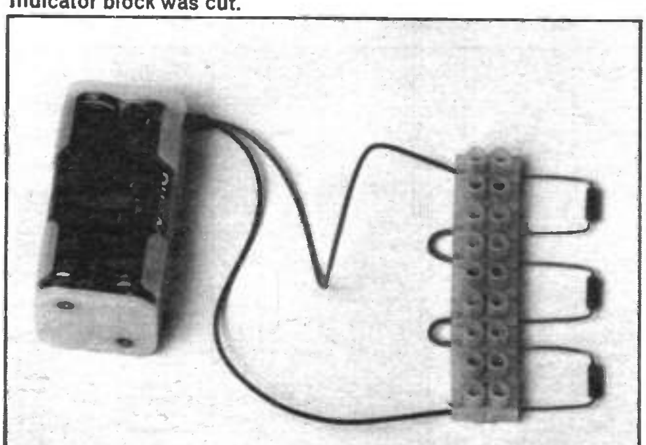
Check the Indicator by connecting *A* and *B* to your 6V battery. The brightness of the l.e.d. is as great as it can be in our experiments. You will see that they are not very bright and don't show up well in sunlight or a brightly lit room.

CURRENT IN A CIRCUIT

In Fig. 1.3a the three resistances are in series. That is, the current flows through one resistance after another on its round trip from positive battery terminal to negative.

Does the current get weaker as it goes through the resistances? This can be checked by inserting the indicator into the circuit at points *A*, *B*, *C* and *D*. If the current grows weaker the l.e.d. will glow less brightly at the further points. Connecting up the resistors as in Fig. 1.3b creates suitable links which can be removed to insert the Indicator.

The circuit of Fig. 1.3 fully assembled on the block from which the Indicator block was cut.



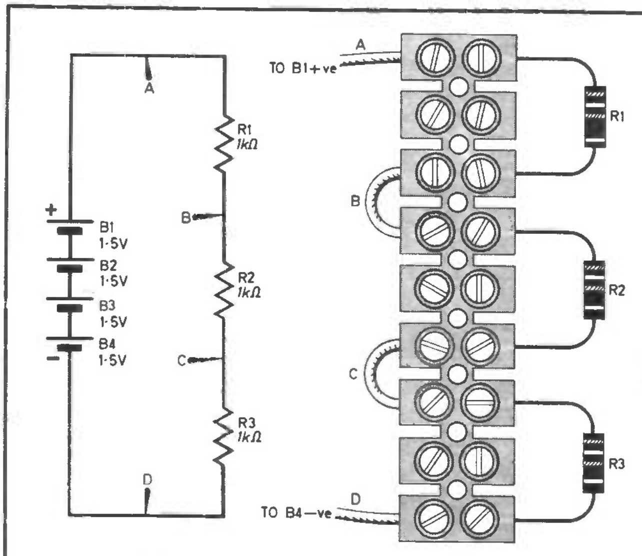
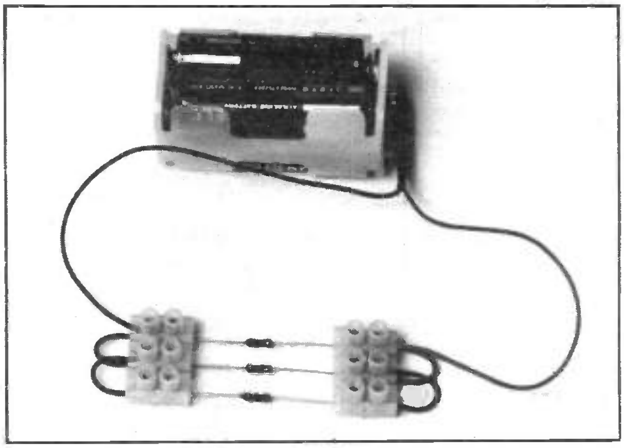


Fig. 1.3. (a) The circuit diagram showing three resistors connected in "series" to four 1·5V cells (B1 to B4) which are also connected in series to provide a 6V supply (b) how to connect up the circuit on screw terminal blocks.



The circuit of Fig. 1.4 fully assembled. The two blocks need not be cut as shown. The remaining 9-way and one 12-way block may be used instead.

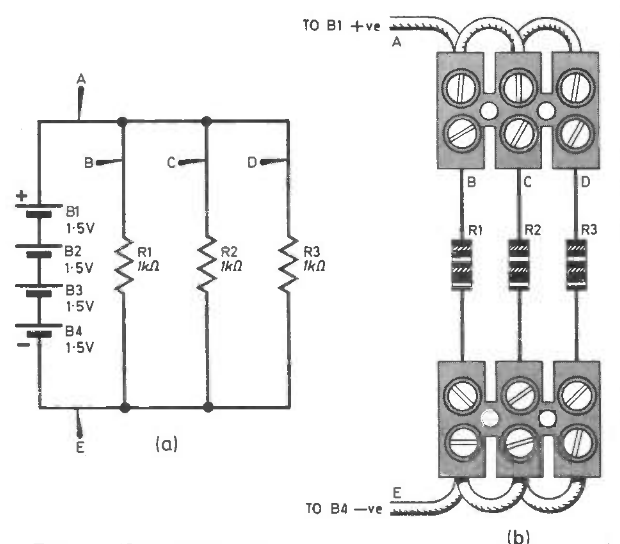


Fig. 1.4. The three resistors in the previous diagram are now re-arranged to be in parallel. (a) The circuit diagram for this parallel arrangement (b) how to connect them on the screw terminal blocks.

You should find that the current is the same at all points. The l.e.d. lights only dimly because the resistances in a series circuit add up. In this case they add to 3kΩ (3 kilohms = 3,000 ohms). If you short out one resistor the l.e.d. will be brighter, and two shorted makes it brighter still.

In a series circuit, the battery voltage is shared out among the various resistances in proportion to their size (that is their ohms values, not their physical dimensions). With three equal resistances, our 6 volts (6V) is shared equally. If you could measure the voltage across each individual resistor it would be 2V.

If two of our resistors were replaced by a single one of value equal to 2 kilohms the current would remain the same but the voltage drop across the 2kΩ would be 4V. The voltage drop across the total 3kΩ in the circuit must be 6V, because this is what we apply to the circuit from our battery.

Note that the ratio of voltage to resistance is the same whether we consider individual 1kΩ resistances or combine them into larger resistances: 2V/1kΩ = 4V/2kΩ = 6V/3kΩ. In every case the ratio is 2. But two what? In fact, two milliamperes. The ratio of voltage to resistance is the current. If you divide volts by kilohms (thousands of ohms, kΩ) the answer comes out in thousandths of amperes, milliamperes.

Don't worry if these units are unfamiliar, or if you're not much of a hand at maths. It needn't stop you having fun with electronics.

RESISTORS IN PARALLEL

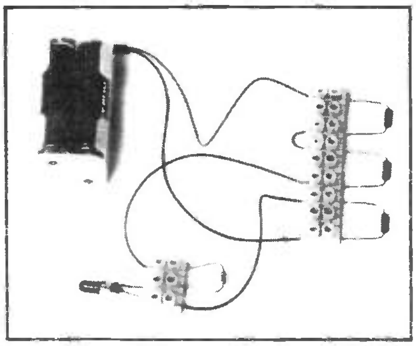
If you now rearrange your three 1kΩ resistances, connecting them in parallel (Fig. 1.4) the full battery voltage is applied to each. Each resistance passes a current of 6V/1kΩ = 6mA so a lamp placed in circuit at points *B*, *C*, or *D* will glow more brightly than in the series circuit.

At point *A*, the total current of 18mA passes and a lamp here glows more brightly still. This shows that when resistances are in parallel the combination allows more current to pass than each individual resistance would.

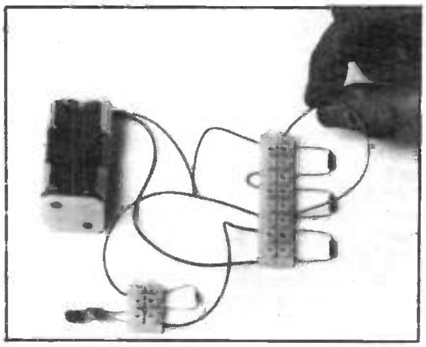
Common sense tells us that in our case, with three equal resistances, and three lots of current, the combination is equivalent to one resistance of one-third the value of the individual ones. In this case the equivalent resistance is 1kΩ/3 = 333 ohms. If there had been only two 1Ω resistances in parallel the equivalent would have been 1kΩ/2 = 500 ohms.

By looking at the circuit you can see that if an extra, very high resistance were connected in parallel it would allow only a small additional current to flow. In parallel circuits, it is the lowest resistances which have the greatest effect.

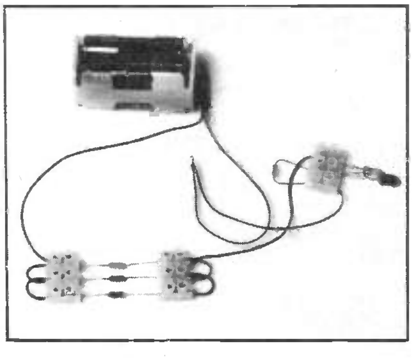
To be continued



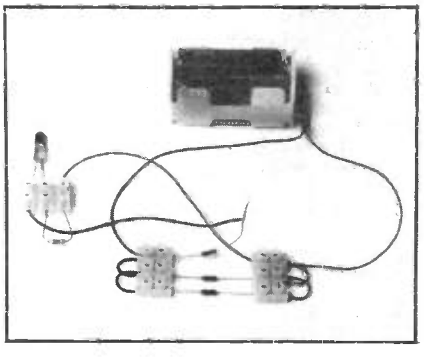
Placing the Indicator in series with the circuit of Fig. 1.3 at point C.



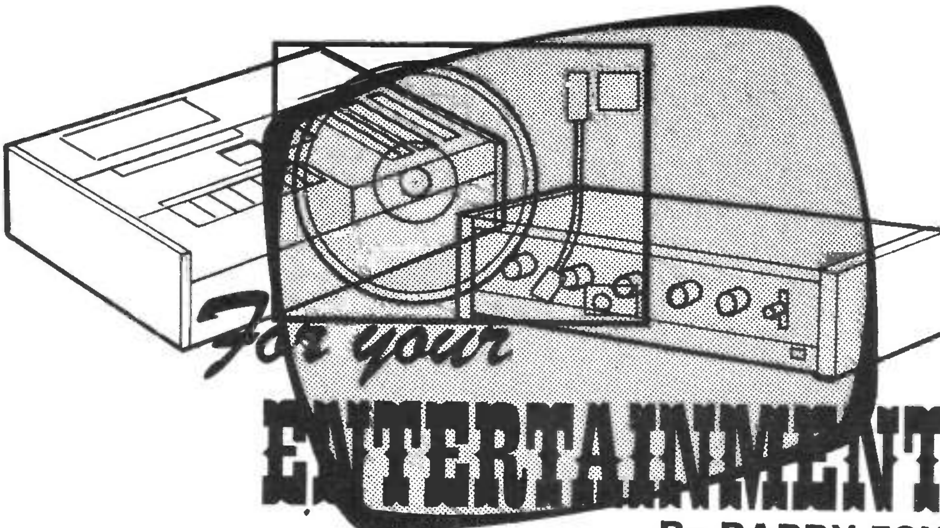
Shorting out the two upper resistors will cause the Indicator brightness to increase.



Inserting the Indicator at point A in the circuit of Fig. 1.4.



Inserting the Indicator at point B in the circuit of Fig. 1.4.



By BARRY FOX

On The Line

I make no apology for returning to the subject of telephones. Liberalisation, or *supposed* liberalisation, of the British telephone service is in the news again. But it's also in a mess. And there has been some interesting feedback from the trade on my previous pieces.

The Government has now brought in new laws which will make it illegal to advertise a telephone, or any gadget for connection to the telephone lines, without marking it as officially approved, or non-approved.

The new laws will also make it illegal to sell a phone that isn't marked in this way. Note well, however, the subtle but important fact that the new laws don't make it illegal to sell non-approved telephones or to use them.

The idea is to give the public a clear choice between buying authorised and illicit equipment. If subscribers buy an authorised phone then they can legitimately have it installed by British Telecom (née the Post Office) and use it without fear of retribution. If they buy unauthorised equipment, they will have to connect it themselves and risk falling foul of British Telecom.

The Department of Industry, which has brought in the new laws, says it is backing British Telecom to the hilt over BT's rights to demand that any telephone subscriber disconnects unauthorised equipment. If subscribers refuse to disconnect unauthorised equipment, BT can disconnect their telephone lines at the exchange.

Red or Green

Unfortunately it's not half as straightforward as at first appears. There has already been confusion over when and how the new laws come into force. The restriction on advertising (Telecommunications Order 490 of 1982) came into force on July 1 1982. But the restriction on marking (Order No. 491) is in two parts.

It is now illegal for shops to display equipment without also displaying a notice which says whether it is authorised or not. But only after November 1 1982 must the equipment itself be clearly marked with a "green for go" approved label, or a "red for no-go" label for prohibited equipment.

If you think this sounds confusing you are in good company. Even the Department of Industry got it wrong in a statement to the press which told editors that equipment must carry the go and no-go labels from June 1 1982. As a result some newspapers got it wrong too.

Why, you may well ask, is it taking so long for approved telephones to get into the shops. The British Telecommunications Act, which came into force on October 1 1981, ended British Telecom's monopoly. And it gave the British public a chance to buy their own telephones outright (over and above the first which always has to be rented from British Telecom).

But, even by the end of March 1982, when those marking orders were laid before Parliament, there still wasn't a single authorised phone for sale in the shops. There was however a wide range of unauthorised phones. And anyone who connected these was at the risk of being harassed by British Telecom.

Even the Chairman of the Football Association in Lancaster Gate wasn't immune. "It has been brought to my notice they you have connected a telephone that is not approved", BT told the FA. "I look forward to receiving your confirmation in writing that this telephone has been permanently disconnected."

Testing Time

The snag is that the Department of Industry opened the legal door to authorised telephones before organising an authorisation system. In July 1981, when the Telecommunications Act received Royal Assent, the DOI asked the British Electrotechnical Approvals Board (BEAB) to arrange a test programme.

BEAB needed standards for testing. These had to be drawn up by the British Standards Institution (BSI) which in July 1981 set up five separate committees to examine the problems. One committee alone had representatives from over twenty official bodies as diverse as British Gas, The Dept. of Industry, British Telecom, The Independent Broadcasting Authority, The Oil Industry and the Post Office Engineering Union.

To try and get things moving, at the end of 1981, the Department of Industry asked British Telecom to do some interim testing. BT has charged £2,000 a phone to do some stop-gap tests and by the time this article appears in print there should be a few BT-approved phones on sale in the shops.

If you are an *afficianado* of exotic phones, don't get too excited. The phones approved by British Telecom in the Spring of 1982 were from GEC, STC, Plessey and Thorn-Ericsson. Approval was automatic and no charge was made because these companies were already supplying telephones to British Telecom. So what initially goes on sale to rival British Telecom will in fact be nothing more than telephones that are already available from British Telecom!

Some foreign firms have refused to submit their phones for this interim testing, because they fear a rough ride from British Telecom. Out of ninety-five phones that were submitted in another batch for paid testing, only nine were passed on by the Department of Industry to British Telecom. These came from six companies (Conversation Pieces, Astral Telecom, Ace Telecom, Store-a-call, GEC and STC) and some are foreign.

Tests on these phones should have been completed by now, so if any pass muster they might soon be in the shops. Telephones approved by the BABT should be in the shops by October, exactly one year after the new law came into force. Then liberalisation will begin to mean something.

Protected Network

The British telephone network must, of course, be protected against unauthorised connections which can either create dangers, by putting mains onto the line, or degrade the service. But over the last year I've been appalled by the muddle, and misinformation surrounding liberalisation of our telephones.

There is little doubt that firms in the business of selling telephone equipment are being hamstrung by red tape. At a conference called to discuss recent "privatisation" developments, John Wakeham, the Minister responsible, got so confused when answering my questions that two of his colleagues had to seek me out afterwards to give clear, corrected facts.

When Sir George Jefferson, Chairman of British Telecom, guested on the Jimmy Young radio show to answer listeners' questions on telephones he told one lady: "It is illegal to connect a purchased telephone in place of a British Telecom one."

But it isn't illegal or punishable by law. It contravenes the telephone regulations and is punishable by BT who can disconnect your phone lines.

Interestingly the new laws, on marking and advertising, mean that it is perfectly legal and legitimate to advertise and sell non-approved telephones as long as they are clearly marked as such. Purchasers can then perfectly legitimately connect them to a private system, for instance a business intercom.

As one journalist put it to John Wakeham recently. "So it's all right to sell dangerous sub-standard equipment provided it only fouls up a private network and only electrocutes engineers who aren't working for British Telecom?"

1983 SCHOOLS Electronic Design Award COMPETITION

over £2,000 in Prizes

Mullard Ltd—the largest electronic components company in the UK—and Everyday Electronics join forces to present this rewarding challenge to Secondary Schools. . . .

DESIGN A PIECE OF ELECTRONIC EQUIPMENT HAVING A DIRECT PRACTICAL APPLICATION IN A SCHOOL'S SCIENCE LABORATORY

This competition is open to any United Kingdom Secondary School, State or Independent. Pupils of either sex in the age group 11-18 are eligible to participate in a team representing their school.
The competition will be conducted in two stages.

STAGE 1
Submission of Papers describing the proposed project with full circuit details.
Papers will be judged for novelty, ingenuity and viability. Particular attention will be given to originality and good circuit design technique.
Schools whose designs are adjudged to be the most promising will be asked to produce a working model.

STAGE 2
Models will be examined and prize winners selected on the basis of mechnical design, neatness of wiring and general assembly, plus operational performance.

All models will be exhibited at Mullard House, London, where the official presentation of prizes will be made at the end of June 1983. Representatives of finalists will be invited to stay overnight in London as guests of the SEDAC sponsors.

FIRST PRIZE The SEDAC Trophy and £300*

SECOND PRIZE £200*

THIRD PRIZE £100*

*** Plus a selection of components valued at £200**

NINE RUNNERS UP a selection of components valued at £100

In addition, all twelve finalists will receive a certificate and one year's subscription to Everyday Electronics.

Science teachers of Secondary Schools are invited to apply for a Registration Form which contains full details of this competition.

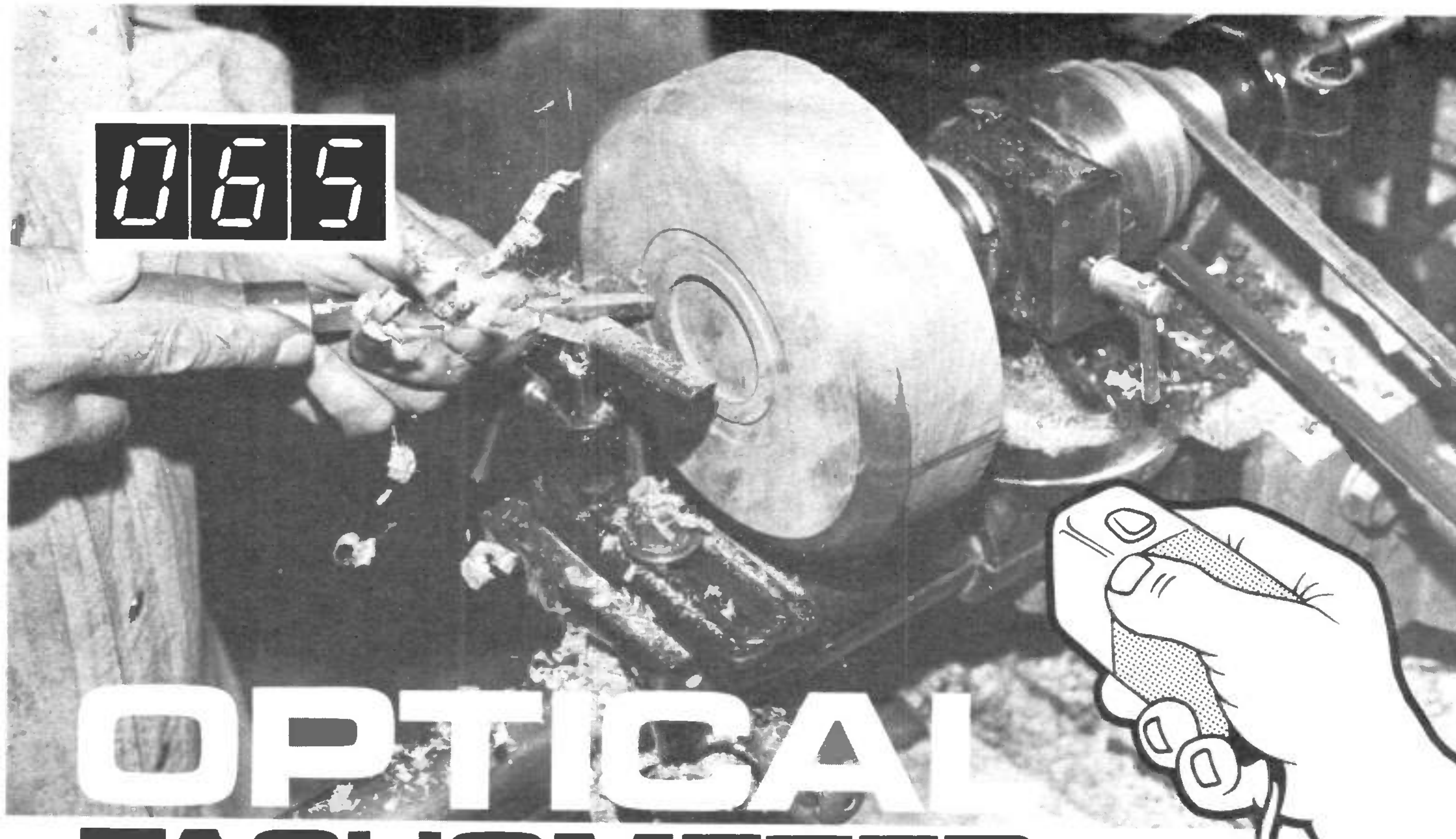
Write to: Schools Competition, Room 2130, Kings Reach Tower, Stamford Street, London SE1 9LS.

Secondary School Pupils—make sure your school accepts this challenge and enters this contest. So bring this announcement to the attention of your science teacher or the head of your school.

Closing date for Registration: November 15 1982

Closing date for submission of Papers: January 31 1983

SCHOOLS ELECTRONIC DESIGN AWARD COMPETITION (SEDAC) SPONSORED BY MULLARD LTD AND EVERYDAY ELECTRONICS



OPTICAL TACHOMETER

by P.H. Leah

OPTICAL Tachometers have the advantage of measuring the number of revolutions per minute (r.p.m.) of any rotating object, such as a wheel, disc or shaft, without having to make actual physical contact with it.

By placing a reflective mark (a piece of white tape or a chalk mark, for example) on the rotating surface and holding the Tachometer detector in close proximity, an accurate reading of the number of times the mark passes the detector is obtained. The detector generates a pulse for every revolution of the object.

In the Optical Tachometer described here, the time between successive pulses from the detector is measured and digitally converted to read revolutions per minute on a numerical display. The display holds the measurement for approximately three seconds and is then reset before the measurement is retaken.

Two ranges are included, 400 to 5,000 r.p.m. and 4,000 to 25,000 r.p.m. each with an accuracy of 5 per cent.

PRINCIPLE OF OPERATION

With reference to the block diagram given in Fig. 1, the photodiode detector "detects" a difference in reflected light intensity from the rotating disc, each time the mark passes it. A lamp in the detector provides a local light source. The photodiode output is amplified to produce a pulse for each revolution.

Conventional frequency measurement techniques of counting incoming pulses over a known time period cannot be used for determining the relatively slow time periods of mechanical rotations. The measurement of a wheel rotating at 3,000 r.p.m. would take at least 10 seconds to obtain an accurate reading. Lower speeds of rotation would take even longer.

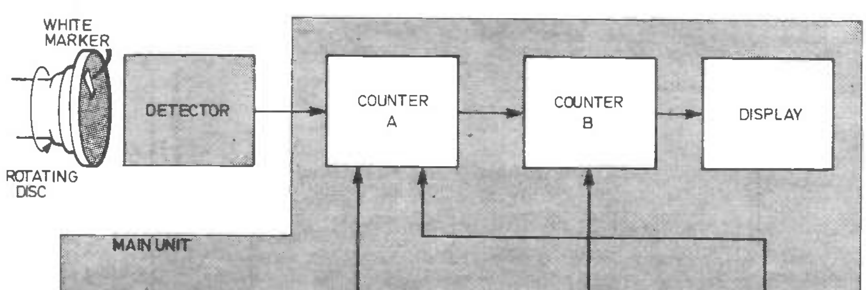
So consequently a novel but simple measurement and conversion technique is employed in this Tachometer.

The main unit measures the time interval between three successive outpulses from the detector (that is, two revolutions). So, assuming the detector is picking up pulses from a wheel rotating at 1,200 r.p.m., for example, this time interval will be 100 milliseconds (1,200 r.p.m. = 20 revs/sec, therefore on revolution takes 50 milliseconds).

A counter (*A*) is enabled for this period, whilst being clocked by a 833Hz clock. Hence 83 clock pulses will be counted and stored in binary form. This count of 83 presets another counter (*B*), and exactly 10,000 clock pulses are passed to this presettable counter.

The output pulses from the second counter (*B*), equal to 10,000/83 = 120,

Fig. 1. Block diagram of the Optical Tachometer.



are then counted by a three digit binary coded decimal counter and displayed on a digital readout. As only three digits are used for the display, a multiplication factor of 10 must be applied to the display to give the correct reading of 1,200 r.p.m.

A basic clock frequency of 8·33kHz is used for the higher range measurements (4,000 to 25,000 r.p.m.) therefore a multiplication factor of 100 must be applied to the display reading.

DETECTOR CIRCUIT

The detector circuit, shown in Fig. 2, comprises of two operational amplifiers in series. IC12, a CA3240 dual op-amp was selected for the detector for its relatively low noise and high impedance f.e.t. input.

IC12a is connected as a simple amplifier to amplify the variation in reverse leakage current through the photodiode, D1. The greater the intensity of light falling on the diode, the greater the reverse current through it will be. R13 provides additional bias current in order to ensure the output voltage of IC12a remains within the active region of the amplifier, even under extreme conditions of illumination. R17 is the feedback resistor for IC12a.

Under artificial light conditions, the output of IC12a at pin 1 will be about 2V and will change to approximately 1V by placing a cover over D1.

The output of the first op-amp is connected via R18 and R19 to the inputs of IC12b. This op-amp is wired with positive feedback by connecting the output at pin 7 to the positive input, pin 5, via R20. This feedback ensures that the amplifier output switches between the supply rails, V_{DD} and V_{SS}. It also means that the output switches between these two states at a very small difference in the input voltage, and will remain in that state.

As R18 and R19 are equal values, the current flowing into pins 5 and 6 of IC12b will be identical. However, an additional current will flow into pin 5 via the feedback resistor, R20. Hence, if the output is at V_{DD}, pin 5 will be positive with respect to pin 6.

A sudden change in light intensity falling on D1 will cause a rapid drop in voltage at pin 1, the output of IC12a. This fall in voltage will simultaneously appear at pin 5 of IC12b

COMPONENTS

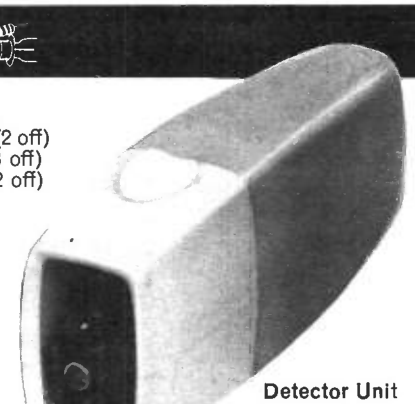
Resistors

R1	4·7kΩ	R13	1·5MΩ
R2	3·3kΩ	R14,15	2·2kΩ (2 off)
R3	100kΩ	R16,17,20	1MΩ (3 off)
R4-10	680Ω (7 off)	R18,19	20kΩ (2 off)
R11	100kΩ	R21	390Ω
R12	1kΩ	R22	150Ω

All ¼W carbon film ±5%

Capacitors

C1	68pF polystyrene
C2	10μF, 10V elect.
C3	1,500pF ceramic
C4,5	47μF, 6·3V tantalum (2 off)
C6	1,000pF ceramic
C7,8,9	0·01μF ceramic (3 off)
C10	1,000μF 25V elect.



Detector Unit

Semiconductors

D1	Photodiode IPL 33 (equivalent to RS 305 462)
D2,3	1N4002 silicon rectifier (2 off)
TR1,2,3	2N3702 silicon *pnp* (3 off)
TR4	BC109 silicon *npn*
IC1	4001B CMOS quad 2-input NOR gate
IC2,3	4520B CMOS dual 4-bit binary counter (2 off)
IC4	40103B CMOS 8-stage presettable down counter
IC5	4553B CMOS 3-digit b.c.d. counter
IC6	4511B CMOS b.c.d. to 7-segment driver/decoder
IC7,10	4011B CMOS quad 2-input NAND gate (2 off)
IC8,9,11	4518B CMOS dual b.c.d. counter (3 off)
IC12	CA3240 dual f.e.t. op-amp
IC13	7805 5V, 1A regulator
X1-3	DL704 0·3in. high 7-segment, common cathode display (3 off)

See Shop Talk page 635

COMPONENTS approximate cost £29·80 excluding case

Miscellaneous

S1	s.p.d.t. miniature toggle
S2	s.p.s.t. miniature toggle
VR1	1kΩ miniature horizontal preset
T1	miniature mains transformer, 9-0-9V, 0·5A secondary
LP1	12V, 0·5W filament lamp

Single sided p.c.b. 128 × 128mm and 75 × 28mm (2 pieces); 0·1in. matrix stripboard, 26 strips by 20 holes; console type case, 220 × 174 × 100mm (Vero type no. 202-21032D); pocket torch; 16 pin d.i.l. holder (9 off); 14 pin d.i.l. holder (3 off); 8 pin d.i.l. holder; lamp holder (2 off); red display filter 25 × 65mm; twin screened cable; mains cable; 7/0·2mm equipment wire; M2.5 or 6BA screw, 25mm long (4 off); M2·5 or 6BA nut (8 off); M2·5 or 6BA nylon nut (4 off); transformer mounting hardware.

Complete Optical Tachometer Unit

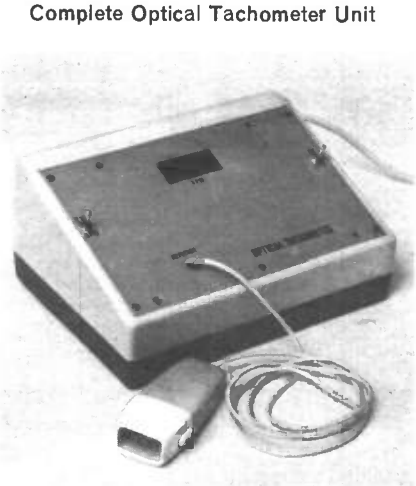
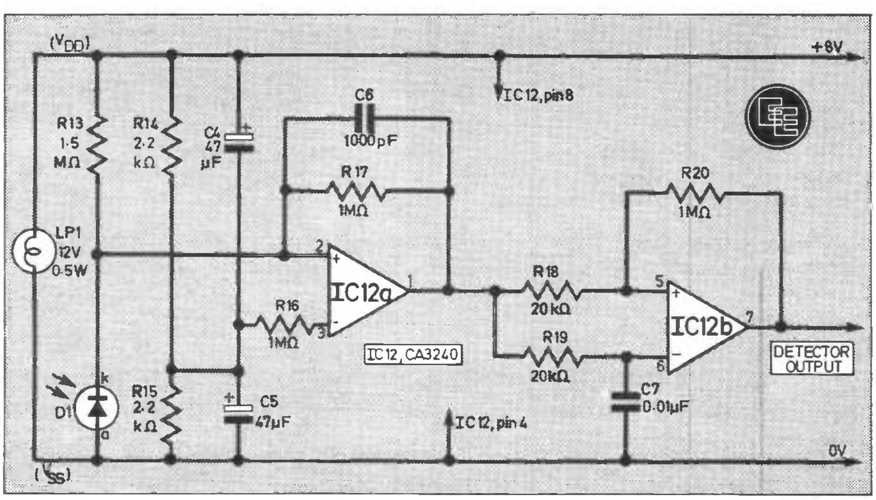


Fig. 2. Circuit diagram of the detector unit. Photodiode D1 is an IPL 33.



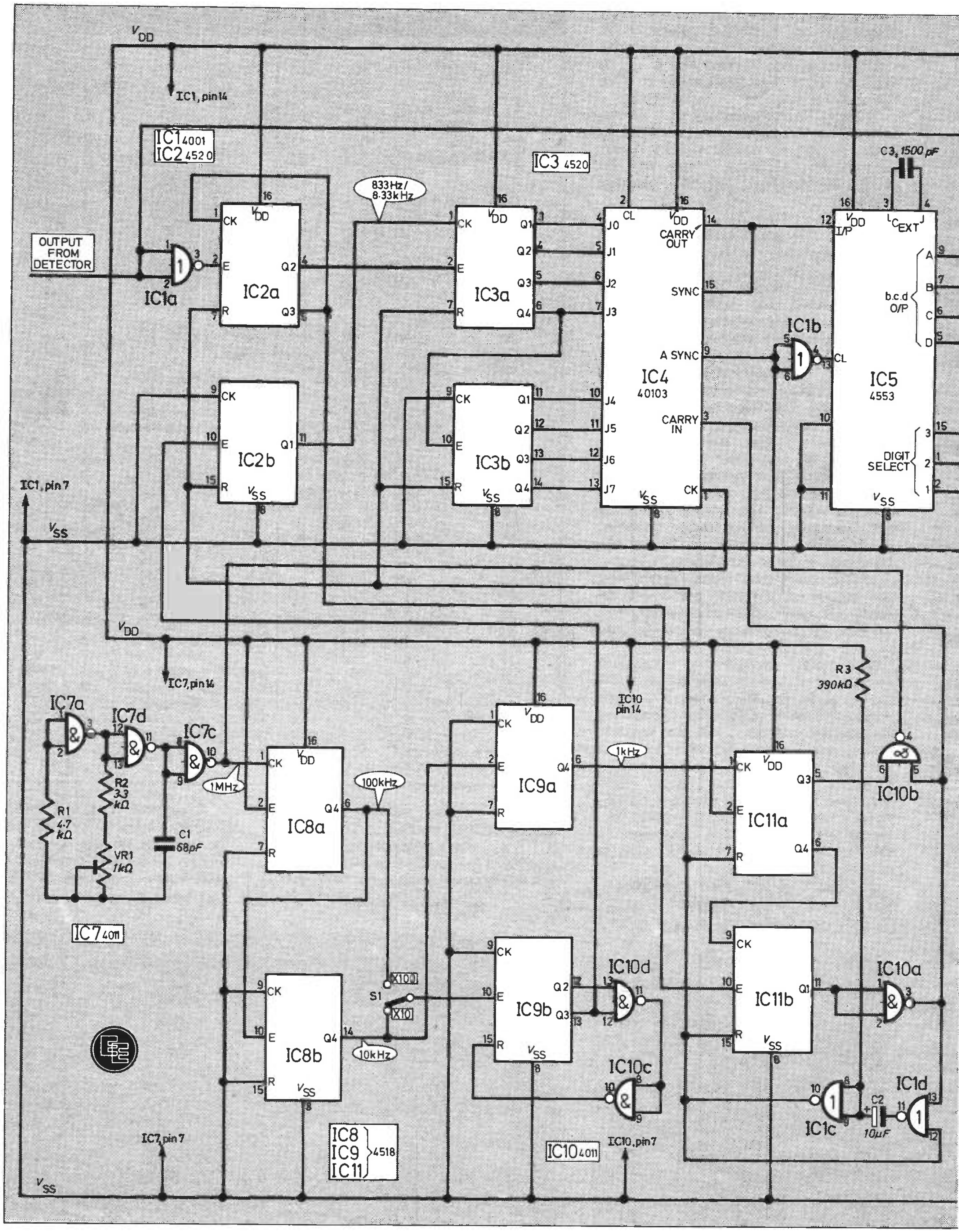
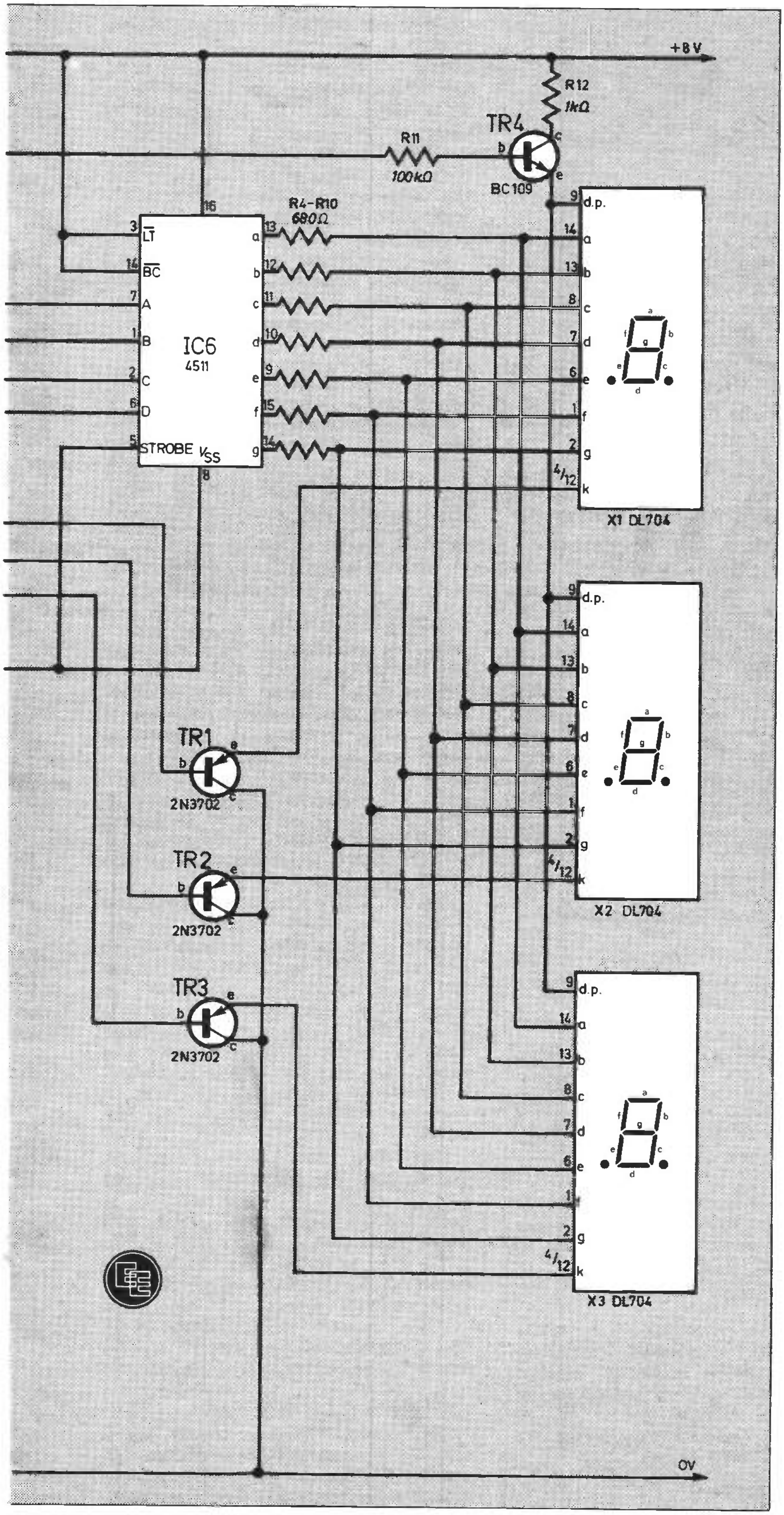


Fig. 3. Circuit diagram of the Optical Tachometer main unit. Frequencies quoted are for use when setting-up and fault-finding.



but due to C7, pin 6 will be slower to respond to this voltage drop.

Consequently, pin 5 will go negative with respect to pin 6 and the output will switch states to V_{SS} (low). Due to the positive feedback, the output of IC12b will remain low until a positive going voltage occurs at the output of IC12a.

R14 and R15 provide a potential divider to supply bias voltage for IC12a and C4 and C5 are decoupling capacitors. The 12V filament lamp, LP1, provides a local light source.

MAIN UNIT

Fig. 3 shows the circuit diagram of the main unit. The output pulse from the detector is inverted and buffered by a 4001 CMOS NOR gate, IC1a, before enabling CMOS binary counter, IC2a. During the the time interval between the 3rd and 5th pulses from the detector, pin 4 of IC2a will be high. This period is equal to two revolutions of the wheel being measured. The logic high from pin 4, IC2a enables another counter, IC3. After the fifth pulse from the detector, pin 5, IC2a will go high and inhibit any further counting.

IC3 is a CMOS dual 4-bit binary counter in which the two counters are cascaded together to form an 8-bit binary counter. This counter counts and stores the number of pulses from a 833Hz clock during the period that it is enabled from IC2a. The 8-bit parallel output from IC3 is preset into the CMOS presettable down counter, IC4.

The 833Hz clock frequency is derived from a 1MHz oscillator comprising of CMOS NAND gates, IC7a and IC7d. This oscillator can be varied by adjusting RV1. IC7c buffers the oscillator output before it is connected to IC8, a CMOS dual decade counter.

IC8a and IC8b are cascaded in series to provide outputs of 100kHz and 10kHz and these are connected to the high/low range switch, S1. The output is then connected to IC9b, another decade counter, which divides the incoming frequency by six using NAND gates IC10c and IC10d.

The output of IC9b on pin 13 will be either 16·67kHz or 1·667kHz depending on the position of S1. These frequencies are then divided by two by IC2b to produce the two clock frequencies of 8·33kHz and 833Hz (high and low ranges respectively) for counter IC3a.

The 10kHz signal from IC8b is further divided by ten by decade counter IC9a to produce 1kHz and then again by decade counter IC11a to give 100Hz at pin 6. The output from pin 5 of IC11a is used to preset IC4 and to clear IC5. The signal is usually active but is inhibited by NAND gate IC10b.

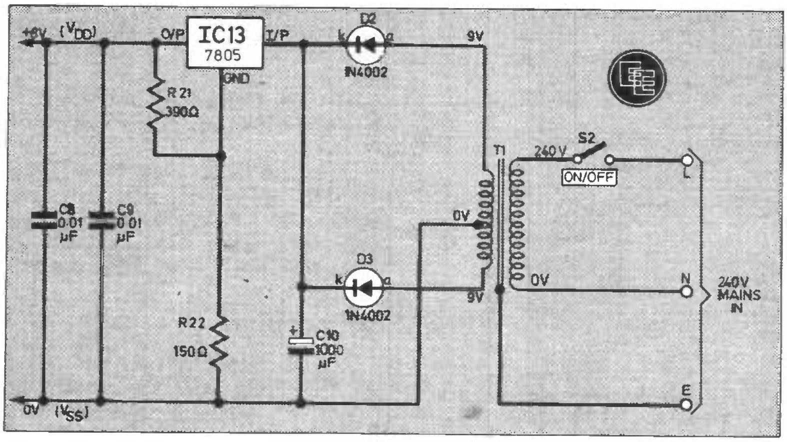


Fig. 4. Circuit diagram of the power supply section. C8 and C9 are decoupling capacitors and are placed on the main unit p.c.b. close to the i.c.s.

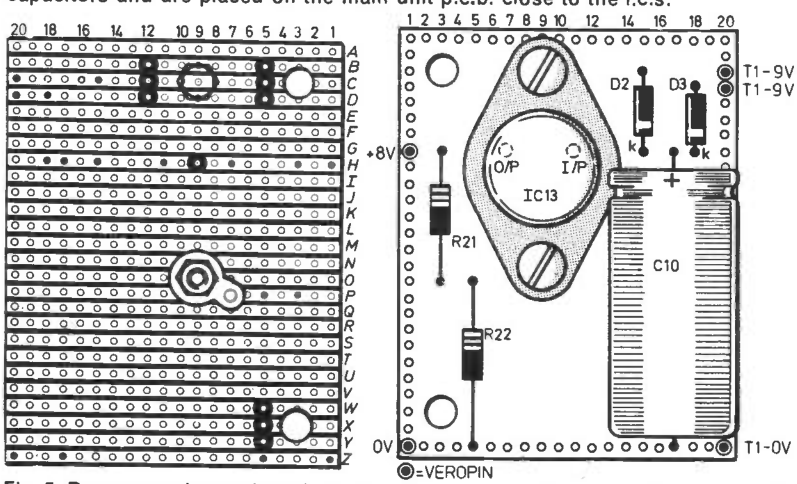


Fig. 5. Power supply stripboard layout. Note that the solder tag on the underside must be soldered to track *P*. The regulator, IC13, used by the author is the larger TO3 device (shown here), however, the smaller 7805 (TO220) type can be used with suitable track modifications.

Counter IC11b is enabled only after the fifth pulse from the detector is counted by IC2a, and the output at pin 11 of IC11b is a 50Hz signal having an equal mark to space ratio. Hence a logic 1 (high) appears for exactly 10ms, the time it takes for 10,000 pulses from the 1MHz oscillator to be counted. Thus the 10ms pulse enables IC4 whilst the 1MHz oscillator clocks IC4.

The resulting pulse train from pins 14 and 15 of IC4 is clocked into IC5, a CMOS three digit b.c.d. counter, to be counted and displayed.

The falling edge of the 10ms enable pulse activates the reset monostable comprising of NOR gates IC1c and IC1d. The resulting reset pulse of approximately three seconds duration, resets IC2, IC3 and IC11, thus inhibiting further counting during those three seconds.

After the rest period, a further measurement will commence.

DISPLAY

IC5 provides a binary coded decimal, three digit multiplexed display. The b.c.d. outputs are connected to IC6, a CMOS b.c.d. to seven segment driver/decoder which drives the displays X1 to X3 via current limiting resistors R4 to R10.

The digit driver transistors TR1 to TR3 operate directly from the multiplexed digit select outputs of IC5 to switch on the displays as appropriate (at a rate faster than the eye can detect).

The decimal points of all the digits are commoned to provide an indication that a pulse is being received from the detector. They are driven by TR4. If the decimal points fail to illuminate it shows that no pulses are reaching the main circuit.

POWER SUPPLY

As the unit only requires about 180mA at 8V d.c. it would be possible to power the Optical Tachometer from a 9V battery. However the author utilised a regulated mains power supply, the circuit of which is shown in Fig. 4.

The full wave rectified output from the 9-0-9V centre tapped transformer T1 is about 12V. This is smoothed by reservoir capacitor C10 before it is connected to the regulator IC13. This regulator, although a 5V type, has the output effectively boosted to 8V with R21 and R22 without loss of regulation.

C8 and C9 are supply decoupling capacitors to suppress any noise on the supply rail. These are particularly important for counting circuits.

CONSTRUCTION starts here

PRINTED CIRCUIT BOARDS

With the exception of the power supply, the prototype was laid out on two printed circuit boards. The component layout and track pattern artwork of the detector circuit p.c.b. is shown in Fig. 7 and the component layout and track pattern artwork of the counter p.c.b. is shown in Figs. 6 and 8. Both printed circuit boards are shown full size and all holes are 1mm, except for the board mounting holes which are 3mm.

Particular care should be taken in placing the CMOS devices on the counter p.c.b. as the orientation of the i.c.s vary. This was necessary to aid the track layout. Also, a number of wired links are necessary on this circuit board as cross-overs could not be avoided. The use of low profile i.c. sockets is recommended, or Soldercon pins, so that i.c.s may be removed without damage to the board.

Regarding the detector circuit board, both the photodiode, D1, and the 12V bulb, LP1, were mounted in bulb holders which were glued with epoxy resin (such as Araldite) to the p.c.b. It is essential that the diode is mounted slightly forward of the 12V bulb so that direct light does not impinge directly on the diode. Also, the diode should just extend beyond the detector printed circuit board.

MECHANICAL ASSEMBLY

The detector printed circuit board was designed to push fit into a pocket size torch, once the bulb, reflector and switch mechanism had been removed. It is held in place using a padding of foam rubber at the bottom of the

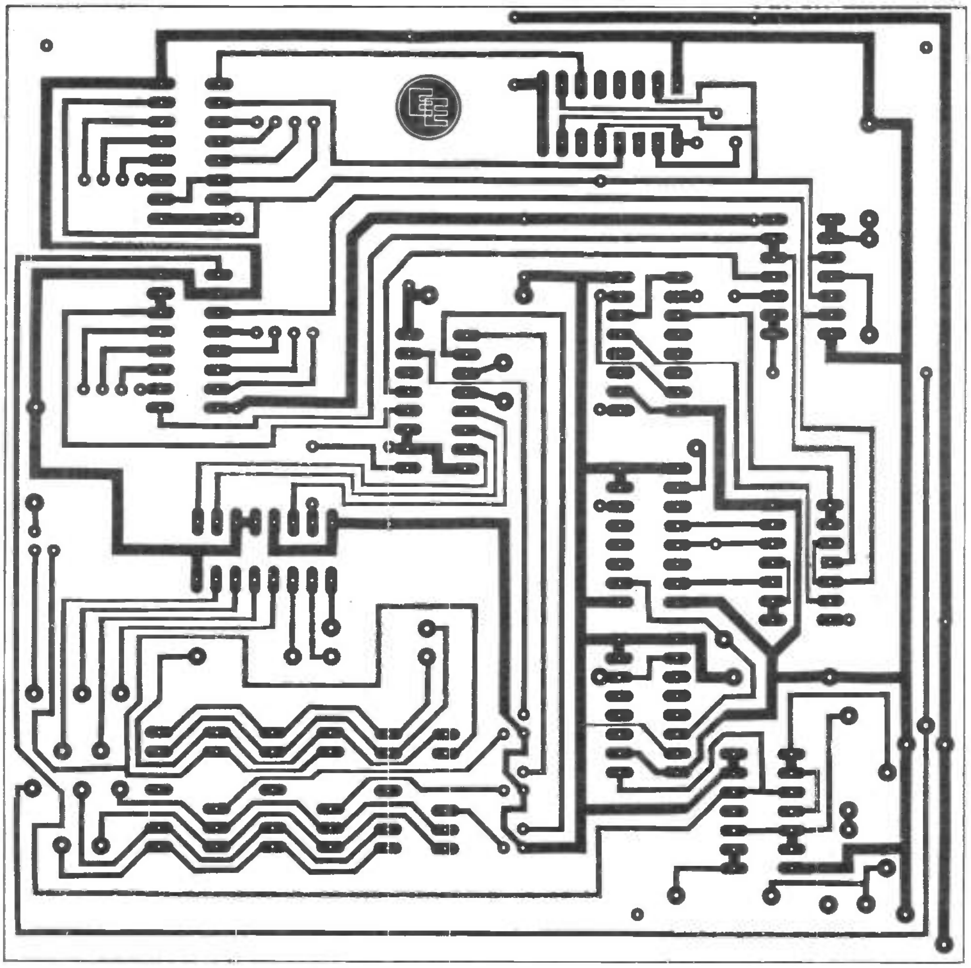


Fig. 6. Full size p.c.b. track pattern for the main unit.

torch such that the photodiode touches the clear plastic cover of the torch. Therefore light from the bulb will not reflect off the clear plastic onto the photodiode. The flexible screened cable carrying the power supply and detector output, enters the torch through a hole in the base of the torch.

The power supply and counter p.c.b. were mounted in a Vero console type Instrument Case. As the display circuit is mounted on the main p.c.b., the complete board is attached to the lid of the Instrument Case using the three mounting holes drilled in the p.c.b.

A rectangular hole 35×13mm needs to be cut into the case lid for the display, and should be backed by a red display filter glued to the lid, to emphasise the digits. Three holes for the range switch, the on-off switch and the detector cable must also be drilled.

The power supply was mounted on 0·1mm matrix stripboard as shown in Fig. 5, which was attached to the base of the Instrument Case using the threaded holes already provided in the case. If mains power is chosen, a further hole must be drilled in the Instrument Case for the Mains Cable.

TESTING AND SET-UP

Testing and setting up the Instrument is greatly simplified if an oscilloscope is available, but can be accomplished using a voltmeter. Only the 1MHz oscillator needs to be accurately set up by adjusting VR1. This can either be achieved by monitoring IC7c pin 10 and adjusting VR1 until a 1MHz reading is obtained, or by pointing the detector directly at, and in close proximity to, a mains operated lamp.

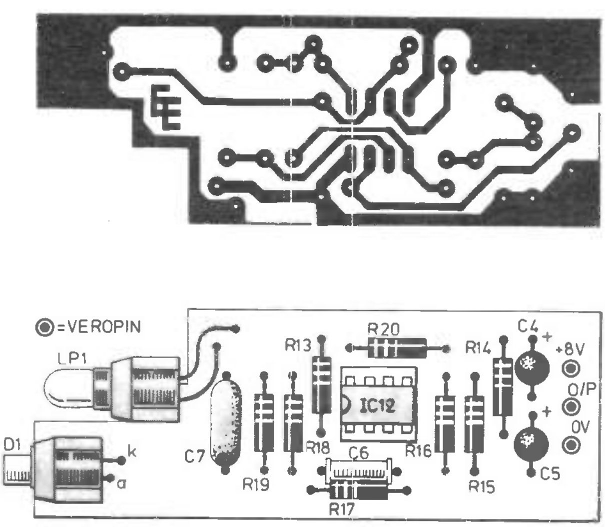
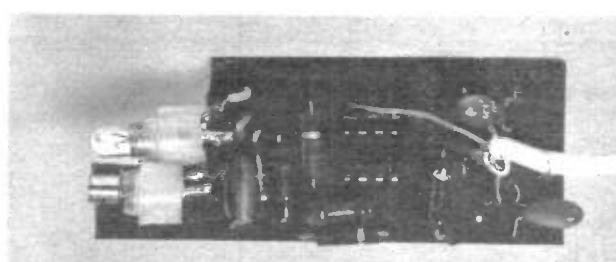
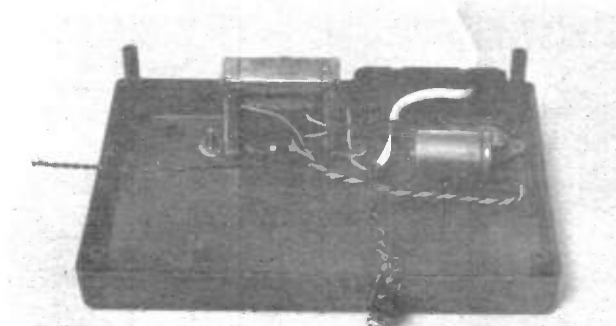


Fig. 7. Full size p.c.b. track pattern and component layout for the detector unit. Note that both LP1 and D1 use lampholders glued to the board.



Detector p.c.b. (above) and power supply wiring (below)



A normal tungsten filament lamp will suffice, and with the Instrument set on its high range, VR1 should be adjusted until a reading of 6,000 r.p.m. (that is a display of 60) is observed.

It should be noted that a 50Hz mains supply provides 3,000 cycles per second, During each cycle, two peaks of intensity are obtained, one of the negative going half and one on the positive going half of each cycle. Hence a reading of 6,000 r.p.m. is detected rather than 3,000 r.p.m.

Having set up the Instrument, it can be tested at relatively low speeds switching it to the lower range and moving a white card about 12mm in front of the detector. Do not point the detector directly at an artificial light during this test. The three decimal points on the LED display should be illuminated during the period that the card is directly over the detector, and should not be illuminated when the card is moved away.

If the card is rapidly moved across the detector at a regular rate, a reading of around 50 (that is, 500 r.p.m.) should be displayed by the Instrument. Although this test does not utilise all aspects of the Instrument, it proves that the logic and the detector is functioning correctly.

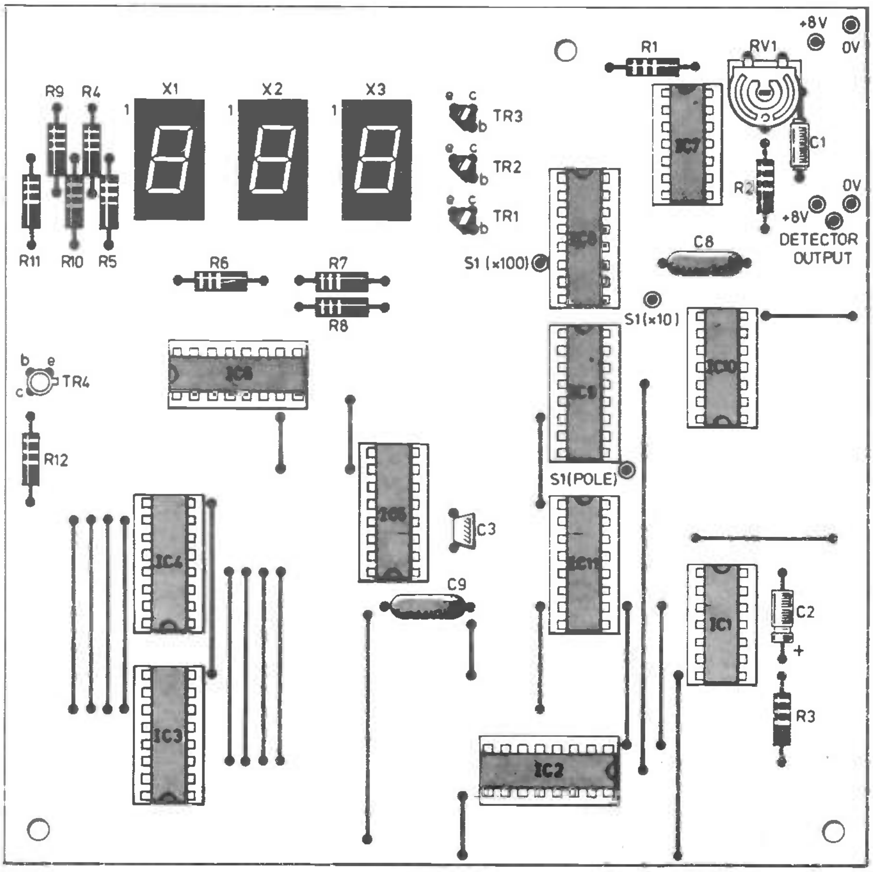


Fig. 8. Component layout for the Optical Tachometer main unit. Connection to the detector is made via a twin-cored screened cable, the screen forming the OV line.

FAULT FINDING

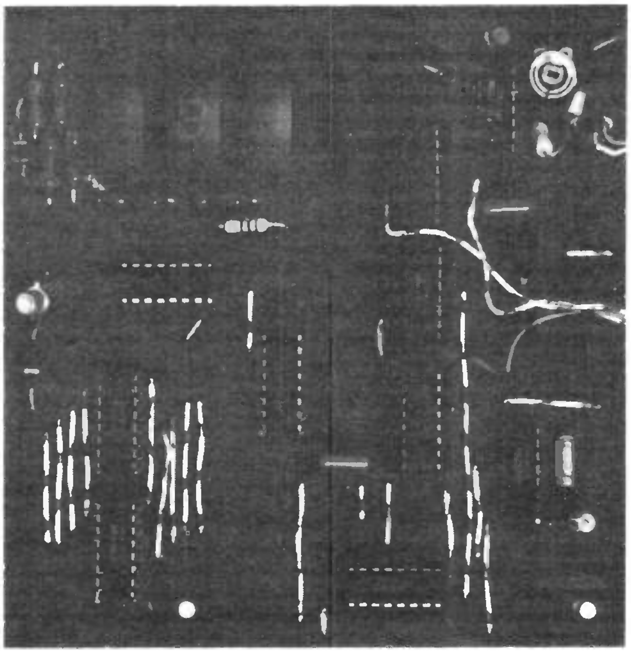
There is unfortunately no easy method of fault finding if the Instrument fails to operate correctly, and it is a case of laboriously plodding through the circuitry. Here an oscilloscope is essential.

Check for the obvious things first, such as ensuring that the supply voltage has not fallen below 8V. Then check that the 1MHz oscillator is operating correctly and that 100Hz is available at IC11 pin 6 while 833Hz is available at pin 11 IC2.

Next identify whether the detector is operating correctly by monitoring the output voltage at IC12 pin 7. This should switch between the Supply Rails as the difference in reflected light is detected.

If all is correct so far, then the conversion or display circuits must be at fault. However, if all digits are displaying something, even if it is all zeros it indicates the display circuit is operating correctly and therefore the control circuitry may be faulty.

When fault finding in CMOS circuits the low logic level should be at 0V while the high level logic state should be 8V. However, any voltage below 3·5V will appear as a low logic state while any voltage in excess of 4·5V will appear as the high voltage state to the input of a CMOS device.



Main unit p.c.b. from the prototype Optical Tachometer. Note the use of sleeved wire for the on-board links to prevent short circuits. The power wires (top right) are connected to the power supply board and the three wires to S1 go straight to the range switch on the front panel.

ACCURACY

As a digital method of calculating the rotations speed is employed, a quantisation error is introduced. This error is greatest at the high end of the ranges where it is approximately five per cent, whereas the error at the lower end of the scale is only one per cent. Further, the quantisation levels become more apparent at the higher end of the ranges.

For instance, when measuring a rotational speed of approximately 4,000 r.p.m. on the low range, readings of either 384, 400 or 416 will be displayed. There will be no intermediate readings. However, on the higher range, readings of either 40, 41, or 42 will be obtained.

PRACTICAL CONSIDERATIONS

As explained previously, the detector picks up differences in light intensity which impinge directly on the photodiode. It is also very sensitive. False readings will result when using the instrument if an external light source, such as an electric light, shines directly on the photodiode. Also false readings will result if the rotating object produces more than one change in reflected light intensity during each revolution.

Most metal objects will reflect light continuously but at fluctuating levels during each revolution, which makes a regular output pulse from the detector difficult to obtain.

Under such circumstances, it may be necessary to place a matt surfaced sticking tape or masking tape over the complete circumference of the metal shaft, and make a small mark. A contrasting colour to that of the sticking tape should be used. Hence a relatively even reflection will be obtained during most of each revolution, but a different reflection will be obtained when the marked surface is directly under the detector head.

Where possible the rotating object should be revolved slowly at first to ensure that the detector is operating correctly. The decimal points on the display should all illuminate and switch off during each revolution.

If the speed of rotation of the revolving object is outside the range of the instrument, spurious readings will be displayed, particularly at the low end of the scales.

Finally, as a point of interest, the following speeds of rotation were measured from a few common household items, when used at constant speeds: hand drill 500r.p.m.; electric power drill 2,700 r.p.m.; electric toy racing car 7,000r.p.m.

Note that the speed of an electric power drill quoted by the manufacturer is the minimum speed when on load. Off load the drill will run faster. ⌑

COUNTER INTELLIGENCE

By PAUL YOUNG

Component Guide for Neophytes

Although we know that new readers join us all the year round, it is reasonable to assume that a greater influx of neophytes occurs during the Autumn and Winter. On that assumption I usually write a few words of a didactic nature on the subject of obtaining supplies.

Before commencing any design make sure that all the parts required are freely available. Any items that are special are dealt with under the *Shop Talk* banner.

This still leaves the run of the mill components, such as, resistors, capacitors, and potentiometers. You may be lucky enough to have a good supplier near at hand. If you have you are a lucky person. Most of us are obliged to resort to Mail Order suppliers. Luckily there are plenty to choose from, as will be seen from the advertisements.

The next point I must emphasise, is that the field of electronics is now so vast that most retailers can only deal with a small segment of it. Therefore to get all your requirements you will have to deal with at least two or three.

My advice is this: first of all obtain three or four catalogues and study them carefully. Next, make a few notes on the prices and availability of parts. To avoid disappointment, plan well ahead, in other words, start collecting all the bits you need for your second project before you have finished the first.

Always help your supplier to help you, for example, if he encloses an order form make sure you use it. Write your name and address clearly, and if like me you have an illegible scrawl, either type it, or print it in block capitals.

Never put queries on the bottom of your order form, because it will probably delay the delivery of your goods. We always try and be helpful in replying to queries, but we do expect them to relate to the goods we stock. Today postage is an expensive item so always make sure you enclose a stamped addressed envelope.

One tip that most readers quickly discover for themselves, is the advantage of hanging on to the bits and pieces you don't use and to build up that ubiquitous Junk Box. One friend of mine used to beg an old un-wanted television chassis off the local repair man and then proceed to strip off all the useful pieces. It cost him nothing except his time, it gave him plenty of practice in de-soldering and he could set himself up for the season in potentiometers, resistors, capacitors and some transistors and I.C.s.

Electrohyper

The other day I was walking round what is called a "Hypermarket" which is an outsize Supermarket when it struck me that they sold everything, well nearly everything. The only omission, and I have no doubt that you have already guessed what it is, Electronic Components, but who knows, one day that gap may be filled—just think what that would mean, while Mum buys the groceries, Dad can sneak off to buy his goodies.

The nearest thing I have seen to this, is a self service component store in Paris called Radio Prem. Even here, items that were very small and very expensive, had to be purchased at the counter, for obvious reasons.

Friendly CB

I am still stumbling on articles on CB Radio in the most unlikely places. The latest is in a publication called, *The Home and Freezer Digest* (July 1982). I must say it was most interesting, being mainly a series of letters from readers saying how CB had changed their lives.

There are now a large number of CB Clubs and one of their exercises is called a *Fox Hunt*, where one member with a mobile rig drives on ahead and the rest try and track him down by his broadcasts. It sounds to me like a lot of fun!

I would like to include a short quote from one of the letters which seems to me significant. "I do not know whether CB attracts good people, or whether becoming a 'Breaker' makes you into a very helpful person.

"Last night in a gale, two breaker friends in a particularly isolated spot came on channel; some tiles had blown off their roof—I know for a fact that a couple of other breakers are round there now fixing it for them." This seems to be a recurring theme in the use of CB and it is a nice thought in a naughty world.

Hypnotic Young

I must relate to you how Paul Young was brought down a peg or two. The other night I was speaking to a colleague on the phone when out of the blue he suddenly said "You write that page in EVERYDAY ELECTRONICS don't you?" "Well yes I do, do you like it?" "Yes I do, I always read it going home in the train, it sends me to sleep." Collapse of P.Y.

RADIO WORLD

By Pat Hawker, G3VA

Made in Britain?

The British government seems convinced that "new technology"—in particular electronics and "information technology"—holds the key to the restoration of the economy and to offsetting the effects of the decline of the traditional industries. Much though one would wish to endorse such sentiments there is relatively little evidence that our electronics industry is in any shape to take the lead. Indeed, it often seems that one of the industries most in need of a revival is consumer electronics.

For about a decade only a tiny minority of domestic and portable radio sets on sale in the UK have actually been designed and built here with British made components. Even though many sets are still marketed with British brand names local production is negligible.

But it is sad when long-established firms find themselves in difficulties. The Rank Organisation has announced that its high-quality loudspeaker "Wharfedale" factory at Bradford is to close.

A firm that under G. A. Briggs did so much to create a public demand for higher quality audio. Gilbert Briggs not only wrote a series of entertaining, widely read and pioneering books on high-fidelity but also took over the Festival Hall in London for a number of memorable lecture demonstrations.

Then again the family business of A. J. Balcombe has gone into voluntary liquidation. It was founded as long ago as 1917 by Alfred Balcombe (hence the brand name "Alba"). As a manufacturer of radio receivers it was never a large firm but it has managed to outlast larger rivals.

Who remembers?

It is now many years since Mr. E. K. Cole ran "Ekco" the firm that showed that a plastics cabinet could be made attractive by good design. Similarly Mr. Frank Murphy created the almost legendary series of Murphy radios in the 1930s remembered for their exceptionally well-designed wooden cabinets.

Even earlier Mr. Leslie McMichael, a founder member of the Wireless Society of London, was making broadcast receivers. Now McMichael, as a subsidiary of GEC, is back in the broadcast business—but at the capital equipment end making, for example, highly complex television digital standards converters.

Even 25 years ago there were still very many British firms in the radio and television business. Who now remembers the original R.G.D. de luxe models or such names as Etronic, Beethoven, Pilot, Romac, Masteradio, Defiant, Sobell, Ambassador and consumer models by English Electric, Cossor, Philco, Ever Ready . . . Many, many others came and went or were amalgamated into larger concerns or pulled out of the consumer side of electronics.

The Rising Sun

It must be admitted that the radio and television industry has always been highly competitive and not all the British products were anything special. Over the past two decades much business has been lost to the Far East not on account of "cheap labour" but because of more inspired marketing and manufacturing policies with emphasis on reliability, good production engineering and the building up of an overall brand image rather than concentrating on individual models.

With notable exceptions the bulk of British firms did not go out of their way to win the respect of their customers and, unfortunately, it was often those producing the best sets that were most cavalier in their attitudes. Nor, of course, were they helped in the post-war period by the ever changing "stop-go" credit restrictions.

Others were let down by the component firms who somehow never seemed to acquire the mass-production expertise of the Americans, let alone the Japanese. Quality-assurance and zero-defect production were often talked about—not always implemented.

Before we can hope to gain a "world lead" in new technologies we need to make sure that we can produce basic electronic equipment well. In this respect one must pay tribute to the Thorn group whose "TX" colour television chassis is well thought of not only by André Previn! On the other hand the attempts to marry British and Japanese techniques at Rank-Toshiba and GEC-Hitachi have not proved notably successful.

Repairs for the blind

More and more the standard transistor radio set is regarded virtually as a "disposable" item of "throw-away electronics". The High Street radio trade often shows little interest in undertaking repairs and these can often prove uneconomical both to the dealer and the owner.

Often what goes wrong is simple to put right, the cost is the time it takes to trace the fault. This makes it possible for those with plenty of spare time and the necessary skills to undertake a most valuable service on behalf of a group of people particularly dependent on radio—the blind.

For example, a former colleague, a highly professional IBA television transmitter engineer now retired, tells me that he has been keeping busy and happy by repairing radio sets on behalf of his local Association for the Blind, work that appears to be of little or no interest to local dealers. He has so far restored to good working order some 350 sets, sometimes using parts "cannibalised" from those that are beyond repair.

He finds that something like 10 per cent of the sets that pass through his hands can be restored to working order after simply resoldering connections on the printed circuit boards.

TV Across Frontiers

The problems that have still to be faced before there is genuine international television are highlighted by the efforts of the Dutch Minister of Culture to stop the distribution on the many Dutch cable systems of the pictures received from the Russian *Gorizont* satellite, on the grounds that the USSR has not granted permission to the Dutch cable companies to receive these programmes.

The companies have also been told they must ensure that their systems do not carry the programmes of the 100 or so "cable TV pirates". These firms have developed ways of inserting their programmes into the cable networks after the closedown of normal programmes, often showing tapes of X films and old movies from VCR machines and financed by advertisements from local shopkeepers.

For many years international committees have been earnestly discussing questions relating to "cultural or economic imperialism", the effects of "exposure to outside ideas and life-styles", the concept of "prior consent" and "participation", the protection of copyright and "intellectual property rights" and so on—but almost invariably they have been unable to come to any firm decisions.

In the UK it is not possible for a cable operator to distribute any programme channel without the permission of the Home Office. It is still all a very tangled web.

Walkabout TV

The success of walkabout audio is encouraging a revival of interest in the Dick Tracy concept of wristwatch TV. The Japanese firm of Seiko, well known for their digital watches, are planning to make a watch that also includes a 1·2in diagonal liquid-crystal video display.

The watch will have a thin flexible connection to a pocket unit which not only includes all the TV circuits but also a stereo VHF/FM radio and headphone socket. It is claimed the television display will be sufficiently clear as to permit the reading of graphics material and to see ball games.

In Japan the 525-line version will sell for under £200. So it will soon be walkabout TV.

ELECTRONIC HOBBIES FAIR

Alexandra Pavilion London November 18 – 21 1982

The biggest and best event ever to be staged for the electronic hobbies enthusiast!

Walk into a whole world of electronic equipment. – Everything from resistors, IC's to home computers, transmitting and receiving units, citizens band radio and peripheral equipment, video games, musical instruments, radio control models. . . . In fact whatever your particular electronic hobby you'll find this show will be the most interesting and informative way to discover all the latest developments in your particular field.

Other attractions will include radio and TV transmission, electric vehicles, radio controlled models, and demonstrations by local and national organisations.

This is the age of the train – British Rail are offering a cheap rate rail fare from all major stations in the country direct to Alexandra Palace – a bus will be waiting on your arrival to take you to the show. Ticket price also includes admission to the exhibition – so let the train take the strain to the Electronic Hobbies Fair.

Ticket prices at the door are £2 for adults, £1 for children but party rates are available for 20 people or more. To find out more, contact the Exhibition Manager, Electronic Hobbies Fair, IPC Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ. Tel: 01-643 8040.

Electronic Hobbies Fair is sponsored by Practical Electronics, Everday Electronics and Practical Wireless and is organised by IPC Exhibitions Ltd.

OPENING TIMES

Thursday	18 Nov.	– 10.00-18.00
Friday	19 Nov.	– 10.00-18.00
Saturday	20 Nov.	– 10.00-18.00
Sunday	21 Nov.	– 10.00-17.00

50p OFF

admission if you produce this coupon at the door of Electronic Hobbies Fair. Valid one per person only any day.

EE1

Everyday News

A STAR IS BORN

A new computer language from a new firm

HAVING been deeply involved in the development work for the now famous Sinclair ZX81 and Spectrum home computers, Richard Altwasser and Steven Vickers have joined the ranks of the new wave of entrepreneurs and formed a new British company called Jupiter Cantab to exploit their ideas in the computing field.

Their first offering to the home computer market is the Jupiter Ace. It features full-size moving keyboard, user-defined high resolution graphics and sound.

The Ace is set apart from other personal computers in that it uses a new high-speed programming language called FORTH. The claim for FORTH is that it is as equally easy for humans to understand as computers.

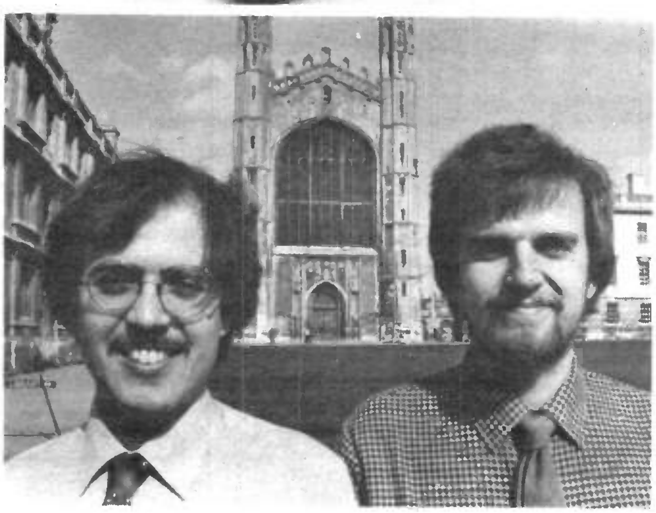
Richard and Stephen discovered FORTH at the same time and immediately recognised it as the ideal language for microcomputers.

They claim that FORTH is both fast and compact because it is compiled, yet its compiled code is accessible to the user in the simplest way imaginable. You give each compiled routine a name, a FORTH "word", and to run it you just type in the word.

By stringing old words together you can define new words. This process lies at the root of FORTH's power and enables the user, starting from the standard words provided in the firmware, to define an infinite variety of your own words.

The machine is available only by mail order for an all-inclusive price of £89·95 from Jupiter Cantab Ltd., Dept EE, 22 Foxhollow, Bar Hill, Cambridge CB3 8EP. For your money you receive the Ace home computer, mains adaptor, leads to connect to most cassette recorders and black and white or colour TV's, a software catalogue and an instruction manual.

We understand that a colour board to plug into the back of the machine is currently under final development.



Message from Busby

Is British Telecom unhappy at the Govenmment's intention at selling its 51 per cent holding and establishing a public limited company? This seems evident from some of the comments released by BT.

"This is, of course, a matter for Government and Parliament. The Board has not been consulted about this decision, but the Secretary of State has now promised the fullest consultation with the Board on the development and implementation of his proposals.

"Until detailed proposals have been made known, and there has been an opportunity to consider them, the Board cannot express any general view on the proposals. . . . The proposals clearly raise issues beyond the establishment of British Telecom as a public limited company and will have far reaching consequences for the whole of telecommunication in the UK.

"The Board is concerned that a regulatory regime should not unfairly fetter British Telecom or frustrate the commercial enterprise that BT has already shown in response to competition.

"The Board can say at this stage, however, that given the right conditions it would welcome freedom from what the Secretary of State has described as the web of Government control and interference."

Soft Centre

Britain's strength in software engineering was confirmed with the opening of a £7 million facility at Pinewood, Wokingham, by Hewlett-Packard.

It will be the company's world-wide development centre for office systems and Britain was chosen, said David Packard at the opening, because the country has the reputation for producing some of the world's finest software engineers.

Communications Crisis

"A massive effort to thwart any meaningful action," on the liberalisation of telecommunications, is the conclusion of a document, "The Report of the Communications Crisis Committee."

The document is a joint effort by a number of associations and companies in the communications industry who have invested money as a result of the Government's pledge of liberalisation in telecommunications.

In conclusion the report goes on to say: "Unless action is effectively taken immediately, the UK future in Information Technology and Telecommunications will be ruined and the very business and enterprise we need, will be killed off.—Action Now!

—ANALYSIS

INTELLIGENCE

The word "intelligence" signifies sagacity and understanding. It also means information gathered openly or, in a more sinister sense, secretly. Both definitions have come into neat conjunction through allegations that two famous Japanese companies have unlawfully conspired to discover trade secrets of IBM, which doubtless include progress on fifth generation computers embodying artificial intelligence—the thinking computer.

Thinking systems are not exactly new. In the pre-electronic age the centrifugal governor provided constant speed control of a steam engine under varying load by mechanical linkage feedback to the steam inlet valve. Fifty years ago the simple electrical thermostat in a closed loop system was maintaining temperature at a constant pre-set level. Both were primitive examples of built-in "intelligence".

What is new is the extra versatility afforded by cheap computing power. The *Temperature Interface For The TRS-80* described in the Aug-Sept '82 issues of EE is an example of how a basically simple sensing device can have its utility enhanced by a computer.

Just as the image of robots conjures up frightening visions of mechanical supremacy over man, so the idea of artificial intelligence implies an intellectual superiority equally disturbing. Computer programs have been developed which can challenge even Grand Masters at chess but the programs were developed by humans. So do we need to worry?

That we do worry is indicated by the introduction of "friendly" systems, the terminal which greets you with a "good morning" and is polite when pointing out you have made an input error. Another indication is that enhancement of today's docile obedient systems into possibly active thinking ones for specialised tasks, i.e. the addition of artificial intelligence, is now coming to be described as "expert systems", a less disturbing phrase. Such subtle changes are supposed to make us feel more comfortable in the presence of powerful machines.

Expert systems will be both powerful and friendly and will seem to have intelligence. They will do a lot more, faster, better, more conveniently and economically than at present. But, broken down into small subsystems, each will be found to be simple in principle and function and only cleverly interfaced (and by humans!) to make an "intelligent" whole. They will be a valuable aid in assisting human thought and action but need never dominate mankind.

Brian G. Peck

Courses . . .

Two short courses on ergonomics and computer systems, one for commercial organisations and one for the process industries, are being organised by HUSAT, at Loughborough University of Technology.

"Human Aspects of Computer Systems, designed for commercial organisations, will run from 19 to 24 September 1982 and "Human Aspects of Computer Systems in Process Control, will run from 17 to 22 October 1982.

Further details can be obtained from Rachel Shattock, HUSAT, Dept of Human Sciences University of Technology, The Elms, Elms Grove, Loughborough, Leics, LE11 1RG.

An evening course designed to prepare students for the Radio Amateur Examination in May/June 1983 is to be run by the Newcastle upon Tyne at the Gosforth Secondary School, Gosforth, commencing in September.

Held on Tuesdays of each week from 7pm to 9pm. Enquiries should be addressed to The Principal, Gosforth Adult Association, Gosforth Secondary School, Gosforth, Newcastle upon Tyne. Tel. N-u-T 668439.

Prism Microproducts of Islington, London, is shortly to begin selling the Sinclair ZX81, as a wholesaler, through High Street computer stores.

Sinclair Research have also announced that the ZX81 is to be available from Boots and Greens as well as the usual W. H. Smiths outlets.

The Southern Centre of the Royal Television Society, in conjunction with Southampton Technical College, are presenting a course of nine evening lectures during the autumn. The course is designed for the benefit of those interested in the engineering in television studios. Each session will be devoted to the theory and operation of a particular equipment or system.

The course commences on 19 October and applications should be made to: Mr C. Terry, Educational Television Unit, Southampton Technical College, St Mary Street, Southampton SO9 4WX.

Sinclair ZX81 breaks the £50 barrier for Personal Computers with the announcement that it is now reduced from £69·95 to £49·95 including VAT.

Arthur C. Clarke, the science fiction writer and scientific research worker, has won the Marconi International Fellowship Award for 1982.

OPPOSITION

The Post Office Engineering Union is opposing the connection of the private Mercury telephone system, now under construction, to the national networks.

School Computing

More than 2,500 primary schools are being assisted by a £9 million government grant to buy microcomputers. This is a new scheme following on that for secondary schools in which it is estimated that all 6,000 now have at least one microcomputer.

TELEPORT

A planned satellite communications centre, dubbed Teleport, on Staten Island, New York, will have 17 earth stations with access to 22 domestic satellites.

It will be linked to the World Trade Centre complex and other local business communities by fibre optic cable.

Reading Aid for the Disabled

An electronic reading aid incorporating the latest in fibre optics has been developed by engineers at Wormald International, a New Zealand company specialising in aids for the disabled.

The aid, called Viewscan, is portable and can be used by the partially sighted at work, school or in the home. It is designed to produce a magnified image of reading material when such material is scanned by a hand-held camera.

A miniature bulb illuminates the page via a high resolution fibre optic ribbon in the camera. The image is transmitted to a photo diode array and the signal from this is fed directly to two microprocessors in the display unit. A buffer memory then reassembles the information into moving lines of print.

The orange display screen, selected for maximum visibility, is a flat neon matrix panel and can be switched easily from a positive to a negative image. Magnification is achieved electronically and there are eight settings from X4 to X64.

PRESTEL

YOUR PHONE-IN TELETEXT

by Cyril Stringer
G3RSK

THERE are several visual data retrieval services available to the public in this country; the BBC provide CEEFAX whilst ITV provided ORACLE. Claimed to be the most advanced system in the world at the moment is PRESTEL. It was developed at the British Telecom Research Establishment at Martlesham in 1975 during experiments to produce the video phone.

Unlike CEEFAX and ORACLE, both of which provide a one-way information service only, PRESTEL utilises the national telephone line network to provide a two-way data communication service. It is also capable of storing vast amounts of information at regional computer centres with the ability to obtain additional or specialised data from other regional or national centres, if called upon to do so.

PRESTEL CAPABILITIES

The present PRESTEL system is restricted to that of an Information Provider, but there are several additional fields of service which may be provided to cater for future trends and markets. The five main fields are:

Information—The provision of topical/reference information, classified ads and shopping aids. Topical information can be sub-divided to cover such items as news, sports results, weather forecasts and timetables.

Each subject can be further subdivided; news can be local, national, international, business or financial. This kind of service also forms the basis of CEEFAX and ORACLE.

Message Communication—Information is stored and then forwarded by the computer to the called subscriber. Such transmissions are preceded by an audio tone announcement.

This aspect of the service bears a similarity to telex, the main difference being the ability to receive, store and release messages at random, thus easing telex congestion. It will play an important future role in the lives of deaf people who are unable to take advantage of the conventional telephone.

Education—PRESTEL can be deployed in three areas of education: As a conventional information service; courses and facilities available, entry qualification requirements.

A learning device to relieve the pressure on teachers and lecturers.

A method of self testing pupils and students. Their work is prepared, marked, and graded—all by computer.

Calculation Service—Since there are many cheap but sophisticated calculators on the market, the aim of the calculation service would be a compromise between such machines and the more complex programmable types often beyond the reach of the public.

The effectiveness of such a service lies in the fact that no specialised computer language is required.

Personal Information—In the case of personal information, use is made of the two-way communication facility where the user can *insert* data into the computer to be recalled collectively by action groups, committees, industries, or individuals with a commodity to sell or an idea to discuss, but where secrecy of information would not be a prime factor.

With such a vast amount of stored information its is essential that it can be recalled easily whilst being both accurate and constantly updated. This is achieved by a nationwide network of 26 GEC 4082 computers into which data is fed and stored from Government Departments, companies, and special information providers.

There are at least 150 contributors of data information, these include: Currys, Cosmos Air Travel, Data Stream International, The Economist, English Tourist Board, Greater London Council, National Computing Centre and Open University.

HOW THE SYSTEM WORKS

The standard arrangement of the PRESTEL system is shown in Fig. 1.

The "*Residential Terminal*" consists of a remote keypad connected through an adapted domestic television set to a standard telephone line which passes through the local Telephone Exchange and Access Unit, into the Viewdata Computer Centre. The telephone handset is only used for the initial call to the local computer centre, all other instructions are carried out by the keypad.

Instead of a keypad, the "Business Terminal" uses a full keyboard incorporated in the user's television equipment to facilitate full message transmission over the telephone line network.

The "*Information Provider Editing Terminal*" uses a full message and editing keyboard. This allows the information provider to amend and upgrade data being fed into the computer.

Also fed into the computer centre with the user terminals are Data Information Bases; these provide the source of all stored information, and are separated into two categories: The Public Base, provides business and residential information; and The Private Base, provides company information. Any user has full access to both sources.

A 12-button keypad is the minimum requirement for access to the computer with code designations 0 to 9, ★ (star) and #(square) normally laid out in the internationally agreed format for telephone keypads. Additional command buttons can be provided to meet specific requirements.

The domestic television receiver must also comply with British Telecom standards and incorporate a Barrier Isolation Unit which prevents high voltages inherent in television equipment from being presented to the telephone line, without inhibiting the transmission and reception of speech and data.

The Access Unit provides interface—a common connection—between the user terminal, telephone network, and computer.

At the Viewdata Computer Centre, which can be regional or national, information is released to the user at the rate of 1200 Bits/sec (120 characters per second) so that one page of information is presented within three or four seconds.

By comparison, the user-to-computer signalling rate is only 75 Bits/sec which is more than sufficient to cater for manual keypad commands.

Since it is not possible to send "logic" down a telephone line, the data is converted into two audio frequency tones which represent mark and space levels. At 1200 Bits/sec the mark tone is 1·3kHz and the space tone is 2·1kHz. At 75 Bits/sec the mark tone is 390Hz and the space tone 450Hz.

The tones are generated by oscillators in the transmit-end Modems (modulator/demodulator) and demodulated by an f.m. detector in the receive-end Modem where they are converted into digital information and subsequently into alphagraphics, the now familiar computer screen type characters which can be displayed in seven different colours.

USING PRESTEL

To make use of PRESTEL, the customer picks up his telephone and dials the local computer centre.

When connection is established the computer returns a 1·3kHz tone which switches the television receiver to the "Data Mode" and advises the computer by a return signal that it is ready to accept data. The telephone receiver is now left at the side of the cradle for the duration of the data transmission.

User identity is then requested by the computer; a 16-digit code number which can be entered by the keypad or returned automatically. On receipt of the code number the computer releases the first page of data. This is usually Page 0, the Master Index Page.

Page 0 offers headed options numbered 0 to 9. The user keys in the required option number relating to business, home or general interest. A further 10 options are presented and the caller continues to choose options until the desired page of data is obtained. This system is known as the Tree Type Selection Method and is shown in Fig. 2.

Before any page of data is released charges for the page are displayed, thus giving the user the opportunity to continue with a programme or cancel.

Five simple keyboard commands have been devised to make operation of the system as simple as possible:

1. ★0 # Return to the top of the tree.
2. ★# Recall the previous page.
3. ★00 Recall the current page.
4. ★N # Jump to a known page number eg. ★357#, thus bypassing the tree selection system.
5. ★★ Correct a miskeying error.

CHARGES

Charges for the service comprise of three components: the normal telephone charge for a local call to the computer centre; a time based charge for use of the computer/data base; and finally the information provider charge per selected page. The latter can range from one to 50 pence.

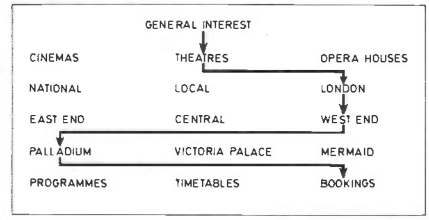


Fig. 2. Tree selection method

In addition, British Telecom charge a quarterly rental for the provision of a PRESTEL jack.

FUTURE POTENTIAL

Today there are over 10,000 PRESTEL customers but present costs restrict its widespread use outside the business sector. The service should, however, be within the reach of most people before 1990.

There are many technical problems to overcome, mostly concerned with matching internationally linked systems. Alphagraphics and foreign language characters must be standardised and modems compatible, but when this is achieved millions of pages of reference will be available worldwide.

There can be no doubt that PRESTEL has proved the enormous potential of the British telecommunications industry—a potential which can only reveal more exciting developments as we race towards the 21st century. ⌘

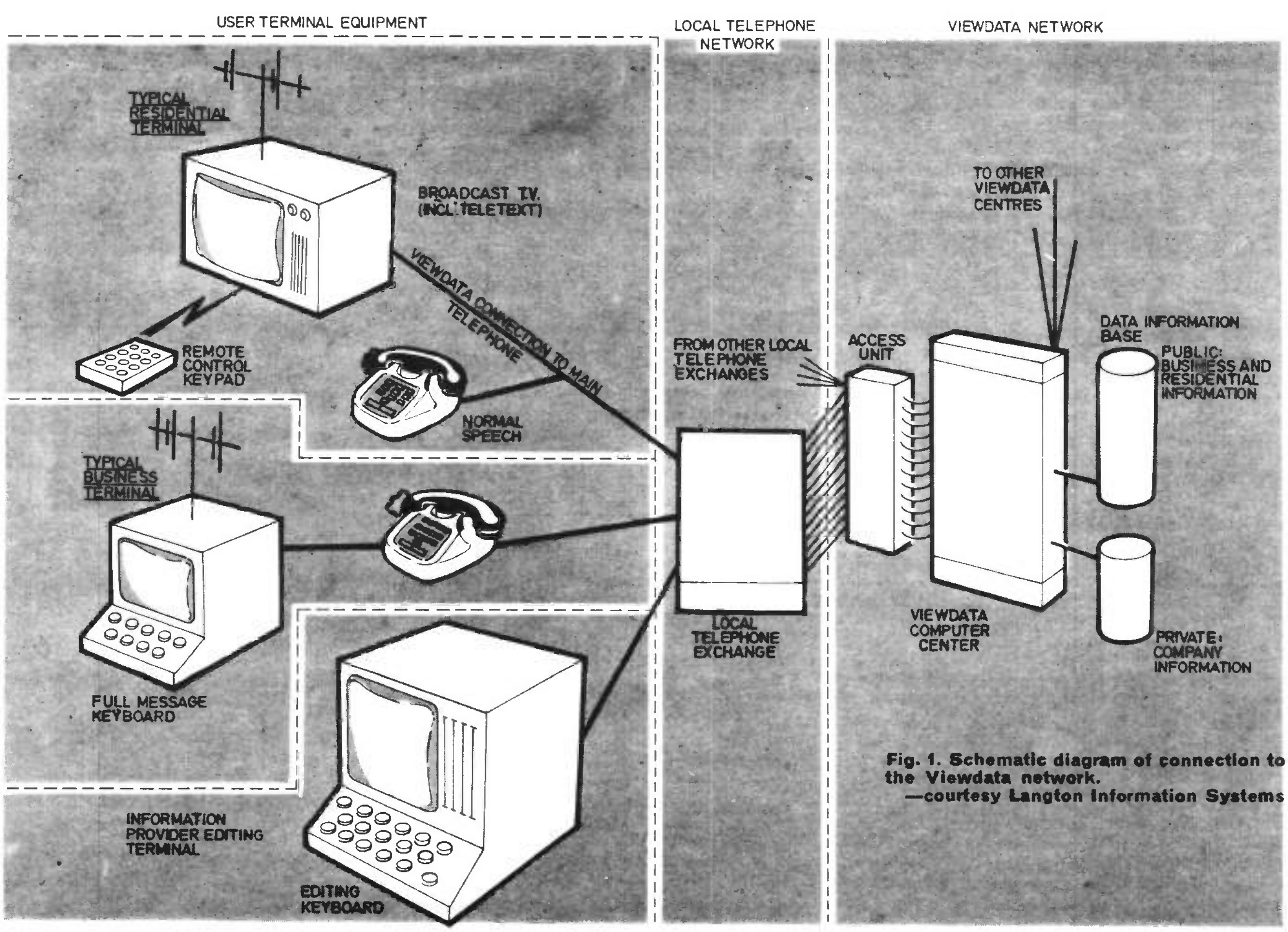
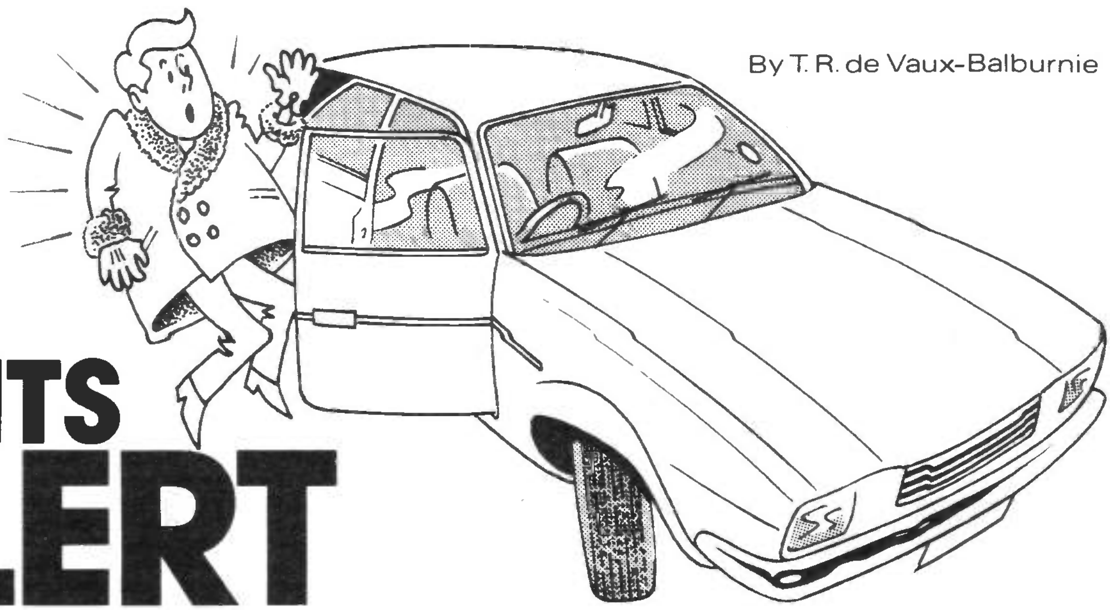


Fig. 1. Schematic diagram of connection to the Viewdata network.
—courtesy Langton Information Systems



CAR LIGHTS ALERT

By T. R. de Vaux-Balburnie

EVERY driver must have regretted leaving the car lights switched on unintentionally and returning to find the battery "flat". Although several circuits have been published to guard against such a mishap, this one has the advantages of simplicity and low cost.

With this system, a warning will sound if the lights remain switched on after a car front door is opened. Should the driver wish to leave the lights switched on for any reason, then the warning will be simply ignored since the sound will stop when he closes the door behind him.

This project is only suitable for negative-earth cars having a courtesy light operated by switches in the door pillars. Most cars in use today fall into this category. Should the courtesy light tend to flicker in operation, or fail to work at all, the switches should be checked and any faulty ones replaced before building commences.

CIRCUIT DESCRIPTION

The existing relevant car electrics, consisting of the courtesy light and door switches, is shown in Fig. 1 with the electronics to be installed.

The new part contains only two active components. These are a 555 timer i.e. IC1 and a transistor TR1. These, together with a few additional components, form a slow-running oscillator and the control to start and stop it. With the specified values of components the rate of oscillation is about 2 per second that is 2Hz. This is obtained at the output (pin 3) of IC1. The output is connected to a solid state buzzer whose tone is therefore pulsed about twice per second. This leads to a very distinctive sound which easily carries above other noises in the car.

The rate of bleeping will depend on component tolerances and on personal taste so a control, VR1, is included. This may be adjusted to give the desired effect.

A connection from the courtesy light switch is taken to the base of the transistor, TR1, via a current-limiting resistor, R4. With the doors closed, therefore, the base of TR1 will be connected to the positive terminal of the car battery via the courtesy light bulb. This holds TR1 "on" so pin 4 of IC1 will be approximately earth potential. This effectively inhibits its action. When a door is opened, the base of TR1 is "earthed" through the door pillar switch. TR1 switches off and pin 4 of IC1 rises to near full battery positive potential. The i.c. is enabled and oscillation commences.

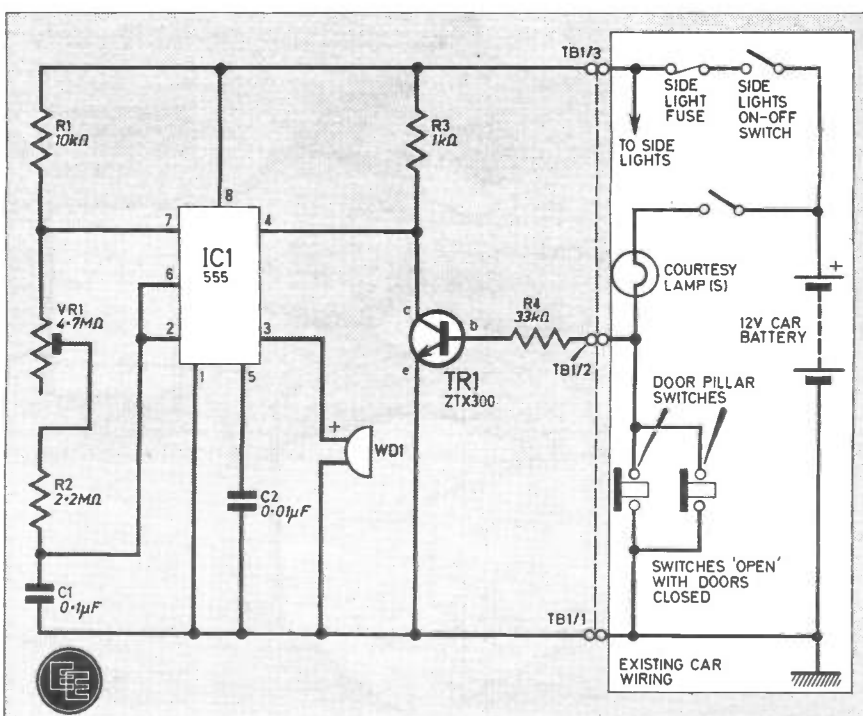
CIRCUIT BOARD

The circuit is built on a piece of 0·1 inch matrix stripboard 14 strips by 21 holes in size as can be seen in Fig. 2. Although the 8-pin d.i.l. socket should be soldered in position along with the other components, the i.c. should not be inserted until later. Particular care must be taken when soldering TR1 in position.

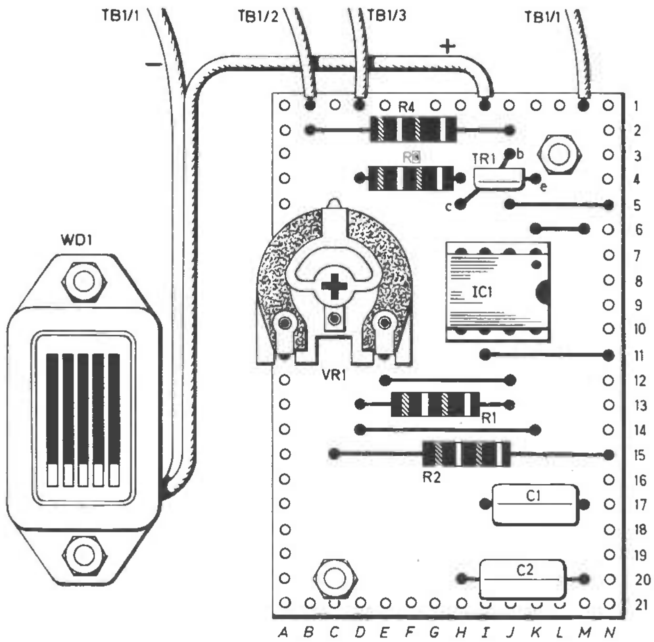
There are several inter-strip links to make and some of the copper tracks on the underside need to be cut. VR1 should be left set at about mid-position.

The red (positive) flying lead of the buzzer may be soldered to the circuit panel. This component will not work if connected the wrong way

Fig. 1. Circuit diagram for the Car Lights Alert. Only suitable for negative earth vehicles.



CAR LIGHTS ALERT



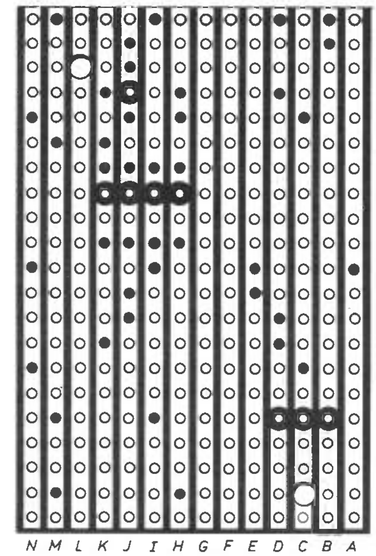
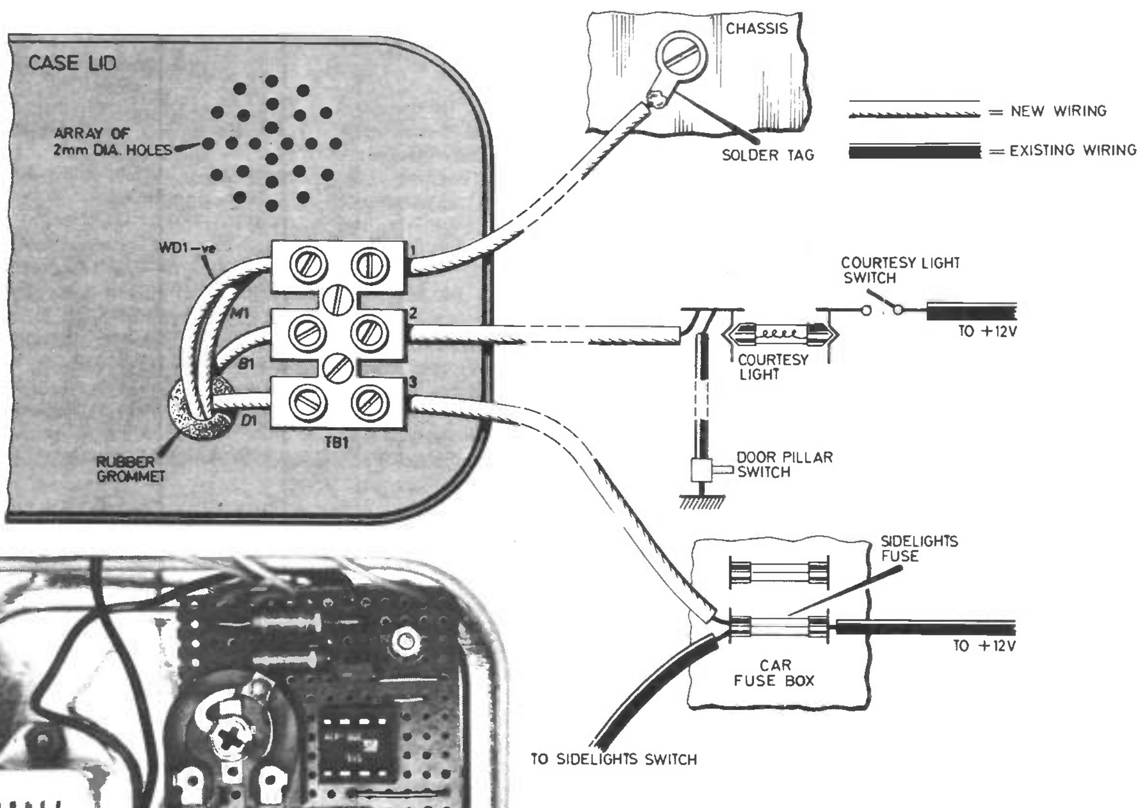


Fig. 2. Layout of components on the topside of the stripboard and details of breaks to be made in the copper tracks on the underside.



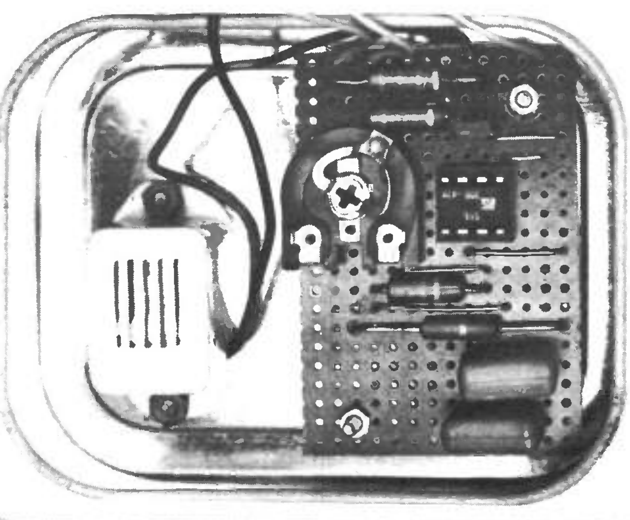
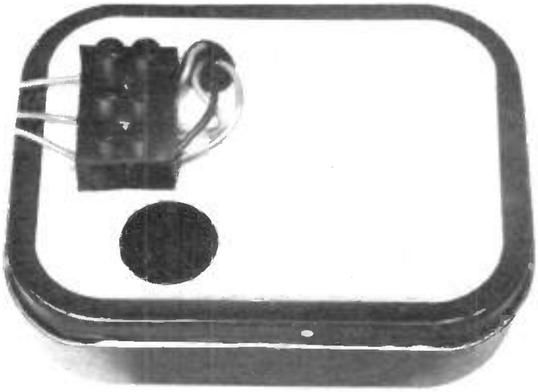


Fig. 3. Wiring from the unit terminal block (TB1) to the various points on the vehicle. Use light duty auto cable for all external wiring from the case.

The photograph on the left shows the circuit board and buzzer mounted in the case. The circuit board should be mounted on spacers to prevent track shorts to the base of the metal case.



The completed unit with a 3-way terminal strip fixed to the lid of the case.

round. A final check should be made to ensure that no connections have been missed and that no copper strips have been accidentally bridged with solder or swarf from the "cut" locations.

TESTING

The circuit may be tested using a 9 volt battery but, of course, the sound will not be as loud as when it is connected to the 12 volt car system. Referring to Fig. 2 make connections to strip *B* (Courtesy Light), strip *D* (Lighting Fuse) and strip *M* (Negative) on the circuit panel. Connect the black flying lead of the buzzer to the latter. Insert the i.c. making sure that it is the right way round (see the small dot on the body).

Lay the circuit panel on an insulating surface to ensure that the copper strips are isolated from one another. Now connect the lead from strip *D* to the positive terminal of the battery and the lead from strip *M* to the negative terminal. If all is well, the buzzer will start bleeping. Gentle adjustment of VR1 will alter its rate.

If the connection from strip *B* is touched onto the negative terminal of the battery the buzzer should continue to sound but when it is touched on the positive terminal it should stop.

BUILDING INTO THE CASE

A small plastic case is best for the project since there will be no problems with insulation. On the other hand, constructors may have metal boxes available such as tobacco or throat lozenge tins. The prototype was built into one of the latter. The circuit board was attached using 8BA nuts and bolts in the positions indicated. Short pieces of plastic wall plug (about 4mm long) or other spacers should be placed on the shanks of the bolts to hold the copper strips and connections well clear if a metal box is used.

In the prototype the buzzer was mounted inside the case. A corresponding hole was made in the lid to allow the sound through and a scrap of black material was stuck on the inside to prevent debris entering the box. Where less room is available, the buzzer may be mounted on top.

A three-way terminal block is mounted on the lid to accept the wires from strips *B D* and *M*, together with the negative connection of the buzzer (see Fig. 3). The wires must pass through a rubber grommet.

INSTALLING IN THE CAR

Some cars have a fuse, or fuses, to protect the lights—others do not. If the car in question is so fitted then locate one by checking that one or more sidelights go off when it is removed. A fuse protecting the rear number plate light would do just as well since this works in conjunction with the sidelights.

A fuse protecting the headlights will not do since the main and dipped beam filaments will be protected by individual fuses and the project would not work if the lights were left switched on in the opposite sense. In any case, it is usually desirable for the alarm to sound if sidelights only are left switched on.

To make a connection to the fuse, first make sure that the "lamp side" is selected so that the new circuit is protected as well. To confirm this, use a 12 volt bulb with one terminal earthed to a metal part of the car. Remove the fuse, switch on the sidelights and touch the other test lamp lead to each terminal of the fuse holder in turn. In one position the lamp will stay off. This is the correct terminal of the fuse to use. Switch off the lights and then make a proper connection using a spade connector. If all the available outlets have been used already, obtain a "piggy-back" connector from a motor accessory shop.

If the car does not have fuses for the lighting circuits then make a connection to any sidelight between the lighting switch and the lamp. Generally there will be a "bullet" type connector which may be used for this. The wiring diagram in the car handbook will help.

Do not run the wire straight back to the unit but include a line fuse (of the type used for car radios). This should be fitted with a low value fuse rated at about 3A.

Next, make a connection to the courtesy light circuit between the lamp and door pillar switch. Again, a bunch of bullet connectors may be found and the one responsible for the courtesy light determined by disconnecting them one at a time. Often it is easier to remove a switch from the door pillar and make a direct connection there.

COMPONENTS

See Shop Talk page 635

Resistors
R1 10kΩ
R2 2·2MΩ
R3 1kΩ
R4 33kΩ
All ¼W carbon ±5%

Capacitors
C1 0·1µF plastic or ceramic
C2 0·01µF plastic or ceramic

Semiconductors
TR1 ZTX300 *npn* silicon
IC1 555 timer i.c.

Miscellaneous
VR1 4·7MΩ miniature horizontal carbon preset
WD1 12V solid state buzzer
TB1 5A 3-way screw terminal strip

Stripboard: 0·1 inch matrix size 14 strips × 21 holes; rubber grommet; auto connectors; light duty auto cable; tinned copper wire; 2BA solder tag and self-tapping screw to suit; case, plastic (preferred) or metal size approx. 100 × 75 × 25mm; 8BA fixings: 10mm long screws (4 off); nuts (4 off); washers (4 off); 4mm spacers (2 off).

Guidance only Approx. cost £3.30 excluding case

Run the two wires to the terminal block on the unit. These wires should be of proper light duty auto-type. Do not use single solid core wire as this will fail in service. If the wires must pass through metal then a rubber grommet should be used.

Finally make the earth connection to the unit. Perhaps there is an existing point nearby. If not, drill a small hole in a metal part and make the connection using a solder tag secured with a self-tapping screw.

FINAL CHECK

Before hiding the project under the dashboard, give it a final test. Switch the lights on and open either front door. The buzzer should bleep. Check with the engine running also.

Note that the buzzer will begin to sound immediately if the courtesy light bulb fails. It will also operate if the side-lights are on and the courtesy light is switched on manually. If this proves to be a nuisance then an on-off switch may be included in the run of wire to the lighting fuse to inhibit the circuit on these occasions.

If the lights are left on intentionally, then the buzzer will stop sounding when the car door is closed but, of course, it will sound when the user returns to the car and opens the door.

This simple project will help you to keep a charged battery and prevent frayed nerves. ⌑

SIMPLE SHORT WAVE RADIO

BY A. SPROXTON

THE interest in the simple short wave receiver never abates and here is a neat and effective receiver using two transistors. There is no great difficulty in constructing it, but the parts need careful positioning if it is to fit together, so keep closely to the measurements and other details as given in the diagrams.

The receiver tunes approximately 10·8MHz to 30MHz and is capable of long distance reception when used with a reasonably effective aerial. This could be 20ft to 30ft of wire out-of-doors, high and clear of buildings if possible. An earth is not essential but is beneficial.

CIRCUIT DESCRIPTION

The circuit diagram for the Simple Short Wave Radio is shown in Fig.1.

Signals picked up by the aerial are fed via preset trimmer C1 to the aerial coil L1. This is tuned by variable capacitor C3 to the desired frequency, and this signal is then applied to the gate of the field effect transistor TR1. Demodulation of the signal takes place in TR1 and the resultant audio signal is passed on to the second transistor TR2 which acts as an audio amplifier. The signal at the collector of TR2 is at a sufficient level to operate a set of headphones; these are connected via jack socket SK2

VR2 is a preset gain control which controls the level of input applied to the base of TR2.

A low value variable capacitor C4 connected in parallel with C3 provides a fine tuning control.

In the drain circuit of TR1 is a second coil L2. This is wound on the same former as L1 and is thus inductively coupled to L1. Some of the radio frequency (r.f.) signal amplified by TR1 is fed back inductively into L1, so reinforcing the original signal and increasing the sensitivity of this stage. The amount of r.f. signal fed back is determined by the setting of the potentiometer VR1 which is usually referred to as the reaction control. The effectiveness of this type of receiver circuit depends very largely on the careful use of this reaction control.

The receiver is powered from a 9V layer dry battery. The battery is automatically connected whenever the headphones plug is inserted into jack socket SK2 (the switch S1 is an integral part of SK2).

CONSTRUCTION starts here

CIRCUIT BOARD

Start with the circuit board. This is a piece of perforated s.r.b.p. board and can be either 0·1 or 0·15in matrix but the overall size must not exceed $2\frac{5}{8}$in × $1\frac{3}{4}$in.

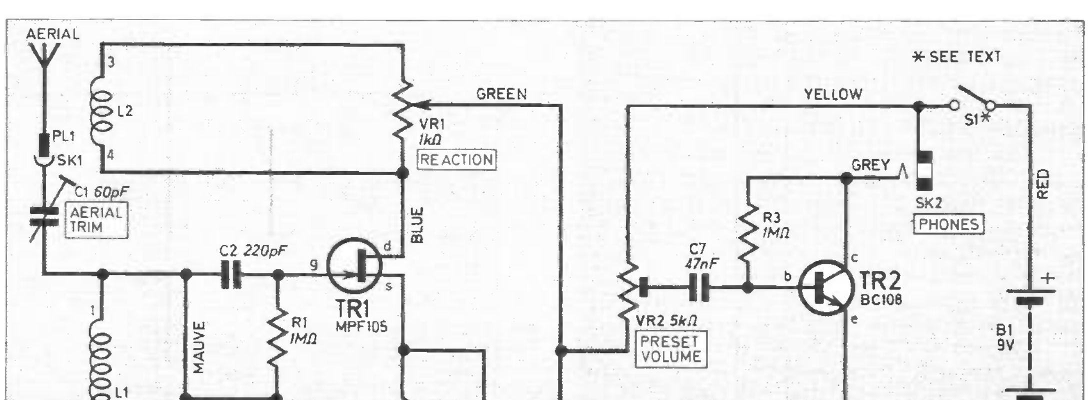


Fig. 1. Circuit diagram of the Simple Short Wave Radio. The first transistor TR1 is the detector, and TR2 is the audio amplifier. Positive feedback (or reaction) is applied to the aerial input via L2.

COMPONENTS

Resistors
R1 1MΩ
R2 2·7kΩ
R3 1MΩ
All ¼W carbon ±10%

See **Shop Talk** page 635

Potentiometers
VR1 1 kΩ, linear
VR2 5kΩ horizontal skeleton

Capacitors
C1 60pF (max) preset trimmer
C2 220pF silver mica or polyester
C3 140pF variable (Jackson 87/073)
C4 10pF variable (Jackson C804)
C5 0·01μF polyester
C6 0·001μF polyester
C7 0·047μF polyester

Semiconductors
TR1 MPF105 f.e.t.
TR2 BC108 *npn* transistor

Miscellaneous
B1 9V PP3 battery
L1,L2 Aerial and reaction coils (Wearite PA3)
S1 part of SK2
SK1 Aerial socket (2mm)
SK2 jack socket 3·5mm with switch

Pair of PP3 battery connectors. Perforated s.r.b.p. board (0·1 or 0·15in matrix) 2⅝ × 1¾in maximum. Six double-ended solder pins. Bracket (R8). Plastics case 5⅞ × 2 15/16 × 1⅞in. Three knobs; two 6BA × ½in round head screws. One 6BA × ¼in round head screw. Four 6BA nuts; two 6BA solder tags. One 4BA × ½in round head screw. Two 4BA nuts; two 4BA washers; one 8BA nut. Four lengths of coloured flexible wire (1 foot).

Approx. cost Guidance only £12.50

When you have cut the board to size, study Fig. 2. Position VR2 approximately as shown and drill a ¼in hole where the centre point is. Remove VR2 and place the board in the case as shown in Fig. 3. Mark where the hole at the centre of VR2 is on the case, and drill a ¼in hole in the case at this point. (VR2 controls the volume but as it will be at maximum most of the time, it can be adjusted by a small screwdriver externally, this is why the holes are required).

Replace VR2 on the board and fit all the components as shown in Fig. 2a. Insert the six double-ended pins (three for each transistor) in the positions shown. Wire up on the underside of the board as shown in Fig. 2b.

You should have six wires coming from the board including the earth wire. A glance at Fig. 3 will give you an idea how long they will need to be.

SIMPLE SHORT WAVE RADIO

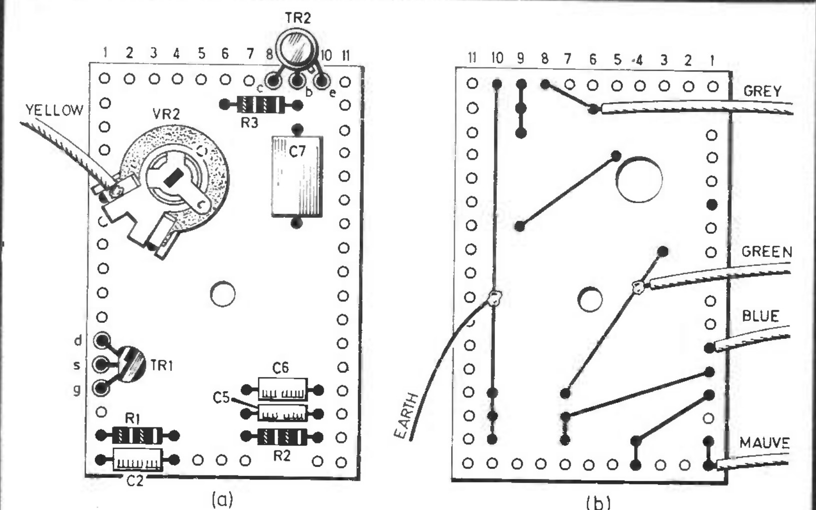


Fig. 2. Circuit board. (a) top view with components in place (b) underside view showing wire links and "flying leads".

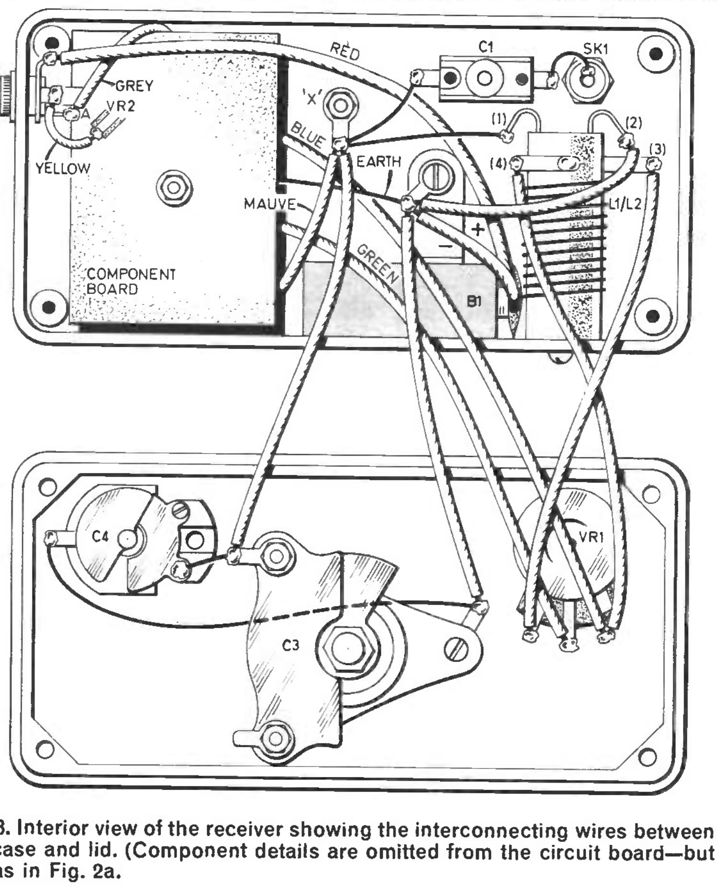
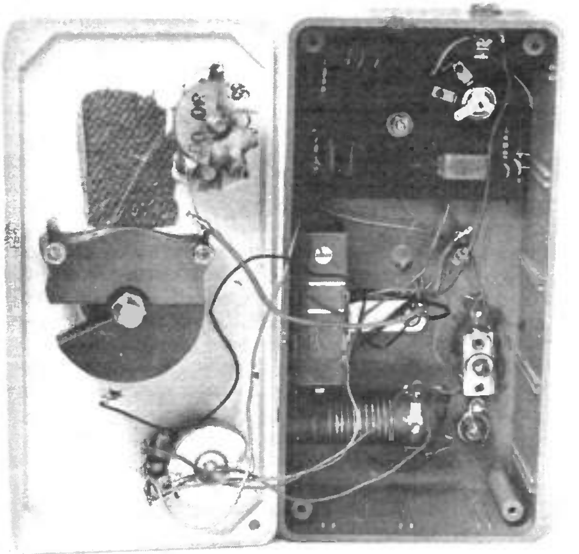


Fig. 3. Interior view of the receiver showing the interconnecting wires between the case and lid. (Component details are omitted from the circuit board—but are as in Fig. 2a.



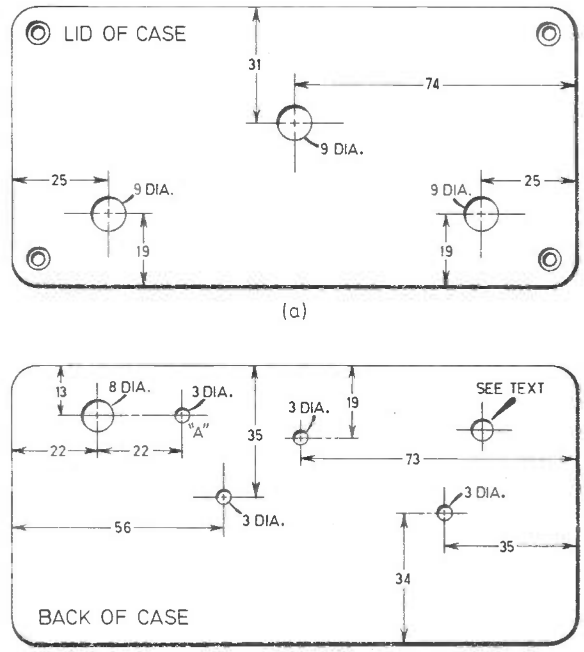
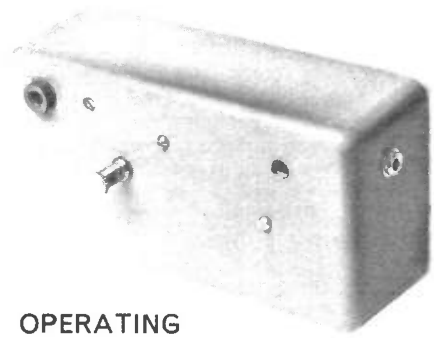


Fig. 4. (Above, right) Case drilling details (a) lid of case (b) back of case.

Photo (Above) The completed Simple Short Wave Radio with case lid "opened" (Right) general exterior view of the Radio.



It might help you to use a different colour for each wire, as shown in the illustrations. (These colours are also marked on the circuit diagram to assist identification.)

PREPARING THE CASE

Place the board in the case and drill a small hole near the centre, through the board and the case. Fix it to the case with a 6BA×$\frac{1}{4}$in nut and bolt.

Drill the holes in the back of the case as shown in Fig. 4b but concerning the screw used to fix the bracket, it might be safer to place the PP3 battery in the case, put the bracket against it and then mark the hole (the purpose of the bracket is to keep the PP3 in position). This hole should be big enough for a 4BA×$\frac{1}{2}$in screw and this is fitted with an extra nut and washer at the back allowing it to double as an earthing point.

HINTS AND TIPS

Most of the holes required can be made with a small hand drill. With care the bigger holes can be made with a soldering iron. Enlarge the hole gradually cutting away the surplus with a sharp knife, finish off with a round file.

Position the coil as shown, but near the back of the case. Mark the position for the coil fixing screw on the side of the case. Drill hole and secure coil with 6BA screw. Solder lengths of wire on the four coil tags; two of these can be fairly short but the other two have to reach to VR1 on the front panel.

AERIAL TRIMMER

As you will wish to adjust the aerial trimmer C1 externally this component requires a simple modification. Remove the adjusting screw and insert from the other end. Screw it up tight and on the end put on an 8BA nut and turn until the end of the screw is just showing. SOLDER NUT ON TO SCREW. Bend the tags out straight until they are in line with the body.

Now place C1 in the case so that the screw head is in the centre of hole marked "A" Fig. 4b. Fix C1 to the case with Araldite, putting a small quantity at either end and being careful it doesn't touch any moving parts.

The 6BA screw nut and solder tag at point "X" (Fig. 3a) is only there as a convenient place for the four connections shown.

A 3·5mm jack socket SK2 is fixed in the side of the case (the position is not very critical). This jack socket functions both for connecting the headphones and as an on/off switch. (The jack socket may need a slight adjustment, if the extra contact is a "break contact" instead of "make contact". Take a small pair of pliers and gently bend out the bottom contact until the spring flies clear, then bend it in again and adjust, until it only touches with the jack plug in position).

Drill the holes in the lid of the case with three $\frac{3}{8}$in holes to take C3, C4 and VR1 according to Fig. 4a. It should be possible to complete the wiring by reference to Fig. 2 and Fig. 3.

OPERATING

Connect up the PP3 battery. Turn VR2 to the position for maximum volume. Connect the aerial and earth and insert the jack plug of the headphones. Turn VR1 clockwise until a slight "plop" is heard. If you hear nothing, try turning VR1 fully anticlockwise. If you get the noise in this position, just reverse the two outer connections on VR1.

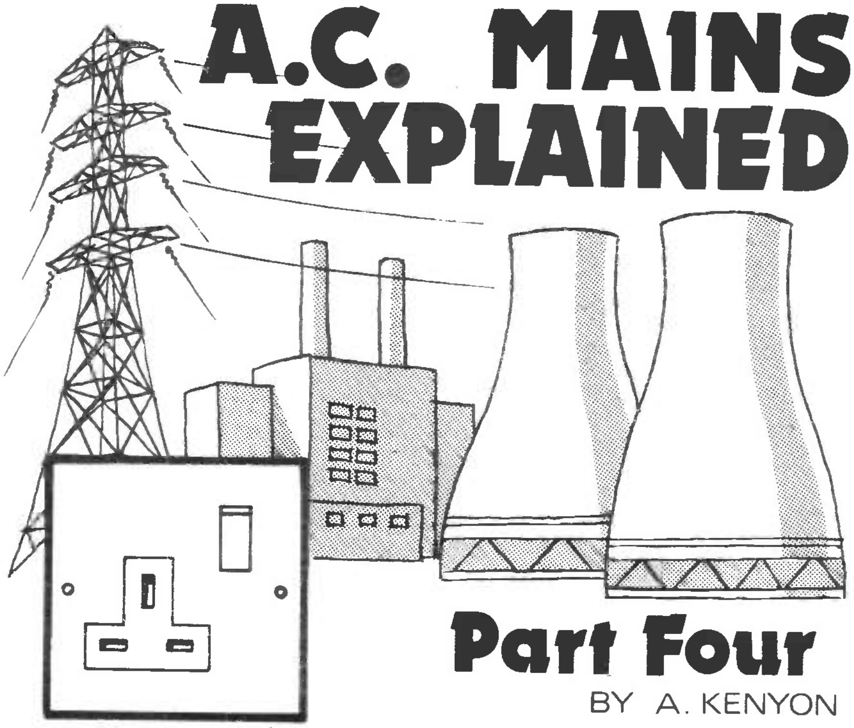
If you hear nothing either way, try putting the lead from the TR1 on the other end of VR1.

Turn VR1 until the plopping sound is just heard, and then try tuning with the main tuning capacitor C3. At some point you should get a series of whistles. Carry on tuning using the bandspread capacitor C4 and at the same time gradually reducing the amount of reaction by turning VR1 anticlockwise, you should then hear a station. Take a small screwdriver and adjust C1 for the best results.

Quite exceptional results can be obtained with this receiver, but they are dependent on the critical use of VR1 and careful tuning.

Don't forget to unplug your headphones after you have finished otherwise you will quickly run down your battery!! ⌑

A.C. MAINS EXPLAINED



Part Four

BY A. KENYON

It has been shown that the power in a single phase circuit is equal to the voltage × current × power factor. However, except for ring mains and lighting circuits, most industrial equipment, such as motors and heating batteries, is supplied from a three phase supply having no neutral.

This type of equipment, termed **balanced three phase loads,** can be connected in one of two ways, known as **star** and **delta** formation.

POWER IN THREE PHASE

To consider power in a three phase system, the heater battery will be examined, as these have purely resistive elements and therefore a power factor of one, thus keeping the calculations simple.

Fig. 4.1. Three-phase 15kW balanced load heater battery connected in star formation.

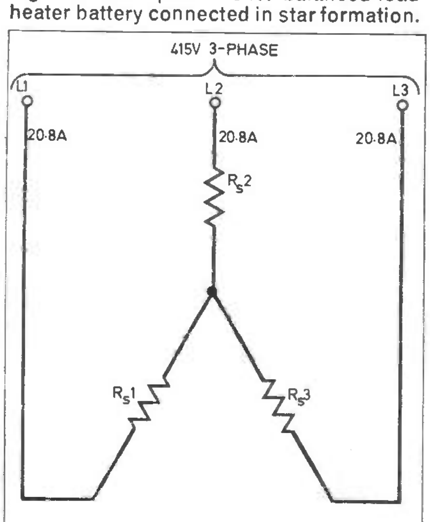
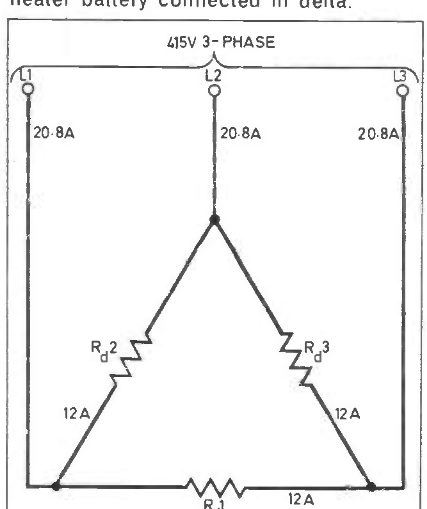


Fig. 4.1 shows a 15kW balanced load heater battery connected in star formation across a 415V, three phase supply and Fig. 4.2 shows the 15kW balanced load heater battery connected across the same supply but in delta formation. Note that neither system has a neutral wire and the reason for this is that in any four wire balanced load system (independent of power factor), no current flows in the neutral conductor therefore the fourth (neutral) wire serves no useful purpose.

In the case of the star formation, the star point is at the same potential as the neutral, so all calculations can be made with the assumption that the star point is virtually the neutral.

So, a balanced three phase load, in star or delta formation, requires only three wires from the three power lines, L1, L2 and L3.

Fig. 4.2. Three-phase 15kW balanced load heater battery connected in delta.



Since the load is balanced, the three line currents supplying either the star or the delta system will be equal. Similarly, when the star and delta balanced loads both have the same power rating, the line currents will be the same for each.

STAR CONNECTION

For the 15kW balanced load, each phase is rated at 5kW. Therefore line current = 5,000W ÷ 240V = 20·8A for each phase. The total input to the system is then 3 × 240V × 20·8A = 15,000VA but since the power factor = 1 (purely resistive system), the input power is also equal to 15,000W.

In part one of this series it was stated that the line voltage = $\sqrt{3}$ × the phase to neutral voltage (star point in this case) = 1·73 × 240V = 415V.

So power = 1·73 × line voltage × line current × power factor = 1·73 × 415V × 20·8A × 1 = 15kW.

DELTA CONNECTION

As the load is also the 15kW balanced load, the line current will still be 20·8A, but in this case each heater element is connected across 415V (2 phases) so the current in each branch is 5,000W ÷ 415V = 12A. This is equal to the line current ÷ $\sqrt{3}$ = 20·8A ÷ 1·73 = 12A.

Input to the system therefore = 3 × 415V × 20·8A/1·73 = 15,000VA but again power factor = 1, so power = 15kW.

Once again, **power = 1·73 × line voltage × line current × power factor.** This is true of any balanced load, three-phase system.

A.C. MOTORS

Although a.c. motors vary in shape and size, the most common types can be divided into two classes. **Universal** commutator motors as used on single phase portable appliances such as domestic vacuum cleaners and hedge cutters and on industrial drills, grinders and polishers, or **Induction** motors, either single or three phase, used to drive commercial and industrial machinery.

Whatever the type of motor, whether a.c. or d.c., the principle of producing a rotating drive is the same, namely, that if an electrical conductor carrying a current is placed in a magnetic field, it is acted upon by a force which pushes it in one direction or the other depending upon the direction of flow of the current, or the direction of the magnetic field. If either the current ceases to flow, or there is no magnetic field, the force acting on the conductor disappears. See Fig. 4.3.

Fig. 4.4 shows the two conductors wound in a loop (or turn) around an

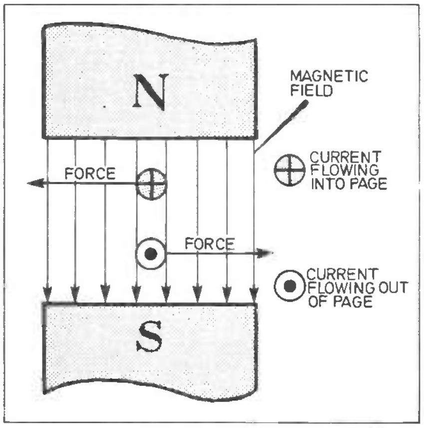


Fig. 4.3. The effect of placing a current carrying conductor in a magnetic field.

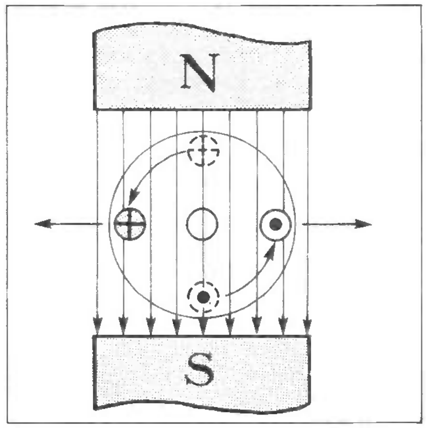


Fig. 4.4. The effect of winding the conductors onto a cylindrical former.

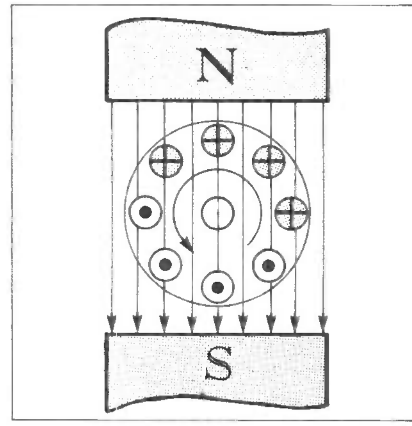


Fig. 4.5. The effect of adding turns and reversing the current every half revolution.

iron cylinder (imagine the rear ends away from you joined together). The top conductor moves to the left and the bottom one moves to the right until they reach a horizontal position where they remain at rest pulling away from each other, or if the current is reversed, pushing towards each other.

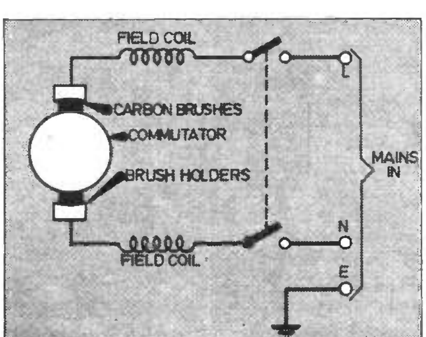
If, however, a number of loops are wound on the cylinder, spaced at regular intervals as shown in Fig. 4.5, and the current through each loop is reversed when it reaches the horizontal position, the cylinder will keep rotating. The component which changes the direction of flow of the current in the conductors at the horizontal position is called a **Commutator**.

Universal motors either a.c. or d.c., have the field coils (which create the magnetic field) connected in **series** with the commutator supplying the **armature** (the iron cylinder having the loops or turns of wire wound onto it). This ensures that the magnetic field and current in the armature conductors are always present at the same time. See Fig. 4.6.

A.C. INDUCTION MOTORS

For simplicity of explanation, the principles of the working of a 2 pole, 3-phase induction motor will be considered. The term **Stator** refers to the stationary part of the motor which is bolted to a solid concrete bed or screwed down to the bench. The term **rotor** refers to the inner part of the motor to which is attached the driving shaft and is inductively turned as explained. See Fig. 4.7 for construction of induction motor.

Fig. 4.6. Schematic diagram of a universal motor with series wound field coils. These field coils generate the magnetic field.



In Part One of this series, it was shown how a three phase supply is generated by three conductors separated by 120 degrees rotating in a magnetic field. A little imagination will show that the same result can be achieved by keeping the conductors stationary and rotating the magnetic field at 3,000 r.p.m. (As a matter of fact, this is how modern alternators operate.)

If the three voltages from the alternator are connected to three coils on a motor stator, each coil being displaced 120 degrees from the other, the coils will produce in the stator, a rotating magnetic field which rotates at the same speed as that in the alternator which is producing the voltage. This principle is known to electronics engineers in the form of the magslip transmitter and receiver, (that is, if the transmitter continues to rotate, the receiver follows it and rotates at the same speed).

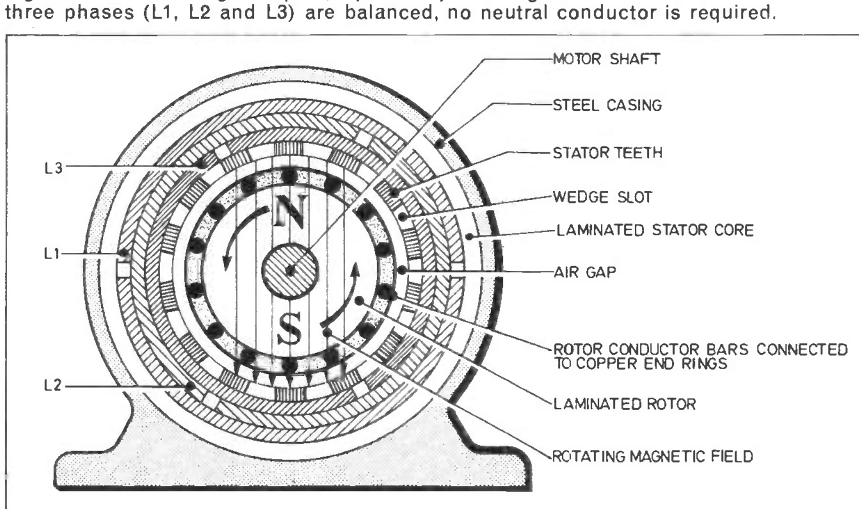
HOW DOES THE ROTOR TURN?

To see how the rotor turns, consider Fig. 4.8. Imagine the motor bolted to a bench with the three phase supply to the stator switched off. The rotor will be stationary as will the shaft and the two particular rotor conducting bars *A* and *B*. Now the supply is switched on. Immediately a stator magnetic field is produced which is rotating at 3,000 r.p.m. and when a magnetic field cuts across a conductor, a voltage is produced in the conductor. Also, if the direction of motion of the magnetic field is reversed, the polarity of the induced voltage is reversed.

The rotating magnetic field is cutting conductor *A* from right to left and conductor *B* from left to right therefore if *A* is positive at the front end, *B* is negative at the front end, but since the two conductors are connected to copper end rings, a current will flow away from us in *A* and towards us in *B*. Here, therefore are the conditions required for rotation, namely, current flowing in a conductor when under the influence of a magnetic field.

Conductor *A* will move to the left

Fig. 4.7. Section through a 2-pole, 3-phase squirrel cage induction motor. Note that as all three phases (L1, L2 and L3) are balanced, no neutral conductor is required.



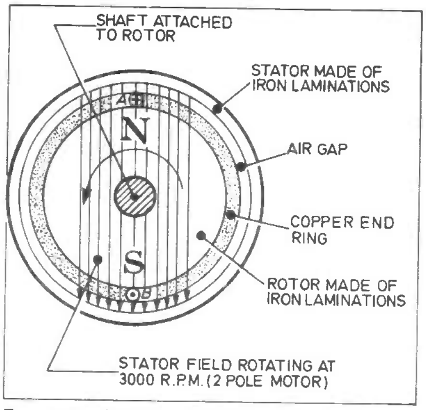


Fig. 4.8. Section through the motor in Fig. 4.7 to illustrate how the rotor turns.

and conductor *B* to the right. However, because the field itself is now rotating, the conductors will follow the field, gradually slipping behind it until the field has left *A* and *B*, but because other conductors are spaced around the rotor, they will take over the force of rotation and the whole rotor will continue to be motivated. The rotor can never reach the speed of the rotating field (known as **synchronous speed**) otherwise the field would not cut the rotor conductors to produce the current necessary to ensure rotation.

In practice, the rotor speed is usually about 95 per cent of the speed of rotation of the stator field, hence a two pole motor runs approximately 95 per cent × 3,000 = 2,850 r.p.m. the difference in speed being called the **slip** of the rotor.

It will be seen that on start up, the rate of the field cutting the conductors is maximum, gradually decreasing until full speed is attained. Hence the starting current is much higher than the running current, usually about four times greater.

STARTING OF INDUCTION MOTORS

Small induction motors up to about 10 horsepower are usually started **direct on Line** (D.O.L.) where a starting current of up to 70 amperes is the maximum that the supply authority will permit. Machines started D.O.L. are capable of starting at full load.

Motors over 10 h.p. are usually started **star/delta** which means that their separate three phase coils are first connected in star formation and then switched to delta. This simply means that the motor is started at one third of its rated horsepower which reduces the starting current accordingly. Subsequently the horsepower at starting is reduced to one third, so the load on the motor has also to be reduced when starting, returning to full load when in the delta position.

Unfortunately a time interval occurs when the motor is disconnected from the mains supply while the changeover from star to delta takes place which again increases the starting current due to the fall back in speed.

A method of starting three phase induction motors which is becoming more popular is known as **part wind.** The stators of these machines are wound with two parallel windings which are connected one after the other. Although such machines still require 50 per cent off-loading at start, the fact that there is no time break as the windings are parallelled ensures a smooth acceleration to full speed. ⌑

PART 3 ANSWERS

3.1 True power = $V \times I \times \cos\phi$ = $240 \times 15 \times 0{\cdot}8$ = 2,880W therefore 2·88 units consumed per hour.

3.2 In-phase current = $I \times \cos\phi$ = $15 \times 0{\cdot}8$ = 12A.
Wattless current = $\sqrt{15^2 - 12^2} = \sqrt{225 - 144} = \sqrt{81}$ = 9A.

BOOKS in BRIEF

Servicing Home Video Cassette Recorders by Martin Hobbs. (Haydon—distributed by John Wiley and Sons Ltd) Limp £9·85. Deals with the circuitry and mechanical features of typical recorders with Beta and VHS formats and designed to handle NTSC standard signals. An American publication aimed at the US market. A store of practical information for those involved in maintaining these machines.

Essential Electronics an A to Z guide by George Loveday. (Pitman) Limp £5·95. A comprehensive reference *cum* text book, subjects appear in alphabetical order. Good for rapid access to vital facts. Thorough treatment with worked out examples.

How to Identify Unmarked ICs by K. H. Recorr (Bernard Babani Ltd.) Limp £0·65. Not a book but chart giving step-by-step instructions for identifying logic i.c.s. of unknown origin using a simple multimeter. Useful only for TTL and the earlier RTL and DTL logic families.

Multi-Circuit Board Projects by R. A. Penfold (Bernard Babani) Limp £1·95. 21 simple projects that can all be constructed on the same printed circuit board. For further simplicity (and economy) all circuits use components from the same basic list of just over 20 items, meaning the constructor can re-use them to make all the projects.

Popular Electronic Circuits Book 2 by R. A. Penfold (Bernard Babani Ltd) Limp £2·25. Another collection of over 70 designs from this well-known author covering the usual range of audio, radio, test-gear, home and car circuits. No constructional details given, just the circuit and a brief description but nothing too difficult for those with some experience.

International Diode Equivalents Guide by Adrian Michaels (Bernard Babani Ltd) Limp £2·25. As one would expect from an equivalents book, this one lists American, European and in some cases, Japanese equivalents of semiconductor diodes. Covers other diode derived devices, including thyristors, Zeners, l.e.d.s etc, but does not include any electrical or operating parameters for the semiconductors listed. Of more use to service technician and designer than the hobbyist.

The 6809 Companion by M. James (Bernard Babani Ltd) Limp £1·95. Written for the "average assembly language programmer" so if you don't fall into this category then this book may be a little difficult to follow. The 6809 is a sophisticated 8-bit microprocessor from the Motorola 6800 family and Mr James' companion is largely a software manual dedicated exclusively to it. Not for the beginner.

Introduction to 6800/6802 Microprocessor Systems by R. J. Simpson and T. J. Terrell (Newnes-Butterworth Limp £6·95. The 6800 and 6802 constitute Motorola's early contribution to the microprocessor revolution, both being powerful 8-bit devices and this book is intended for students, technicians and engineers who wish to acquire an understanding of this processor family. It is a comprehensive introduction covering digital concepts, system hardware, programming and finally, hands-on investigation using a dedicated evaluation system. The text is really written as a course tutor for those with access to such an evaluation system, but could still benefit those without.

26 Basic Programs For Your Micro by Derrick Daines (Newnes-Butterworth) Limp £4·95. A batch of new games programs, only two of which have been published before, written for the personal computer and requiring a maximum of 13K of memory. They are all written in an easy sub-set of Basic so the reader should have little difficulty in translating them to suit any micro, for example into Sinclair Basic. Each game has a descriptive introduction, a program listing and a sample run plus a few notes to bring points of interest to the attention of the reader.

IC Projects For Beginners by F. G. Rayer (Bernard Babani Ltd) limp £1·95. Usual format for a book of this type, with circuit diagrams, stripboard layouts and wiring diagrams for a number of relatively simple projects all using inexpensive and easily obtainable integrated circuits. Subjects include radio, audio, power supplies, timers and oscillators and brief descriptions of the i.c.s. used are also given.

The Art Of Programming The 1K ZX81 by M. James and S. M. Gee (Bernard Babani Ltd) limp £1·95. Having read the manual supplied with the Sinclair to acquire a grounding in Basic, this book makes a good next step for the programmer who wants to make the most of the 1K on-board memory. A descriptive text that uses programs to illustrate features including chapters on randomness, graphics, peeking and poking and finally some useful hints on memory saving. Some interesting games also featured.

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"Take IC No.1 and plug it into hole numbers E35 to E42 and F35 to F42, (pin 1 on the IC goes into F35)"
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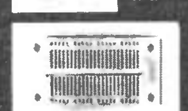

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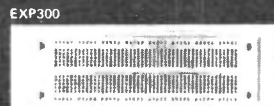

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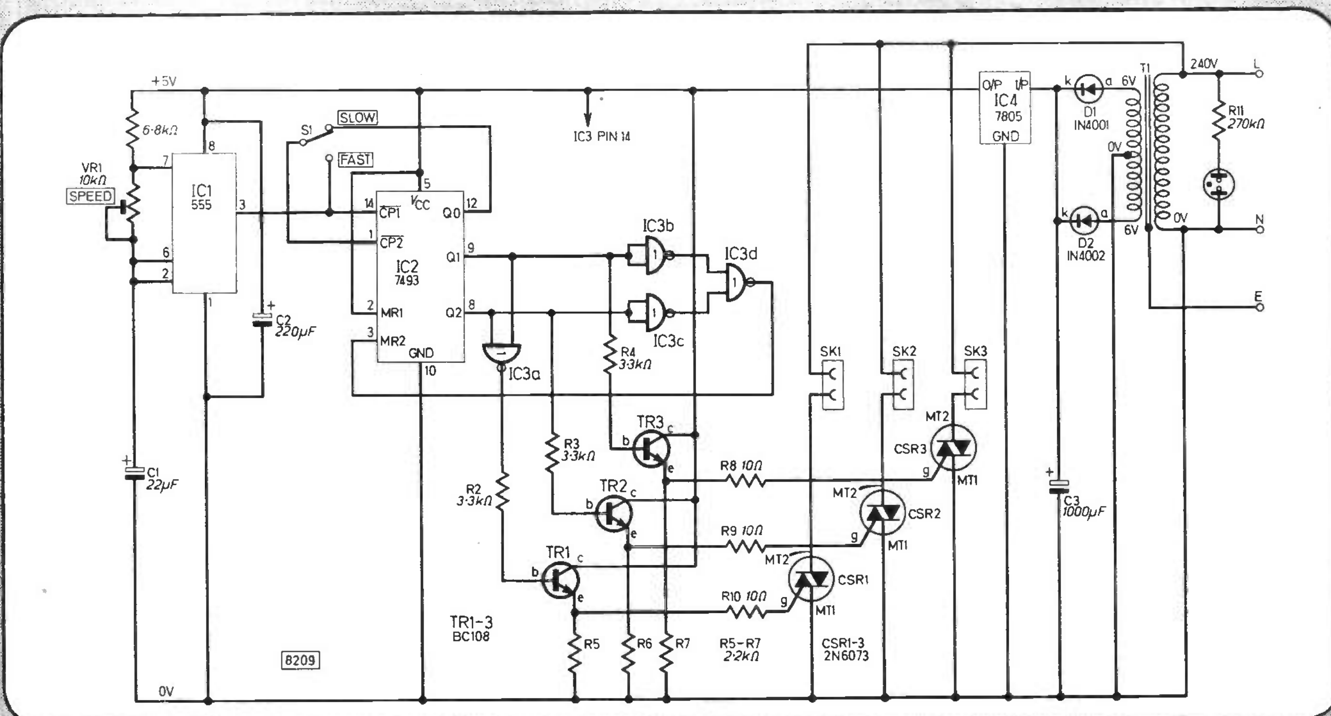
CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised.

Payment is made for all circuits published in this feature.

Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.



CHASER LIGHT

The power supply section of this circuit is conventional with full-wave rectification of the output from a 6-0-6V transformer. This is regulated by IC4, a 7805, to give a 5V supply. Note that the neutral is connected to the 0V line and the earth is *not*.

The 555 i.c. IC1, forms the driver oscillator for the circuit and VR1 controls the frequency.

When a 555 timer i.c. switches, it can put a "glitch" on the power line which would interfere with the operation of the TTL flip-flop i.c.s, so C2 is included to cure this problem and should be mounted as close as possible to IC1 pin 8.

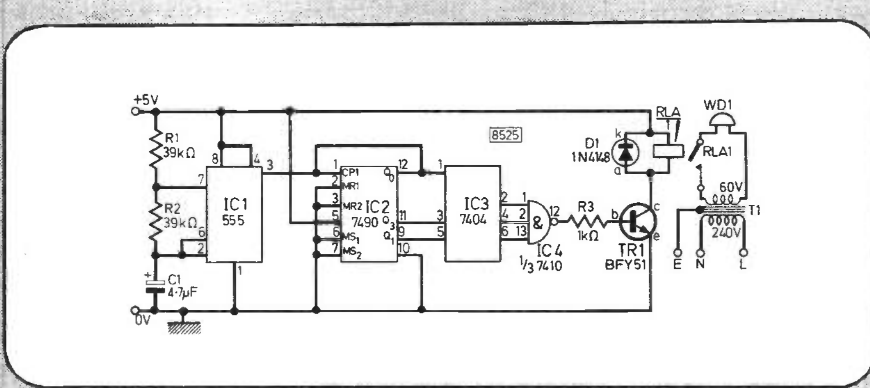
The output from IC1 is connected to pin 14, IC2, the clock input of a TTL 7493 4-bit binary ripple counter. The other clock input at pin 1 is switchable between the output of IC1 and the first output (pin 12) of the ripple counter, giving FAST and SLOW ranges.

The counter works as follows: Initially both the outputs used (pins 8 and 9) are low, therefore the output of IC3a is high. After the first pulse, pin 9 will be high and pin 8 will be low. The next pulse causes pin 9 to go back to low and pin 8 goes high. The third pulse results in both outputs going high and this is detected by a composite AND gate, IC3b, c and d. This resets the counter output back to zero (two lows).

Thus IC3a output, IC2 pin 9 and IC2 pin 8 go high in succession, and these outputs are taken to transistors TR1, 2 and 3, which serve as TTL to triac interfaces. The triacs CSR1, 2 and 3 are therefore triggered in sympathy with the outputs.

The triacs specified can handle up to 700W per channel. However, if full sized bulbs and holders prove to be a little too costly, three sets of Christmas-tree lights could be used.

C. G. Bulman,
Droitwich,
Worcs.



PHONE BELL REPEATER

The circuit shown left was used in our school play to provide an automatic ringing sound on an old unused standard telephone.

The 555 timer, IC1, provides a square wave of approximately 0·6 seconds frequency which is counted by the IC2, a decade counter. Two pulses are selected by the gates to switch a relay, via the transistor TR1, and sound a bell.

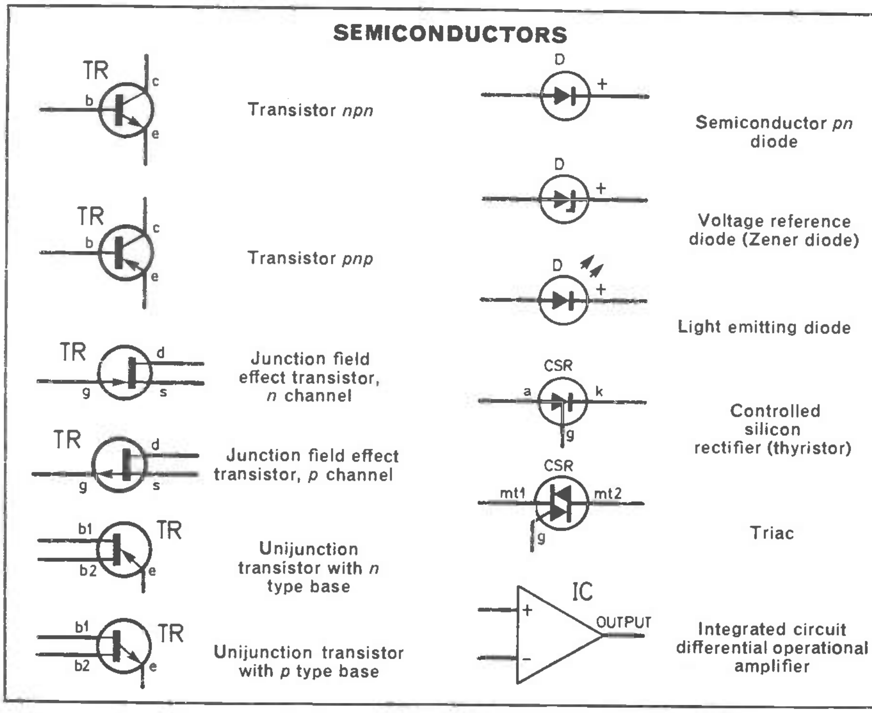
P. K. Yeoman,
Haywards Heath,
Sussex.

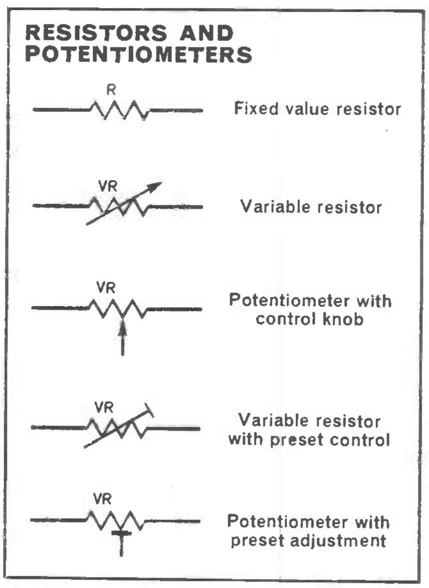
SQUARE one FOR BEGINNERS

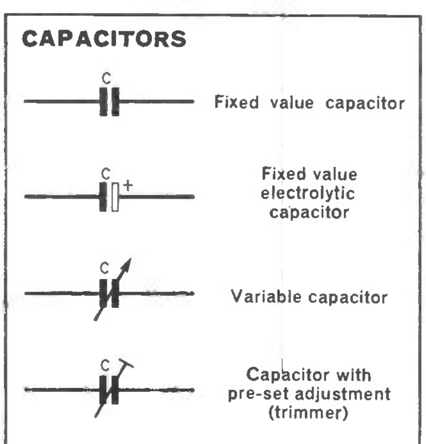
FOR newcomers, some of the mystic of electronics is undoubtedly created by symbols used in circuit diagrams as well as the enigmatic "shorthand" used in text.

Here are the circuit symbols for the more commonly used electronic components.

Abbreviations in common use are listed together with their plain language meaning.







ABBREVIATIONS IN COMMON USE

A	ampere (amp)
a.c.	alternating current
a.f.	audio frequency
a.f.c.	automatic frequency control
a.g.c.	automatic gain control
a.m.	amplitude modulation
BA	British Association (nut and bolt sizes)
b.f.o.	beat frequency oscillator
bit	binary digit
C	coulomb
c	centi (÷ 100)
cm	centimetre
CMOS	complimentary metal oxide silicon
c.r.o.	cathode-ray oscilloscope
c.r.t.	cathode-ray tube
c.w.	continuous wave
d	deci (÷ 10)
dB	decibel
d.c.	direct current
d.i.l.	dual-in-line
DIN	Deutsche Industrie Nummer
d.p.d.t.	double-pole double-throw
elect.	electrolytic
e.h.t.	extra high tension
e.m.f.	electromotive force
e.m.u.	electromagnetic unit
e.s.u.	electrostatic unit
eV	electron volt
F	farad
f.e.t.	field effect transistor
f.s.d.	full scale deflection
f.m.	frequency modulation
G	giga (× 1,000,000,000)
g	gram
H	henry
Hz	hertz (cycles per second)
h.f.	high frequency
h.t.	high tension
i.c.	integrated circuit
i.f.	intermediate frequency
k	kilo (× 1,000)
l.e.d.	light emitting diode
l.d.r.	light dependent resistor
l.f.	low frequency
lin.	linear
l.t.	low tension
log.	logarithmic
l.w.	long wave
M	mega (× 1,000,000)
m	metre (measurement of length)
m	milli (÷ 1,000)
mm	millimetre
MOS	metal oxide silicon
m.w.	medium wave
n	nano (÷ 1,000,000,000)
npn	transistor structure
pnp	transistor structure
op-amp	operational amplifier
p	pico (÷ 1,000,000,000,000)
p.d.	potential difference
p.i.v.	peak inverse voltage
p-p	peak-to-peak
p.t.f.e.	polytetraflouroethylene
p.v.c.	polyvinyl chloride
r.f.	radio frequency
r.m.s.	root-mean-square
s.p.c.o.	single-pole changeover
s.p.s.t.	single-pole single-throw
s.r.b.p.	synthetic resin bonded paper
s.s.b.	single sideband
s.h.f.	super high frequency
s.w.g.	standard wire gauge
T	tera (× 1,000,000,000,000)
t.r.f.	tuned radio frequency
TTL	transistor transistor logic
u.h.f.	ultra high frequency
u.j.t.	unijunction transistor
V	volt
v.c.o.	voltage controlled oscillator
v.h.f.	very high frequency
v.l.f.	very low frequency
W	watt
w.w.	wire wound
X	reactance
Z	impedance
%	per cent
μ	micro (÷ 1,000,000)
Ω	ohm

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Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

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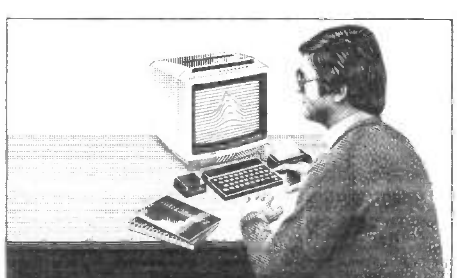
Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

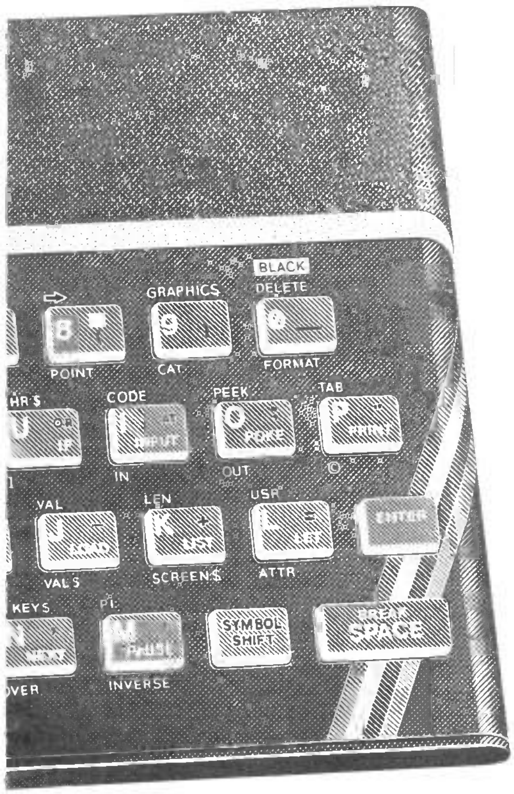
There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.



Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound – BEEP command with variable pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set – with upper- and lower-case characters.
- Teletext-compatible – user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE – 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

'um



RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

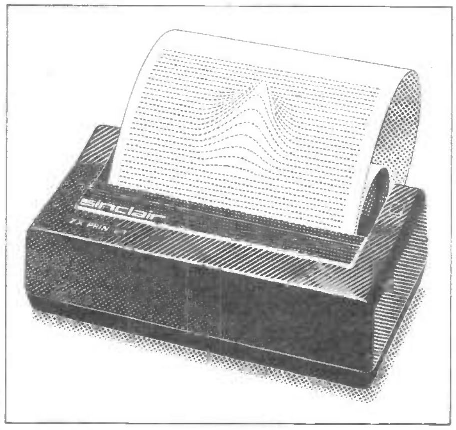
The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.



The ZX Microdrive – coming soon

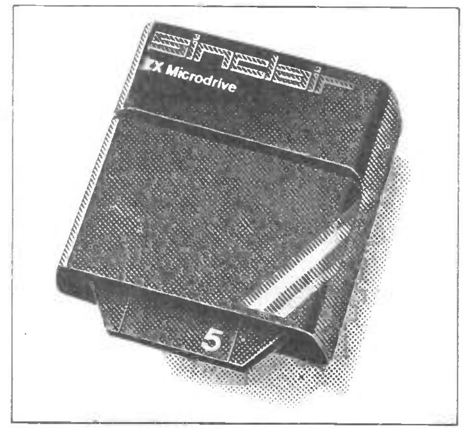
The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.



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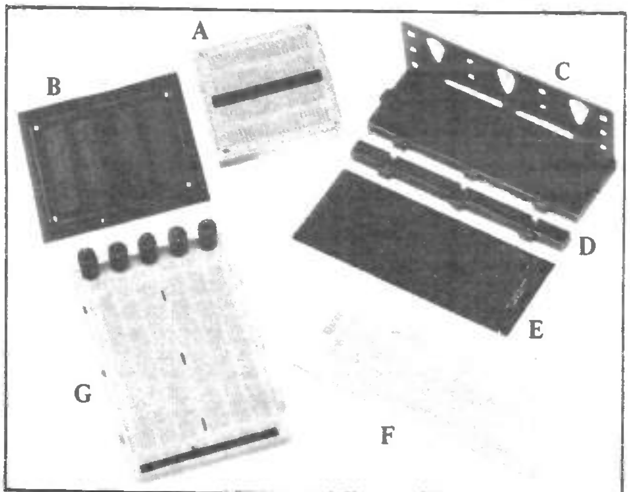

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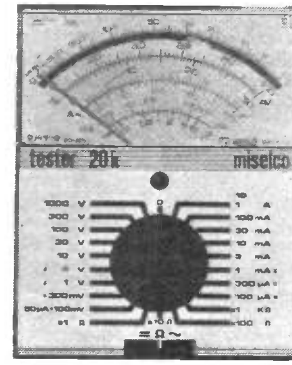

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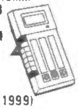

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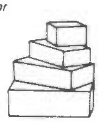

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5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF **15p**; 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7 **12p**; 5n6, 6n8, 8n2, 10n **13p**.

CERAMIC Very small 1.8, 2.2, 2.7 etc. up to 1n **5p each.** 1n5, 2n2, 3n3, 4n7, 6n8 **5p**; 10n, 22n, **6p**; 33n, 47n **7p**; 100n **8p**.

POLYESTER, SIEMENS LAYER TYPE 7.5mm lead spacing 100V
1n, 1n5, 2n2, 3n3 **6p**; 4n7, 6n8, 8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 39n, 47n **7p**; 56n, 68n **8p**; 82n, 100n **9p**; 120n, 150n **11p**; 180n, 220n **12p**; 270n, 330n, 390n, 470n **15p**; 560n, 680n **24p**. *10mm spacing* 1μF **25p**. *15mm spacing* 2μ2 **35p**. *22.5mm spacing* 1μF 400V **54p**; 3.3μF 100V **69p**.
In-depth stocks.

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Pluggable SIEMENS single ended
1/63, 2.2/63, 4.7/63 **10p**; 10/63, 22/63 **12p**; 22/40, 47/16 **10p**; 47/40 **12p**; 47/63 **15p**; 100/16, 100/25 **12p**; 100/40 **15p**; 100/63 **20p**; 220/10, 220/16, 220/25 **13p**; 470/6.3 **15p**; 470/10 **16p**; 470/16 **18p**; 470/25 **22p**; 470/40 **25p**; 1000/10 **24p**; 1000/16 **23p**.

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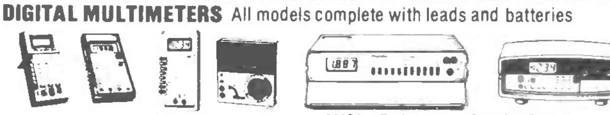

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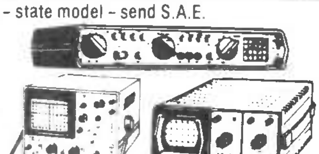

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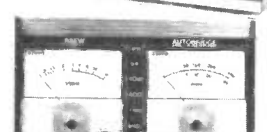

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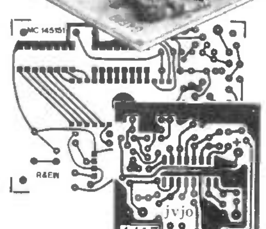

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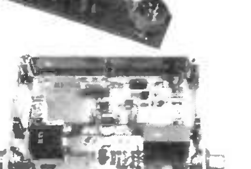

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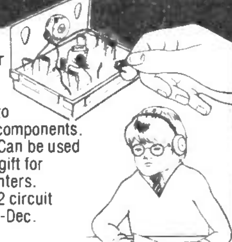

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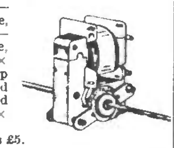

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