NEW SPECIAL HOME PROJECTS ISSUE-SEE INSIDE

Hobby Electronics

OCTOBER '81

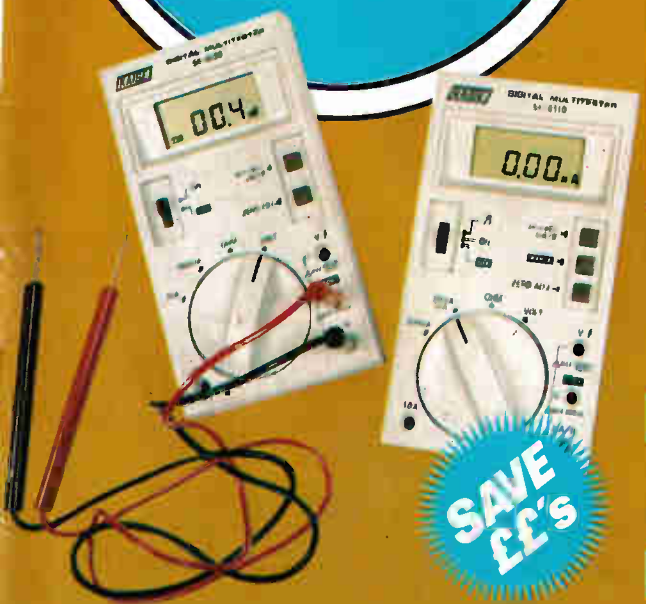
ISSN 0142 6192

Only 60p

For A Down-To-Earth Approach To Electronics

5 Low-cost Projects For The Home

Aerials-teach-in on aerial systems



HE READER OFFER

2 Digital Multimeters

SEE INSIDE

FREE GADGETS, GAMES & KITS SUPPLEMENT INSIDE

LINEAR ICS — THE LOWEST PRICES FOR PRIME CMOS/TTL/74C IN THE UK — TRANSISTORS

TBA120S	1.00
L200	1.95
U237B	1.28
U247B	1.28
U257B	1.28
U267B	1.28
LM301H	0.67
LM301N	0.30
LM308TC	0.65
LM324	0.64
LM339N	0.66
LM348N	1.86
LF351N	0.49
LF353N	0.76
LM374N	3.75
LM380N 14	1.00
LM380N-8	1.00
LM381N	1.81
ZN419CE	1.98
NE544N	1.80
NE555N	0.30
NE556	0.50
NE560N	3.50
NE562N	4.05
NE564N	4.29
NE565N	1.00
NE566N	1.60
NE570N	3.85
SL624	3.28
TBA651	1.81
uA709HC	0.64
uA709PC	0.46
uA710HC	0.65
uA710PC	0.59
uA741CH	0.66
uA741CN	0.27
uA747CN	0.70
uA748CN	0.36
uA753	2.44
uA758	2.35
TBA820M	0.78
TCA940E	1.80
TDA1028	2.11
TDA1029	2.11
TDA1054	1.45
TDA1062	1.95
TDA1072	2.69
TDA1074A	5.04
TDA1083	1.95
TDA1090	3.05
HA1137	1.20
HA1196	2.00
HA1197	1.00
TDA1220	1.40
LM1303	0.99
LM1307	1.55
MC1310P	1.90
MC1330	1.20
MC1350	1.20
HA1370	1.90
HA1388	2.75
TDA1490	1.86
MC1496P	1.25

SL1610P	1.60
SL1611P	1.60
SL1612P	1.60
SL1613P	1.89
SL1620P	2.17
SL1621P	2.17
SL1623P	2.44
SL624C	3.28
SL1625P	2.17
SL1626P	2.44
SL1630P	1.62
SL1640P	1.89
SL1641P	1.89
TDA2002	1.25
ULN2242A	3.05
ULN2283B	1.00
CA3080E	0.70
CA3089E	1.84
CA3090AQ	3.35
CA3123E	1.40
CA3130E	0.80
CA3130T	0.90
CA3140E	0.46
CA3189E	2.20
CA3240	1.27
MC3357P	2.85
LM3900N	0.60
LM3909N	0.68
LM3914N	2.80
LM3915N	2.80
KB4400	0.80
KB4406	0.60
KB4412	1.95
KB4413	1.95
KB4417	1.80
KB4420B	1.09
TDA4420	2.65
KB4423	2.30
KB4424	1.65
KB4431	1.95
KB4432	1.95
KB4433	1.52
KB4436	2.53
KB4437	1.75
KB4438	2.22
KB4441	1.35
KB4445	1.29
KB4446	2.75
KB4448	1.65
NE5044N	2.26
NE5532N	1.85
SD6000	3.75
SL6270	2.03
SL6310	2.03
SL6600	3.75
SL6640	2.75
SL6440	PDA
SL6690	3.20
SL6700	2.35
ICL8038CC	4.50
MSL9362	1.75
MSL9363	1.75
HA11211	1.95

HA11223	2.15
HA11225	1.45
HA12002	1.45
HA12017	0.80
HA12402	1.95
HA12411	1.20
HA12412	1.55
LF13741	0.33
SN76660N	0.80

FREQ. DISPLAY AND SYNTH. DEVICES

SAA1056	3.75
SAA1058	3.35
SAA1059	3.35
11C90DC	14.00
LN1232	19.00
LN1242	19.00
MSL2318	3.84
MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM55271	9.75
MSL2312	3.94
SP8629	3.85
SP8647	6.00
95H90PC	7.80
HD10551	2.45
HD44015	4.45
HD12009	6.00
HD44752	8.00
MC145151	12.45
MC145156	8.75

MISC

ICM7106CP	9.55
ICM7107CP	9.55
ICM7216BP	19.50
ICM7555	0.94

4000 series

4000	0.13
4001	0.13
4002	0.14
4007	0.19
4008	0.70
4009	0.30
4010	0.30
4011	0.24
4011	0.15
4012	0.20
4013	0.35
4015	0.70
4016	0.30
4017	0.65
4019	0.38
4020	0.68
4021	0.75
4022	0.68
4023	0.19
4024	0.45
4025	0.18
4026	1.05
4028	0.60
4029	0.75
4030	0.35
4035	0.75
4040	0.68
4042	0.65
4043	0.68
4043	0.93
4044	0.68
4946	0.69
4047	0.69
4049	0.30
4050	0.30
4051	0.65
4052	0.69
4053	0.69
4054	1.30
4055	1.30
4056	1.35

4060	0.95
4063	1.15
4066	0.38
4067	4.30
4068	0.18
4069	0.18
4070	0.25
4071	0.22
4072	0.22
4073	0.22
4075	0.18
4076	0.60
4077	0.23
4078	0.25
4082	0.25
4093	0.45
4099	0.99
4175	1.15
4502	0.90
4503	0.55
4506	0.75
4507	0.45
4508	1.99
4510	0.70
4511	0.85
4512	0.70
4514	2.20
4515	2.50
4516	0.75
4518	0.75
4520	0.80
4521	2.36
4522	1.49
4527	0.95
4528	0.95
4529	1.40
4539	1.10
4549	3.50
4554	1.73
4555	0.72
4556	0.58
4560	2.18

4566	1.59
4568	2.18
4569	1.95
4572	0.30
4582	0.99
4584	0.49
4585	1.00
4702	4.50
4703	4.48
4704	4.24
4705	4.24
4706	4.50
4720	4.00
4723	0.95
4724	0.95
4725	2.24
40014	0.54
40085	0.99
40098	0.54
40106	0.54
40160	0.69
40161	0.69
40162	0.69
40163	0.69
40174	0.69
40175	0.69
40192	0.75
40193	0.75
40194	0.69
40195	0.69

TTL 'N'

7400	0.10
7401	0.10
7402	0.10
7403	0.11
7404	0.12
7405	0.12
7406	0.22
7407	0.22
7408	0.15

7448	0.56
7450	0.14
7451	0.14
7453	0.14
7454	0.14
7460	0.14
7470	0.28
7472	0.27
7473	0.28
7474	0.28
7475	0.35
7476	0.30
7480	0.26
7481	0.20
7482	0.75
7483	0.60
7485	0.75
7486	0.24
7489	1.05
7490	0.30
7491	0.55
7492	0.35
7493	0.35
7494	0.70
7495	0.60
7496	0.45
7497	1.40
74100	1.10
74104	0.62
74105	0.62
74107	0.26
74109	0.35
74110	0.54
74111	0.68
74112	1.70
74166	1.98
74118	0.85
74119	1.20
74120	0.95
74121	0.35
74122	0.34
74123	0.40

74125	0.40
74126	0.40
74128	0.65
74132	0.50
74136	0.65
74141	0.45
74142	1.85
74143	2.50
74144	2.50
74145	0.75
74147	1.50
74148	1.09
74150	0.79
74151	0.55
74153	0.55
74154	0.55
74155	0.55
74156	0.55
74157	0.55
74159	1.90
74160	0.55
74161	0.55
74162	0.55
74163	0.55
74164	0.55
74165	0.55
74166	0.70
74167	1.25
74170	1.25
74173	1.10
74174	0.75
74175	0.75
74176	0.75
74177	0.75
74178	0.90
74179	1.35
74180	0.75
74181	1.22
74182	0.70
74184	1.20
74185	1.20
74188	3.00

74190	0.55
74191	0.55
74192	0.55
74193	0.55
74194	0.55
74195	0.55
74196	0.55
74197	0.55
74198	0.85
74199	1.00
74221	1.00
74246	1.50
74247	1.51
74248	1.89
74249	1.89
74251	1.05
74265	0.66
74273	2.67
74278	2.49
74279	0.89
74283	1.30
74284	3.50
47285	3.50
74290	1.00
74293	1.05
74297	2.36
74298	1.85
74365	0.85
74366	0.85
74367	0.85
74368	0.85
74390	1.85
74393	1.85
74490	1.85

'LPSN'

7400	0.11
7401	0.11
7402	0.12
7403	0.12
7404	0.13

7405	0.14
7408	0.14
7409	0.14
7410	0.13
7411	0.14
7412	0.15
7413	0.28
7414	0.49
7415	0.14
7420	0.13
7421	0.15
7422	0.15
7426	0.18
7427	0.14
7428	0.35
7430	0.13
7432	0.14
7433	0.16
7437	0.17
7438	0.16
7440	0.13
7442	0.40
7447	0.42
7448	0.65
7449	0.61
7451	0.14
7454	0.15
7455	0.15
7463	1.50
7473	0.21
7474	0.18
7475	0.28
7476	0.22
7478	0.24
7483	0.50
7485	0.70
7486	0.18
7490	0.32
7491	1.25
7492	0.39
7493	0.38
7495	0.48

7496	1.20
74107	0.25
74109	0.25
74112	0.25
74113	0.25
74114	0.25
74122	0.40
74123	0.55
74124	1.80
74125	0.29
74126	0.29
74132	0.45
74133	0.30
74136	0.25
74138	0.40
74139	0.40
74145	1.20
74147	2.10
74148	1.60
74151	0.35
74153	0.35
74154	0.99
74155	0.50
74156	0.50
74157	0.36
74158	0.40
74160	0.40
74161	0.40
74162	0.40
74163	0.40
74164	0.50
74165	1.20
74166	1.75
74168	0.85
74169	0.85
74170	1.85
74173	0.75
74174	0.55
74175	0.55
74181	1.35
74183	2.96
74189	1.28

74190	0.60
74191	0.60
74192	0.68
74193	0.68
74194	0.42
74195	0.42
74196	0.65
74197	0.65
74200	3.45
74202	3.45
74221	0.60
74240	0.99
74241	0.99
74242	1.65
74243	1.65
74244	0.83
74245	1.50
74247	1.35
74248	1.35
74249	1.35
74251	0.46
74253	0.46
74257	0.55
74258	0.39
74259	0.39
74260	0.70
74266	0.24
74273	0.90
74275	3.20
74279	0.35
74280	2.50
74283	0.44
74290	0.58
74293	1.30
74295	1.50
74298	1.50
74365	0.35
74366	0.35
74367	0.35
74368	0.35
74373	0.78
74374	0.78
74375	1.15
74377	1.99
74378	1.40
74379	2.15
74384	2.50
74385	4.20
74386	0.29
74390	0.68
74393	0.61
74395	2.10
74396	1.99
74398	2.75
74399	2.30
74445	1.40
74447	1.95
74490	1.10
74668	1.05
74669	1.05
74670	1.70

74C CMOS

7400	0.20
7402	0.20
7404	0.20
7408	0.20
7410	0.20
7414	0.55
7420	0.20
7430	0.20
7432	0.20
7442	0.80
7448	1.03
7473	0.50
7474	0.50
7476	0.48
7483	0.98
7485	0.98
7486	0.26
7489	2.68
7490	0.80
7493	0.80
7495	0.94
74107	0.48
74151	1.52
74154	2.26
74157	1.52
74160	0.80
74161	0.80
74162	0.80
74163	0.80
74164	0.80
74165	0.84
74173	0.72
74174	0.72
74175	0.72
74192	0.80
74193	0.80
74195	0.80
74200	4.52
74221	1.06
74901	0.38
74902	0.38
74903	0.38
74904	0.38
74905	5.64
74906	0.38
74907	0.38
74908	0.84
74909	1.52
74910	3.62
74914	0.86
74918	0.98
74925	4.32
74926	4.32
74927	4.32

E&OE

Subject to availability

TRANSISTORS

BF194	18p
BF195	18p
BF224	22p
BF241	18p
BF274	18p
BF440	21p
BF441	21p
BF362	49p
BF395	18p
BF479	66p
BF679S	55p
BFR91	1.33
BFW92	60p
BFT95	99p
BFY90	90p
40238	85p
BF256	38p
2SK55	28p
2SK168	35p
J310	69p
J176	65p
40823	65p
40673	3SK51
3SK45	49p
3SK51	54p
3SK60	58p
3SK88	1.24
MEM680	75p
BF961	70p
BC237	8p
BC238	8p
BC239	8p
BC307	8p
BC308	8p
BC309	8p
BC413	10p
BC414	11p
BC415	10p
BC416	11p
BC546	12p
BC556	12p
BC550	12p
BC560	12p
BC639	22p
BC640	22p
2SC1775	18p
2SA872A	14p
2SD666A	30p
2SB646A	30p
2SD668A	40p
2SB648A	40p
2SD760	45p
2SB720	45p
2SC2547	19p
2SA1085	20p
2SB753	2.34
2SB723	2.34
2SK134	3.10
2SJ49	3.10
2SK135	4.25
2SJ50	4.25
2SK227	3.55
2SJ83	3.55

CRYSTALS

32.768kHz	2.70
100kHz	3.85
455kHz	5.00
1.000MHz	2.95
3.2768	2.70
4.000	2.00
4.1934	2.00
4.096	2.00
4.032	2.00
4.433619	2.00
4.800	2.00
5.000	2.00
6.5536	2.00
7.000	2.00
7.68	2.00
8.000	2.00
9.000	2.00
10.000	2.00
10.240	2.00

CRYSTALS

10.245	2.00
10.6985	2.50
10.700	2.00
10.7015	2.50
11.00	2.00
11.115	2.00
11.520	2.00
8.9985	2.00
9.0015	2.00
21.000	2.00
24.000	2.00
25.000	2.00
26.000	2.00
18.000	2.50

XTAL FILTERS
10M4B1; 10.7Mhz, 15Khz BW, 8 pole. 14.50
10M22D; 10.7Mhz, 2.4Khz BW, SSB, 8 pole. 17.20

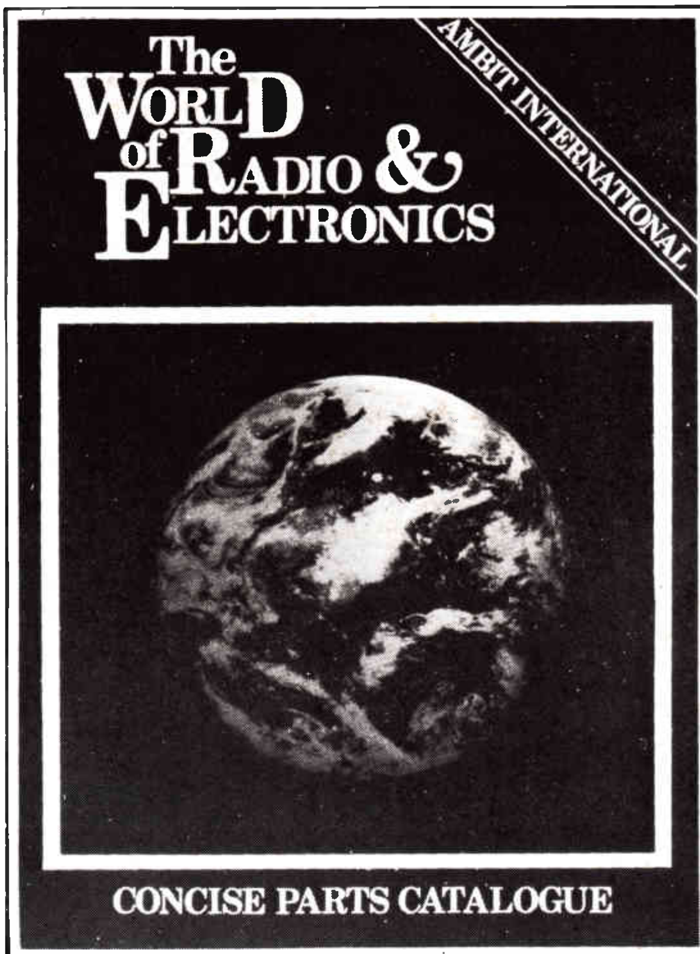
RADIO CONTROL

RC XTALS
AM TX/RX
FM RX:
3rd ot/30pF HC25U 1.65
FMTX: Fund 20pF HC25U ½ freq 1.85
PAIRS...AM 3.10
PAIRS...FM 3.25
CHANNELLING:
27MHz. 50kHz
35MHz: 20kHz

ALL PRICES EXCLUDE VAT – CURRENTLY AT 15%
POSTAGE 50p ORDERS UNDER £12 - FREE OVER £12

The lowest prices for prime, repeatable devices ? We think so, and wait to hear to the contrary. Ambit's new bigger, cheaper and complete range of parts is covered in our new 12 page A4 format short-form and price list: available free with an SAE, and supplied with all orders. You can order by ACCESS/BARCLAYCARD, cheque, PO with order - or come into our refurbished retail shop and use 'real' money! Our 3 catalogues (£1.85 inc. or 75p ea inc) cover the BIGGEST RANGE OF RF components in Europe as well as standard parts, so invest a set today. The saving you make on your first couple orders will soon repay th cost.

AMBIT international TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG
200 North Service Road, Brentwood, Essex



OUT NOW!

AMBIT'S NEW CATALOGUE

In an attempt to collate and organize our burgeoning ranges of 'stock' components (now over 7000 line items), we have at last produced a 'concise' 80 page parts catalogue to supplement the popular 'Tecknowledgey' series of 'wordy' applications catalogues, which now lists a wide range of basic components - as well as our unique RF and Communications components. The *World of Radio and Electronics* contains everything the informed electronics user needs, at prices which we guarantee will match the lowest on the market for equivalent product.

Prices appear on the page alongside the part numbers, and the catalogue is now updated quarterly - available either direct from here (60p all inc) or at most newsagents and bookstalls where you can find electronics publications. So as well as all the 'run-of-mill' items like resistor, capacitors, hardware, solder etc - you now have the first genuinely *complete* parts source for the radio, communication, electronics, computer user.

Ambit International
200, North Service Road,
Brentwood,
Essex CM14 4SG

Hobby Electronics

OCTOBER 1981
Vol 3 No 12

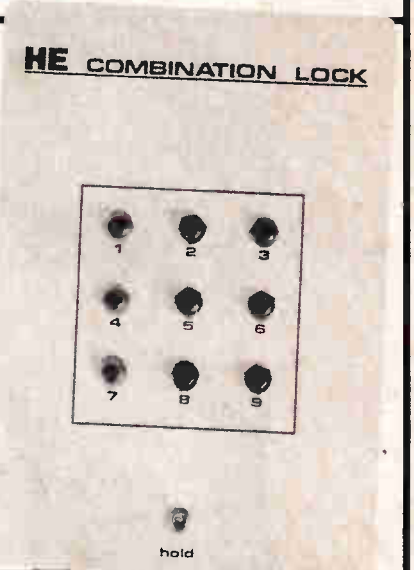
Editor: Hugh Davies
Senior Art Editor: Andrew Sawyer
Advertisement Sales Executive:
Melanie Mackenzie-Aird

PROJECTS

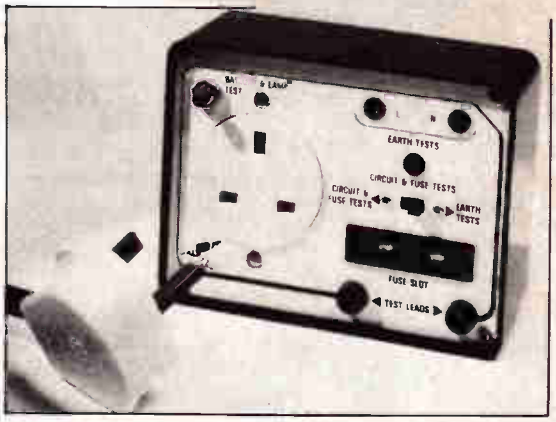
FEATURES

NEWS & INFORMATION

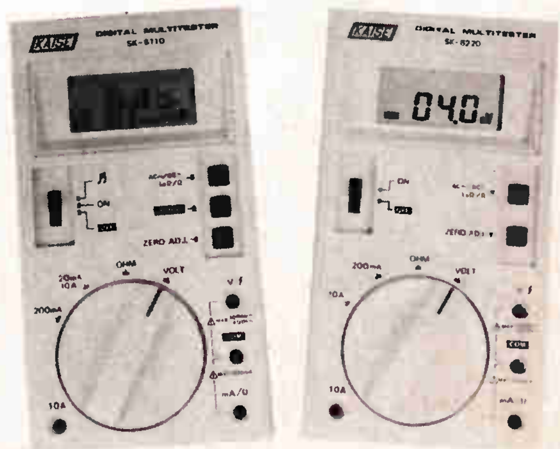
Assistant Editor: Keith Brindley Editorial Assistant: Judith Jacobs
Drawing Office Manager: Paul Edwards Managing Editor: Ron Harris BSc
Layout Artist: Enzo Grando Managing Director: T. J. Connell



Combination Lock — one of this month's five projects for the home (see page 21)



Simple mains fault-finding with the Easy-Check Test Unit — see Gadgets, Games & Kits supplement (page 31)



Choice of two Digital Multitesters from HE — see special offer on page 43

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.
Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE, 01 437 1002. Telex No 8811896. Published by Modmags Ltd.
Distributed by Argus Press Sales & Distribution Ltd, 12-18 Paul St, London EC2A 4JS. Printed by QB Ltd, Colchester. Covers printed by Alabaster Passmore.

20 POWER AMPS

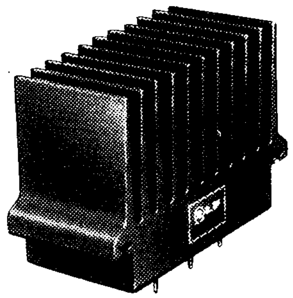
19 FUNCTIONAL MODULES

DAWN

POWER UP TO 480 WATTS RMS SINGLE CHANNEL

Which amplifier?

I.L.P. Amplifiers now come in three basic types, each of which is available with or without heatsink. Having decided the system you want — home hi fi (models HY30, 60 or 120 for example), super quality hi fi with extra versatility (MOS120, MOS200) or Disco PA Guitar (HD120, HD200 or HD400) you will then decide whether amplifiers housed within their own heatsinks or plate amplifiers for bolting to a metal chassis will suit. With choice such as this and a brilliant new range of I.L.P. functional modules to choose from you now have the chance to build the finest audio system ever offered to the constructor.



AMPLIFIER WITH HEAT SINK

BIPOLAR Standard, with heatsinks — Without heatsinks

MODEL NUMBER	OUTPUT POWER Watts rms	DISTORTION T H D Typ at 1kHz	DISTORTION I.M.D. 60HZ 7kHz 4:1	SUPPLY VOLTAGE TYP/MAX	SIZE mm	WT gms	PRICE	VAT	MODEL NUMBER	SIZE in mm	WT gms	PRICE	VAT
HY30	15w 4-8Ω	0.015%	<0.006%	±18±20	76x68x40	240	£7.29	£1.09					
HY60	30w 4-8Ω	0.015%	<0.006%	±25±30	76x68x40	240	£8.33	£1.25					
HY120	60w 4-8Ω	0.01%	<0.006%	±35±40	120x78x40	410	£17.48	£2.62	HY120P	120x26x40	215	£15.50	£2.33
HY200	120w 4-8Ω	0.01%	<0.006%	±45±50	120x78x50	515	£21.21	£3.18	HY200P	120x26x40	215	£18.46	£2.77
HY400	240w 4Ω	0.01%	<0.006%	±45±50	120x78x100	1025	£31.83	£4.77	HY400P	120x26x70	375	£28.33	£4.25

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

HEAVY DUTY with heatsinks — Without heatsinks

MODEL NUMBER	OUTPUT POWER	THD	IMD	SUPPLY VOLTAGE	SIZE	WT	PRICE	VAT	MODEL NUMBER	SIZE	WT	PRICE	VAT
HD120	60w 4-8Ω	0.01%	<0.006%	±35±40	120x78x50	515	£22.48	£3.37	HD120P	120x26x50	265	£19.84	£2.98
HD200	120w 4-8Ω	0.01%	<0.006%	±45±50	120x78x60	620	£27.38	£4.11	HD200P	120x26x50	265	£23.63	£3.54
HD400	240w 4Ω	0.01%	<0.006%	±45±50	120x78x100	1025	£38.63	£5.79	HD400P	120x26x70	375	£34.28	£5.14

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

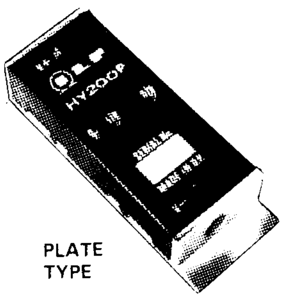


PLATE TYPE

MOSFET Ultra-Fi, with heatsinks — Without heatsinks

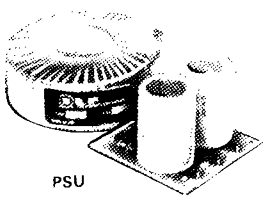
MODEL NUMBER	OUTPUT POWER	THD	IMD	SUPPLY VOLTAGE	SIZE	WT	PRICE	VAT	MODEL NUMBER	SIZE	WT	PRICE	VAT
MOS120	60w 4-8Ω	<0.005%	<0.006%	±45±50	120x78x40	420	£25.88	£3.88	MOS120P	120x26x40	215	£23.32	£3.50
MOS200	120w 4-8Ω	<0.005%	<0.006%	±55±60	120x78x80	850	£33.46	£5.02	MOS200P	120x26x80	420	£28.53	£4.28
MOS400	240w 4Ω	<0.005%	<0.006%	±55±60	120x78x100	1025	£45.39	£6.81	MOS400P	120x26x100	525	£38.91	£5.84

Protection Able to cope with complex loads, without the need for very special protection circuitry (fuses will suffice)
Ultra-fi specifications:
Slew rate 20V/μs *Rise time* 3μs *S/N ratio* 100db *Frequency response (-3dB)* 15Hz - 100kHz
Input sensitivity 500mV rms *Input impedance* 100kΩ *Damping factor* (8Ω 100Hz) >400

POWER SUPPLY UNITS

MODEL NO	FOR USE WITH	PRICE	VAT
PSU30	± 15V combinations of HY6 66 series to a maximum of 100mA or *one* HY67. The following will also drive the HY6 66 series except HY67 which requires the PSU30	£4.50	£0.68
PSU36	1 or 2 HY30	£8.10	£1.22
PSU50	1 or 2 HY60	£10.94	£1.64
PSU60	1 x HY120 HY120P HD120 HD120P	£13.04	£1.96
PSU65	1 x MOS120 1 x MOS120P	£13.32	£2.00
PSU70	1 or 2 HY120 HY120P HD120 HD120P	£15.92	£2.39
PSU75	1 or 2 MOS120 MOS120P	£16.20	£2.43
PSU90	1 x HY200 HY200P HD200 HD200P	£16.20	£2.43
PSU95	1 x MOS200 MOS200P	£16.32	£2.45
PSU180	2 x HY200 HY200P HD200 HD200P or 1 x HY400 1 x HY400P HD400 HD400P	£21.34	£3.20
PSU185	1 or 2 MOS200 MOS200P 1 x MOS400 1 x MOS400P	£21.46	£3.22

All models except PSU30 and PSU36 incorporate our own toroidal transformers



PSU

FP480
BRIDGING UNIT FOR DOUBLING POWER
Designed specially by I.L.P. for use with any two power amplifiers of the same type to double the power output obtained and will function with any I.L.P. power supply. In totally sealed case, size 45 x 50 x 20mm, with edge connector. It thus becomes possible to obtain 480 watts rms (single channel) into 8Ω. Contributory distortion less than 0.005%.
Price: £4.79 + 72p V.A.T

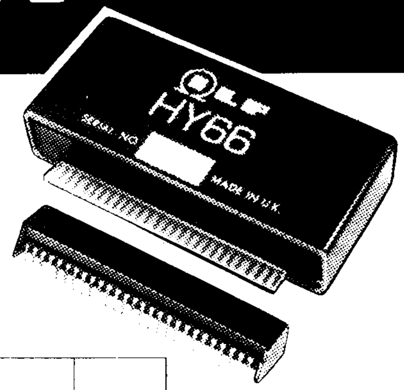
ILP ELECTRONICS LTD.

FREEPOST 6 Graham Bell House, Roper Close, Canterbury, Kent, CT2 7EP
Telephone (0227) 54778 (Technical (0227) 64723) Telex 965780

Available also from MARSHALLS, TECHNOMATIC, WATFORD ELECTRONICS and certain other selected retailers

GOODS BY MAIL ORDER DESPATCHED WITHIN 7 DAYS

OF A NEW ERA ILP



Which modules?

In launching eighteen different units all within amazingly compact cases to help make complete audio systems using I.L.P. power amplifiers, we bring the most exciting, the most versatile modular assembly scheme ever for constructors of all ages and experience. Study the list see how these modules will combine to almost any audio project you fancy and remember *all I.L.P. modules are compatible with each other*. they connect easily. Modules HY6 to HY13 measure 45 x 20 x 40mm. HY66 to HY77 measure 90 x 20 x 40mm. They are so reliable that all I.L.P. modules carry a 5 year no quibble guarantee.

MODEL NO.	MODULE	DESCRIPTION/FACILITIES	CURRENT REQUIRED	PRICE	VAT
HY6	MONO PRE AMP	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Volume/Bass/Treble	10mA	**£6.44**	£0.97
HY7	MONO MIXER	To mix eight signals into one	10mA	**£5.15**	£0.77
HY8	STEREO MIXER	Two channels, each mixing five signals into one	10mA	**£6.25**	£0.94
HY9	STEREO PRE AMP	Two channels mag. Cartridge/ Mic + Volume	10mA	**£6.70**	£1.01
HY11	MONO MIXER	To mix five signals into one + Bass/Treble controls	10mA	**£7.05**	£1.06
HY12	MONO PRE AMP	To mix four signals into one + Bass/Mid-range/Treble	10mA	**£6.70**	£1.01
HY13	MONO VU METER	Programmable gain/LED overload driver	10mA	**£5.95**	£0.89
HY66	STEREO PRE AMP	Mic/Mag. Cartridge/Tape/Tuner/Aux + Volume/Bass/Treble/Balance	20mA	**£12.19**	£1.83
HY67	STEREO HEADPHONE	Will drive headphones in the range of 4Ω - 2KΩ	80mA	**£12.35**	£1.85
HY68	STEREO MIXER	Two channels, each mixing ten signals into one	20mA	**£7.95**	£1.19
HY69	MONO PRE AMP	Two input channels of mag. Cartridge Mic + Mixing Volume Treble Bass	20mA	**£10.45**	£1.57
HY71	DUAL STEREO PRE AMP	Four channels of mag. Cartridge Mic + Volume	20mA	**£10.75**	£1.61
HY72	VOICE OPERATED STEREO FADER	Depth Delay	20mA	**£13.10**	£1.97
HY73	GUITAR PRE AMP	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	**£12.25**	£1.84
†HY74	STEREO MIXER	Two channels, each mixing five signals into one + Treble Bass	20mA	**£11.45**	£1.72
†HY75	STEREO PRE AMP	Two channels, each mixing four signals into one + Bass Mid-range Treble	20mA	**£10.75**	£1.61
†HY76	STEREO SWITCH MATRIX	Two channels, each switching one of four signals into one	20mA	*To be announced*	
†HY77	STEREO VU METER DRIVER	Programmable gain LED overload driver	20mA	**£9.25**	£1.39

† Ready September may be ordered now

All the above modules operate from [illegible] higher voltages being accommodated by use of dropper resistors. HY67 [illegible] with the PSU 30 power supply unit

The modules are encapsulated and include latest design high quality clip-on edge connectors.

For easy mounting we recommend
B6 Mounting board for modules HY6 – HY13
78p + 12p. V.A.T.
B66 Mounting board for HY66 – HY77
99p + 13p. V.A.T.

All I.L.P. modules include full connection data.

I.L.P. Products are of British Design and Manufacture.

ALL WITH ILP'S 5 YEAR NO QUIBBLE GUARANTEE

TO ORDER USING OUR FREEPOST FACILITY

Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. If sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order. *When ordering, U.K. customers must include the appropriate V.A.T. as shown*

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED.

To I.L.P. ELECTRONICS LTD. ROPER CLOSE CANTERBURY CT2 7EP

Please supply ....

Total purchase price £ ....

I enclose Cheque □ Postal Orders □ International Money Order □

Please debit my Access/Barclaycard Account No ....

NAME ....

ADDRESS ....

Signature ....

ALL U.K. ORDERS DESPATCHED POST FREE

HE.10

F RECEIVING YOUR ORDER

BBC Radio's Contribution To Microelectronics Teaching

IT WILL NOT be until the mid-1980s that a syllabus relevant to the electronics technology of the *1970s* can be set as an examination in secondary schools — at least this was the view of Mike Trotter, Series Consultant to BBC Radio. He was speaking at the launch of the Electronics and Microelectronics series at Broadcasting House in July. He saw this lack of progress by the examining boards as 'a tragedy'.

Some hope is offered by the series, which was described by the BBC as being 'one of the most ambitious and exciting projects ever undertaken by BBC School Radio'. The series will be broadcast on Radio 4 VHF in 10 weekly 20-minute parts, starting at 2.20 pm on Tuesday 22nd September.

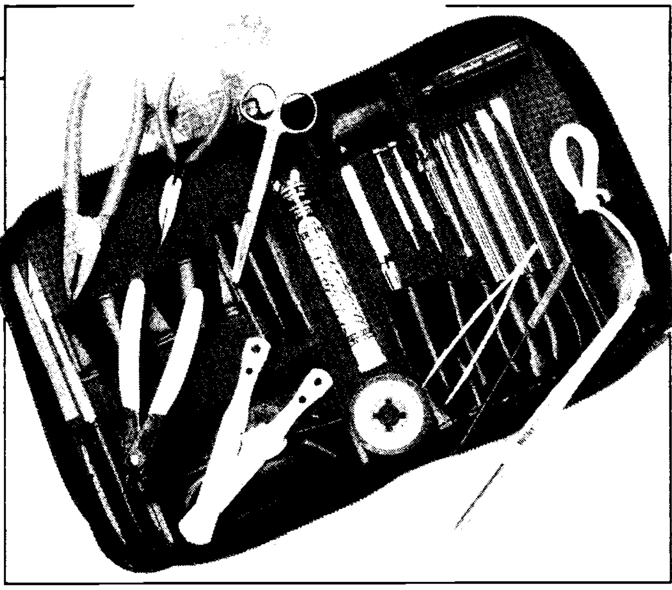
According to producer Arthur Vialls, the course on which the series is based is aimed to teach children in the 14 to 16 age group the 'nuts and bolts' of electronics and micro-electronics.

It is a practical course, and kits of component parts have been made available at a cost of £7.95 (including VAT, postage and packing). These kits, which require no soldering (component leads are held in position by screw cups which are pressed into a fibre board base) are claimed to be sufficient for three or four pupils. Kits can be ordered from Science and Technology Education on Merseyside Limited, STEM Walton Unit, 65 Walton Lane, Liverpool L4 4HG.

Support material for the course includes five filmstrips which can be accompanied by recordings of the radio broadcasts (available in cassette form). A 24-page illustrated booklet of teachers' notes is also available, free-of-charge, from Electronics and Micro-electronics, BBC School Radio, 1 Portland Place, London W1A 1AA. An A4 self-addressed envelope, stamped at 20p, must be enclosed.

In collaboration with the project, BP Educational Service is producing a booklet *'Micro-electronics: Practical Approaches for Schools and Colleges'*. It is compatible with the series and is divided into two parts: the first provides guidance on choosing equipment and resources and the second describes practical projects. The booklet, costing £1.25, will be available from mid-September from BP Educational Service, PO Box 9, Wetherby, West Yorkshire LS23 7EH.

The series has been supported by a £14000 grant from the Department of Education's Microelectronics in Education Programme (MEP).



Hobby Aids From Toolmail

TOOLMAIL LIMITED has introduced two aids for the electronics hobbyist. The first (on special offer until the end of 1981) is a hobby service case and the second is a service wallet, containing a set of miniature tools.

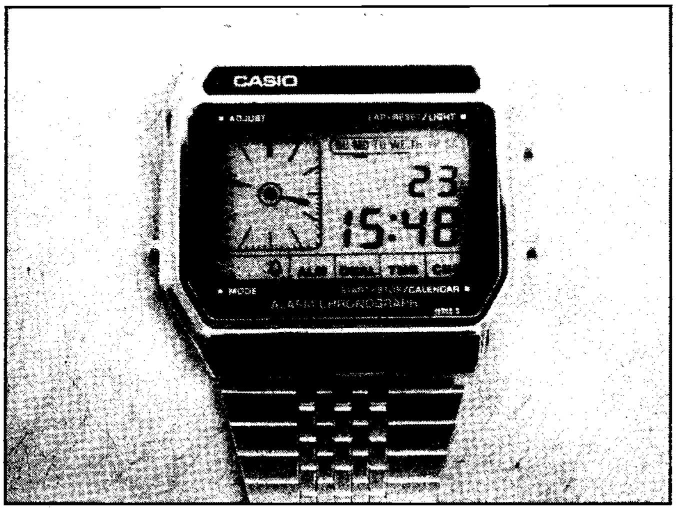
The service case has a metal frame containing 16 clear styrene drawers (each 5½ x 2¾ x 1½") for small components and a base drawer (11 x 5½ x 3¾") for larger items. The front of the vinyl outer case folds down to provide a working surface. Overall height of the vinyl case is 12" and it is fitted with a carrying handle.

Special introductory price for the service case is £29.95 including VAT and delivery in the UK (normal RRP £34.95).

Aid number two is a zipper wallet containing 25 miniature tools. These include a miniature soldering iron, desolder braid, solder, soldering tools, screwdrivers, pliers and cutters, wire strippers, IC extractor, tweezers, scissors and contact cleaners. Kit cost is £39.50 including VAT and delivery in the UK.

The Toolmail catalogue is now available, at a cost of £1.

Toolmail Limited, Parkwood Industrial Estate, Sutton Road, Maidstone, Kent ME15 9LZ (tel 0622 672 736).



Two-in-one LCD Watch From Casio

WHEN IT COMES to choosing a watch, many people still prefer to stay with analogue — traditional minute and hour hands, that is — while others have made a firm choice to 'go digital'. (This second choice is likely to have been influenced by the vast number of cheap digital watches on the market.) For those who can't make up their minds (or who want both types of display) watches have become available in recent years which offer both — but rarely with any great success.

Criticisms have been: 'the digital display is too small' or 'the analogue dial and hands are too small' or (especially when talking about the early models) 'the whole watch is too bulky'.

About a year ago, Casio introduced its model AA-81, which had an LCD display and which enabled you to switch between analogue *or* digital time.

Now Casio's model AX-210 is available in the UK and, like the AA-81, it has an LCD display but with analogue and digital shown side-by-side. As you might expect from Casio, the AX-210 offers a host of functions apart from simple time display. A brief specification is given below:

Accuracy at normal temperature: ±15 seconds/month

- Normal timekeeping mode:
  Analogue: hour and minute hands, second (by flash)
  Digital: (time) hour, minute, second, AM/PM, day; (calendar) year, month, date, day; (monthly calendar) this month and next month
  Time system: changeover between 12-hour or 24-hour formats
  Calendar system: auto-calendar pre-programmed until year 2029
- Daily alarm with three selectable melodies
- Hourly alarm
- Dual time
- Countdown alarm: Input range: from 1 to 60 minutes
  Measuring unit: 1 second
  Repeat function: pre-entered time retained for re-use
- Stopwatch mode:
  Measuring capacity: 59 minutes, 59.99 seconds
  Measuring unit: 1/100 second
  Measuring modes: normal time, net time, lap time and 1st-2nd place times
- Battery:
  One lithium battery (type BR-2016)
  Approx life: 18 months

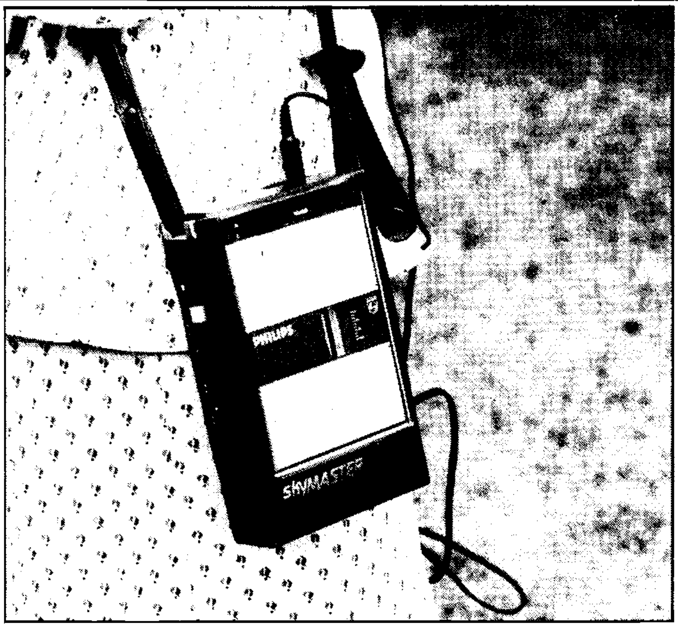
The 'three selectable melodies' in alarm mode are: *Dixie Land* (D. Emmett), *Greensleeves* (Traditional, reputed to have been composed by Henry VIII) and *My Darling Clementine* (Percy Montross).

All the various noises produced by the watch (including 'Big Ben' at 12 noon) are at a fairly low volume — but we found that the alarm was loud enough to arouse even an exhausted HE Editor!

We did find the display of our sample model a little lacking in contrast, which made the analogue display tricky to read under low-light conditions. However, the digital read-out of time was large enough to see at a glance.

The AX-210 has a chrome-finished case with a dark-blue surround. It has an adjustable stainless steel bracelet.

It is available for £29.95 (normal RRP £34.95) from Tempus, The Beaumont Suite, 164-167 East Road, Cambridge CB1 1DB (tel 0223 312866/67503).



New Cassette Player Range From Philips

PHILIPS IS INTRODUCING a new range of cassette players for use with up to two sets of headphones. First model to appear will be the Skymaster cassette player, which should become available in September for around £49.95. (These models will play *compact* cassettes, not *micro*cassettes.)

When we had a fleeting glance of a sample Skymaster we were surprised by how large it was compared with some of the tiny models around at present. Its colour was also a little surprising: dark blue and silver.

We did have an opportunity to try out the Skymaster and we were impressed by the sound quality (worth thinking about when you consider the price). The only niggle was that the sound was not suppressed during rewind and forward wind: it was necessary to press the 'mute' button to reduce the racket.

Skymaster has independent slider volume controls for right and left channels, a Hi/Lo tone switch and two headphone sockets. It comes complete with headphones and a blue carrying case fitted with a shoulder strap.

It is not a lightweight machine and requires four AA-size cells or a plug-in 6 VDC adaptor. (Philips may offer a suitable adaptor later this year.)

When HE asked Philips about the choice of design (and colour) we were told that the decision had been made at Philips' HQ in Eindhoven, Holland. The player is manufactured in Japan.

A combined radio/cassette player in the same style is planned for later this year.

Philips Audio, PO Box 298, City House, 420-430 London Road, Croydon, Surrey CR9 3QR (tel 01 689 2166).

Fancy A Career In Computing?

WITH THE RAPID expansion of computer installations over recent years, the shortage of trained personnel in the computer industry has grown.

To help satisfy the demand for skilled computer specialists in engineering and data processing, colleges throughout the UK are offering a wide range of courses.

Slough College of Higher Education designed a new course in 1978 with the cooperation of minicomputer manufacturers — Data General, Digital Equipment Company, Hewlett Packard. This one-year intensive course comprises three terms in college, with two industrial training periods during the Easter and Summer vacations. It leads to a Higher Technician Certificate in Computer Technology, and this is awarded by the Technical Education Council (TEC). Suitable applicants are eligible for a TOPS (Training Opportunities Scheme) grant from the Manpower Services Commission.

The course will provide training for applicants wishing to work as field service engineers, and there will also be opportunities for work in microelectronics and computer programming.

Interviews for the course start at Slough College in September 1981 for the January 1982 course. Entry qualifications include 'A' level, OND/ONC, TEC/BEC and City and Guilds certificates. Each application will be considered carefully, and advice on further studies will be given to students who are not eligible for the course.

Enquiries to: Dr. Eva Huzan, Head of Computing Division, Slough College of Higher Education, Wellington Street, Slough SL1 1YG, Berkshire (tel 0753 34585, ext 37).

Wander Cordless With Mike

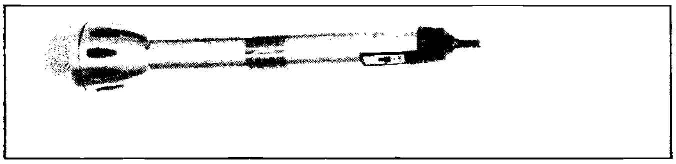
AS ITS NAME implies, you can roam around with Wander-Mike without tripping over a cable.

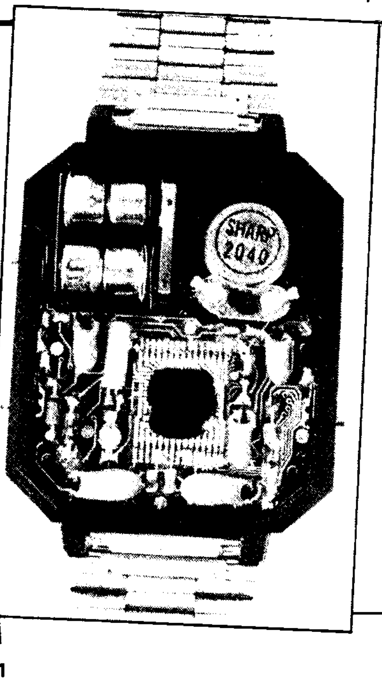
The microphone, introduced recently by TMC, has two modes of operation: 'cordless' (producing a radio signal which can be picked up by an FM radio receiver tuned to about 90 MHz, and within a range of about 100 ft) and 'corded' (linked to amplifying equipment in the conventional way by a length of screened cable).

Wander-Mike is about 8" long by ¾" diameter and it has a polished stainless steel case. Two AA-size cells provide the power for the built-in radio transmitter.

Cost, including stand attachments, cells, instructions and 5 m of cable terminated with a jack plug, is £39.50 plus VAT. It is available from Watford Electronics, 33/35 Cardiff Road, Watford, Herts (tel 0923 40588).

A word of warning: the Home Office does not permit the use of radio microphones of this type in the UK.





Time For Talking

TRAFALGAR WATCH Company has announced a talking digital watch. Yes, you read it correctly — a *talking* digital watch.

Apart from the usual digital time functions, the Talking Watch literally *tells* you the time of day (vocal accent and dialect is American, of course), at the press of a button. And if you think you will sleep through being *told* to wake up, followed by 16 seconds of Bocharini's Minuet, then think again.

We took the back of the watchcase off to see the innards and weren't surprised to find that about half of the watch is taken up by batteries and, what must be the world's tiniest loudspeaker. The remainder of the space seems to be taken up by a multipin IC and a few other components.

Although the watch is quite bulky to wear, it is deceptively light and is held very securely by a good quality stainless steel strap. Retail price is £59.95 (including VAT) plus £1.22 Registered Postal charge (total £61.17). Apart from the persistent gadget lovers, the watch could be a useful aid for blind people. Both time and alarm functions are easy to set and use without actually looking at the watch, because every time an adjustment is made the 'little man' inside tells you the new setting.

We might consider the Talking Watch for a special HE Reader Offer.

Trafalgar Watch Company Limited, Trafalgar House, Grenville Place, Hale Lane, London NW7 3SA (tel 01 906 0311).

Hobby Electronics

Projects Galore!

Next month is a special projects issue. Crammed into your November copy of HE will be 11 — yes, that's right 11 — projects for you to build and use, including:

Light Beam Telephone

Convert your torch into a super-duper communications device. With the HE Sound Torch you can talk to your friends at a distance without using radio waves! Thus you don't need a licence, and no way is it illegal. Who needs CB?

How's it done? Find out next month!

Metronome

Keep your time with our metronome project. A superb circuit for the musician to build which will make sure a beat is never missed again.

Scratch Filter

If you have any scratched or worn records, with lots of surface noise, then you'll know how irritating it is to listen to music when all you seem to hear is — hissss click-clack, hissss click-clack. Our scratch filter project next month isn't guaranteed to eliminate all the extraneous noise but it should certainly reduce it to a more acceptable level.

LED VU Meter

If you do a lot of tape recording using a cassette or reel-to-reel machine you'll know the importance of a good VU meter. Next month we present the HE LED VU Meter which is a peak reading device — unlike ordinary VU meters — and lets you see when sharp, spiky signals (such as you might obtain when recording from a voice or percussive instrument source) are being recorded at too high a level.

PLUS

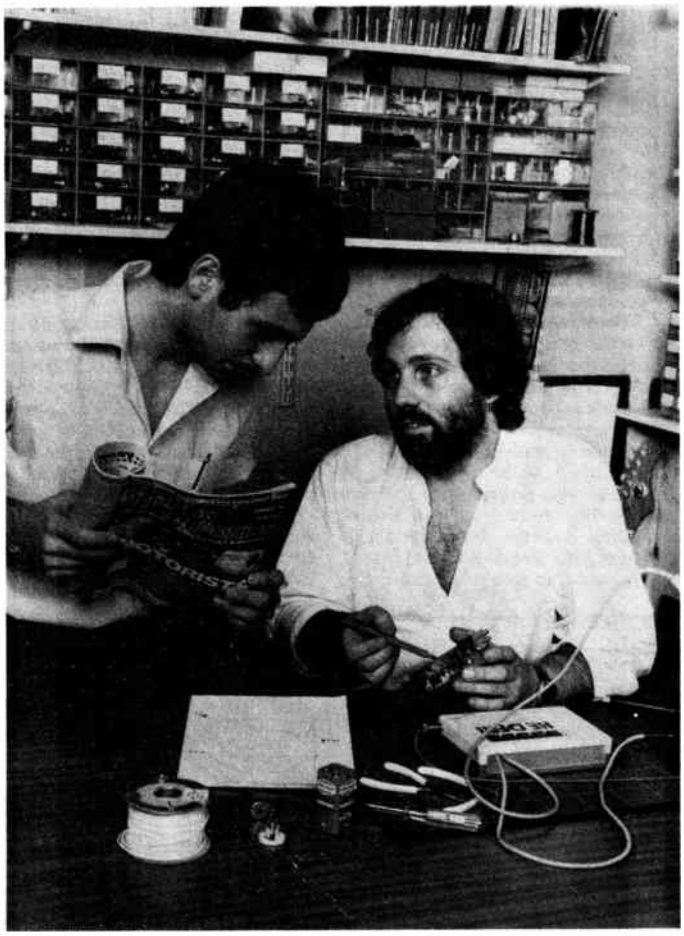
Free Eight-page Projects Supplement

Five of next month's projects are extracted from a new series of books for the electronics enthusiast, published by Newnes. We've picked a sample of five constructors' projects (one from each book) for you to build and use around the home or in your hobby. The projects we have planned are:

- fire detector
- ticking eggtimer
- flashmeter
- frequency meter
- VHF receiver

All in all, the November issue of Hobby Electronics is one not to be missed — so order your copy now!

The November issue of Hobby Electronics is on sale at your local newsagent from 9th October. Don't miss your copy - order it NOW!



Main Feature

Digits On Display

It may sound like an exhibition of five-finger exercises, but it's not. Instead, guest writer John Gilliam hopes to illuminate your knowledge of the main types of electronic display devices. From light emitting diodes (LEDs) to gas discharge displays (GDDs), this article will enlighten you on how these devices work.

WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.Os OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 50p TO ALL ORDERS UNDER £10 NET. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. ACCESS ORDERS WELCOME.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 15% to the total cost including p&p.

We stock thousands more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday, 9 a.m. to 6 p.m. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2 82p; 4µ7 85p.
160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n, 38p; 1µF 42p; 1µ5 45p; 2µ2 48p.
1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n 48p; 100n 50p; 470n 99p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10nF, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1µF 23p; 1µ5 40p; 2µ2 48p; 4µ7 60p.

ULTRASONIC TRANSDUCERS
40kHz 395p/pr

ELECTROLYTIC CAPACITORS: (Values are in µF) **500V:** 10 52p; 47 78p; **250V:** 100 65p; **63V:** 0.47, 1.0, 1.5, 2.2, 2.5, 3.3 8p; 4.7 9p; 6.8, 10 10p; 15, 22, 12p; 33 15p; 47 12p; 100, 19p; 1000 70p. **50V:** 47 12p; 68 20p; 220 24p; 470 32p; 2200 90p. **40V:** 4.7, 15, 22 9p; 3300 90p; 4700, 120p; **25V:** 1.5, 6.8, 10, 22 8p; 33 9p; 47 8p; 100 11p; 150 12p; 220, 15p; 330 22p; 470 25p; 680, 1000, 34p; 2200, 50p; 3300, 76p; 4700 92p; **16V:** 40, 47, 100 9p; 125, 12p; 220 13p; 470, 20p; 680 34p; 1000 27p; 1500, 31p; 2200 36p; 3300 74p; 4700 79p.
TAG-END TYPE: 70V: 4700, 245p; **64V:** 3300 198p; 2200 139p; **50V:** 3300 154p; 2200 110p; **40V:** 4700 160p; **25V:** 10,000 320p; 15,000 345p.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33 15p; 0.47, 0.68, 1.0µF, 1.5 16p; 2.2, 3.3 18p; 4.7, 6.8 22p; 10µF 28p; **16V:** 2.2, 3.3 16p; 4.7µF, 6.8, 10 18p; 15, 36p; 22 30p; 33, 47 40p; 100 75p; 220 88p; **10V:** 15, 22, 26p; 33, 47 35p; 100 55p; **6V:** 100 42p.

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4n7, 10 6p; 15nF, 22n 30n, 40, 47 7p; 56 100n, 200 9p; 470n/50V 12p.

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

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

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

SILVER MICA (Values in pF) 2, 3.3, 4.7, 6.8, 8.2, 10, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF 15p each; 200, 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 21p each; 1000, 1200, 1800, 2200 30p each; 3300, 4700pF 60p each

CERAMIC CAPACITORS 50V: 0.5pF to 10nF 4p; 22n to 47n 5p, 100n 7p.

EURO BREADBOARD £5.20.

POTENTIOMETERS: Rotary Carbon Track 0.25W Log & 0.5W Lin
500Ω 1KΩ & 2KΩ (Linear only) Single Gang 29p
5KΩ-2MΩ Single Gang 29p
5KΩ-2MΩ Single Gang D/P Switch 78p
5KΩ-2MΩ Double Gang 88p

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

PRESET POTENTIOMETERS
Vertical & Horizontal
0.1W 50Ω–5MΩ Miniature 7p
0.25W 100Ω–3.3MΩ horiz. 10p
0.25W 200Ω–4.7MΩ vert 10p

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

	RANGE	VAL	1-99	100+
¼W	2Ω2-4M7	E24	2p	1p
½W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-10M	E12	5p	4p
2% Metal Film	10Ω-1M		6p	4p
1% Metal Film	51Ω-1M		8p	6p

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

Gas and Smoke Detectors
TGS 812 and 813 575p

OPTO ELECTRONICS
LEDs with Clips

TIL209 Red	13
TIL211 Grn	18
TIL212 Yel.	18
2" Red	14
2" Yllw. Grn	18
Square LEDs	29
ORP12	86
2N5777	45
LD271	46
SFH205	98
TIL32	52
TIL78	54
7 Segment Displays	
TIL321 .5 CA	115
TIL322 .5 CC	115
DL704 .3 CCth	99
DL707 .3 CA	99
3 Green CA	120
DL747 .6 CA	180
FND357	120
MAN3640	175
10 Seg Bargraph	225
LCD 3½ Digits	550

SWITCHES
MEC. Black body. Red Grn. Blue.

SRL Latching	95
SRM Momentary	95
TOGGLE: 2A 250V.	
SPST	33
DPDT	44
4 Pole on/off	54
SUB-MIN TOGGLE	
SP changeover	60
SPST on/off	54
DPDT 6 tags	75
DPDT c/off	80
DPDT Biased	145
SLIDE 250V:	
1A DPDT	14
1A DP c/off	15
½A DPDT	13

We stock most of the parts for the Projects in this magazine

ACCESS
Just phone your order through. We deal with the rest (but min. £10 please).

SWITCHES Miniature Non-Locking
Push to Make 15 Push Break 20
ROCKER: SPST on/off 10A/250V 28
ROCKER: Illuminated (black) chrome bezel, lights when on DPST 3A 240V 85
ROTARY: (ADJUSTABLE STOP) 1 pole/2-12 way, 2p/2-6 way, 3p/2-4 way, 4p/2-3 way 45
ROTARY: Mains 250V AC. 4 Amp 52

DIL SOCKETS: 8-pin 8p; 14-pin 10p; 16-pin 10p; 18-pin 16p; 20-pin 22p; 24-pin 25p; 28-pin 28p; 40-pin 30p.

VOLTAGE REGULATORS

1A	TO3	+ ve	– ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	—	
18V	7818	145p	—	
1A	TO220 Plastic Casing			
5V	7805	50p	7905	55p
12V	7812	50p	7912	55p
15V	7815	50p	7915	55p
18V	7818	50p	7918	55p
24V	7824	50p	7924	55p
100mA	TO92 Plastic Casing			
5V	78L05	30p	79L05	60p
6V	78L62	30p	–	
8V	78L82	30p	–	
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

CA3085	95p	LM323K	625p	TAA550	50p
LM300H	170p	LM325N	240p	TBA625B	75p
LM305H	140p	LM326N	240p	TDA1412	150p
LM309K	135p	LM327	270p	78H05	550p
LM317K	350p	LM723	35p	78HG5	650p

JACKSONS VARIABLE CAPACITORS

Dielectric		0.2 365pF with slow	
100/300pF	220p	motion Drive	495p
500pF	250p	00 208/176	435p
6:1 Ball Drive		00 208/176	
4511/DAF	185p	with slow	
Dial Drive 4103		motion drive	495p
6:1/36:1	775p	C804-5pF: 10: 15:	
Drum 54mm	59p	25: 50pF	278p
0-1.365pF	350p	100, 150pF	350p
00-2.365pF	435p	'L' 3×310pF	725p
		00-3×25pF	575p

DENCO COILS

'DP' VALVE TYPE		RFC 5 chokes	140p
Range 1 to 5 BL.,		RFC 7 (19mH)	
RD, T1 Wht.	122p		160p
6-7 B-Y-R	110p	13; 14; 15; 16; 17	
1.5 Green	150p		120p
'T' type 1 to 5. Bl,		18/1.6	135p
Rd, Wht, Yl	150p	18/465	152p
B9A Valve Holder		TOC 1	124p
	42p	MW5FR	122p
RDT2	145p	MW/LW SFR	154p

VEROBOARD

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

COPPER
Clad Boards
Fibre glass 6x6" 90p
6x12" 150p
SRBP 9x8 95p
Ferric Chloride 1lb Anhydr 195p

DIODES

BY126	12
BY127	12
CRD33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5401/2	15
IN5404	16
IN5406	17
IN5408	19
IS44	9
1S921	9

We stock a wide selection of Electronic Books and Magazines

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

NOISE
Diode 195p

BRIDGE RECTIFIERS

(plastic case)	p
1A/50V	20
1A/100V	22
1A/400V	29
1A/600V	34
2A/50V	35
2A 200V	46
2A/400V	48
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A, 200V	215
10A/600V	350
25A/200V	240
25A/600V	395
BY164	56
VM18	50

DIAC
ST2 25

SCRs Thyristors

1A200V	58
1A400V	70
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

TRIACS

3A100V	48
3A200V	54
3A400V	56
8A100V	60
8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	135
16A100V	103
16A500V	115
25A800V	220
25A1000V	480
T2800D	120

7400 TTL

7400	11	7441	68	7497	120
7401	11	7442	38	74100	85
7402	11	7443	90	74104	54
7403	14	7444	90	74105	55
7404	14	7445	65	74107	32
7405	18	7446	55	74109	35
7406	28	7447	50	74110	40
7407	28	7448	50	74111	55
7408	16	7450	16	74112	170
7409	16	7451	16	74116	88
7410	14	7453	16	74118	80
7411	20	7454	16	74119	90
7412	20	7460	16	74120	75
7413	24	7470	35	74121	30
7414	32	7472	30	74122	45
7416	25	7473	30	74123	50
7417	25	7474	25	74125	42
7420	16	7475	40		
7421	20	7476	30		
7422	20	7480	48		
7423	22	7481	120		
7425	28	7482	70		
7426	30	7483	50		
7427	27	7484	80		
7428	28	7485	95		
7430	16	7486	26		
7432	26	7489	205		
7433	27	7490	28		
7437	27	7491	45		
7438	27	7492	30		
7440	17	7493	30		
		7494	34		
		7495	50		
		7496	45		

74126	40	74173	65
74128	42	74174	72
74132	48	74175	72
74136	35	74176	55
74141	70	74177	75
74142	190	74178	95
74143	250	74180	65
74145	70	74181	140
74147	99	74182	75
74148	75	74184	99
74150	80	74185	99
74151	45	74188	290
74153	45	74190	70
74154	75	74191	70
74156	75	74192	70
74157	45	74193	65
74159	99	74194	75
74160	60	74195	65
74161	60	74196	65
74162	62	74197	65
74163	64	74198	99
74164	64	74221	80
74165	62	74246	150
74166	65	74247	150
74167	185	74248	150
74170	168		
74172	290		

74LS

74LS00	12	LS48	80	LS147	199
LS01	13	LS55	30	LS148	99
LS02	14	LS63	150	LS151	39
LS03	14	LS73	25	LS153	39
LS04	15	LS74	25	LS155	39
LS05	15	LS75	28	LS157	35
LS06	15	LS76	20	LS158	36
LS08	15	LS83	50	LS160	41
LS09	15	LS85	70	LS161	41
LS10	15	LS86	38	LS162	41
LS11	15	LS90	35	LS163	41
LS12	15	LS92	36	LS164	48
LS13	30	LS93	36	LS165	145
LS14	48	LS95	45	LS166	85
LS15	15	LS96	120	LS173	72
LS20	15	LS107	43	LS174	72
LS21	15	LS109	30	LS175	58
LS22	15	LS112	30	LS181	130
LS26	18	LS113	40	LS190	58
LS27	15	LS114	35	LS191	58
LS28	20	LS122	44	LS192	58
LS30	18	LS123	55	LS193	65
LS32	15	LS124	105	LS195	40
LS33	16	LS125	30	LS196	58
LS37	16	LS126	30	LS197	85
LS38	16	LS132	45	LS221	60
LS40	16	LS133	35	LS240	96
LS42	35	LS136	28	LS241	96
LS47	40	LS138	35	LS242	85
		LS139	38	LS243	85
		LS145	75	LS244	80
				LS245	118
				LS247	40
				LS248	65
				LS249	68
				LS251	40
				LS253	40
				LS257	48

CMOS

4000	14	4015	66	4053	78	4412	800
4001	14	4016	32	4054	125	4415	480
4002	14	4017	48	4055	125	4419	280
4006	66	4018	68	4056	120	4422	770
4007	18	4019	42	4057	1915	4433	770
4008	62	4020	61	4059	480	4435	850
4009	35	4021	70	4060	90	4440	999
4010	40	4022	66	4061	1225	4450	350
4011	15	4023	20	4062	995	4451	350
4012	18	4024	45	4063	99	4490	350
4013	34	4025	19	4066	36	4500	675
4014	75	4026	130	4067	399	4501	28
		4027	38	4068	22	4502	90
		4028	58	4069	20	4503	50
		4029	77	4070	26	4504	105
		4030	50	4071	20	4506	65
		4031	170	4072	20	4507	40
		4032	125	4073	20	4508	265
		4033	165	4075	20	4510	68
		4034	195	4076	60	4511	68
		4035	95	4077	26	4512	75
		4036	275	4078	26		
		4037	115	4081	26		
		4038	110	4082	21		
		4039	290	4085	65		
		4040	59	4086	70		
		4041	78	4089	140		
		4042	60	4093	43		
		4043	70	4094	168		
		4044	65	4095	90		
		4045	170	4096	90		
		4046	75	4097	320		
		4047	75	4098	88		
		4048	55	4099	95		
		4049	30	4160	95		
		4050	30	4161	99		
		4051	78	4162	99		
		4052	78	4163	99		
				4174	99		
				4175	105		
				4194	105		
				4408	790		
				4409	790		
				4410	725		
				4411	695		

LINEAR ICs

2102-2	225	LF351	48
2114L-3	99	LF355	75
2708	225	LF356	85
2716	250	LM300HX	170
4116	99	LM301A	26
6502	495	LM308	95
6522	495	LM318	200
6800	375	LM324	50
709C 8 pin	35	LM339	68
710	48	LM348	90
733	75	LM349	115
741 8 pin	14	LM358	50
747C	78	LM379	375
748C	36	LM380	80
753	150	LM381	145
810	159	LM382	125
81LS95	115	LM384	99
81LS96	115	LM386	99
81LS97	115	LM387	120
9400CJ	350	LM1458	45
AY-1-0212	675	LM2917	195
AY-1-1313A	660	LM3900	60
AY-1-1320	225	LM3909N	70
AY-1-5050	99	LM3911	125
AY-1-5051	160	LM3914	220
AY-3-8500	390	LM3915	220
AY-3-8910	720	LM3916	240
AY-5-1224A	235	M252	625
AY-5-1230	450	M253AA	1150
CA3018	68	MC1304P	260
CA3020	186	MC1310	150
CA3023	191	MC1455	150
CA3028A	80	MC1458	45
CA3035	235	MC1488	75
CA3045	365	MC1489	75
CA3046	70	MC1494	694
CA3048	214	MC1495	350
CA3059	195	MC1496	92
CA3080E	65	MC1648	290
CA3081	190	MC1709G	90
CA3085	95	MC1710	79
CA3089E	215	MC3340P	120
CA3090AQ	375	MC3360P	120
CA3123E	150	MC3401	52
CA3130	90	MC3403	89
CA3140	48	MFC6040	97
CA3189	295	MK50398	635
ICL7106E	795	MM5303	635
ICL7107	975	MM5307	1275
ICL8038CC	340	NE543	210
ICM7205	1150	NE544	185
ICM7216A	1950	NE555	16
ICM7217A	790	NE556	55
ICM7555	80	NE560	325
LA4032	295	NE561	398
LC7130	495	NE562	410
LD130	452	NE564	435
		NE565	120
		NE566	160
		NE567	170
		NE570	450
		NE571	420
		RC4136	69
		S566B	245
		SAB3209	425
		SAB3210	275
		SAB3271	485
		SN76003	240
		SN76013N	250
		SN76023	170
		SN76033	195
		SN76477	175
		SP8629	299
		TAA621	250
		TA7205A	225
		TAD100	159
		TBA120	70
		TBA641	250
		TBA800	90
		TBA810	95
		TBA820	70
		TCA965	120
		TDA1004	290
		TDA1008	310
		TDA1022	575
		TDA1024	105
		TDA1490	290
		TDA2020	320
		TL061	46
		TL063	95
		TL071CP	45
		TL074	140
		TL081	42
		TL082	70
		TL083	95
		TL084	120
		UAA170	170
		UAA180	170
		XR2206	300
		XR2211	575
		Z80CPU	390
		Z80ACPU	550
		Z80ACTC	440
		Z80CTC	400
		Z80P10	400
		Z80AP10	440
		ZN1034E	200
		ZN1040E	685
		ZN414	95
		ZN424E	130
		ZN425E	415
		ZN426E	325
		ZN427	625
		ZN428	478
		ZN429	210

TRANSISTORS

AC125	35	BC477	40	E421	250	TIS44	45	2N3704/5	10
AC126/7	35	BC516/7	40	MJ2955	90	TIS88A	50	2N3706/7	10
AC128	25	BC547/8	14	MJE340	54	TIS90	30	2N3708/9	10
AC141/2	30	BC549	14	MJE370	100	TIS91	32	2N3710/11	10
AC176/87	25	BC556/7	15	MJE371	100	ZTX107/8	11	2N3713	140
AC188	30	BC558/9	15	MJE520/1	95	ZTX109	12	2N3771	179
ACY17/18	70	BCY70	16	MJE2955	99	ZTX300	13	2N3772	195
ACY20/1	75	BCY71	18	MJE3055	70	ZTX301/2	16	2N3773	270
ACY22	60	BCY72	20	MPF102	66	ZTX303	25	2N3819	22
AD140	120	BD131/2	48	MPF103	36	ZTX304	17	2N3820	45
AD149	79	BD133	60	MPF104	36	ZTX314	25	2N3822/3	65
AD161/2	42	BD135	45	MPF105	36	ZTX326	30	2N3866	90
AF115	60	BD136/7	40	MPF106	40	ZTX341	30	2N3903/4	18
AF139	40	BD138/9	40	MPSA05/6	25	ZTX500	14	2N3905	15
AF178	75	BD140	40	MPSA12	30	ZTX501/2	15	2N3906	17
AF180/6	70	BD695A	85	MPSA55	30	ZTX503	18	2N4037	46
AF239	78	BD696A	85	MPSA56	30	ZTX504	25	2N4058	10
BC107/8	10	BDY17	195	MPSU06	55	ZTX531	25	2N4061/2	10
BC108B	12	BDY60	160	MRSU56	60	ZTX550	25	2N4069	45
BC108C	12	BDY61	160	OC28	120	2N526	58	2N4859	78
BC109	10	BF115	35	OC35	125	2N696	30	2N4871	55
BC109B	12	BF167	29	OC36	120	2N697	23	2N5135/6	20
BC109C	12	BF173	27	OC41/2	120	2N698	40	2N5138	18
BC117	24	BF177	25	OC44	120	2N699	48	2N5179	45
BC119	38	BF178	30	OC45/70	40	2N706	19	2N5180	45
BC137	40	BF179	35	OC71/2	40	2N918	35	2N5191	75
BC140/3	30	BF180	38	OC76	50	2N930	20	2N5305	24
BC147/8	9	BF194/5	12	OC81/2	50	2N961	65	2N5457/8	36
BC149	9	BF196/7	12	OC83/4	40	2N1131/2	24	2N5459	36
BC153/4	27	BF198	16	OC170/1	85	2N1304	65	2N5485	36
BC157/8	10	BF200	30	TIP29	34	2N1305	60	2N5777	45
BC159	11	BF224A	25	TIP29C	60	2N1306/7	65	2N6027	32
BC160	45	BF244	28	TIP30	48	2N1671B	120	2SA715	60
BC167A	10	BF256	35	TIP30A	48	2N2160	350	2SC495	70
BC168C	10	BF257/8	32	TIP30C	58	2N2219A	28	2SC496	70
BC169C	10	BF259	35	TIP31A	45	2N2220A	23	2SC1096	85
BC170	15	BF594/5	40	TIP31C	55	2N2222	25	2SC1173	125
BC171/2	11	BFR39/40	23	TIP32A	46	2N2369A	18	2SC1306	150
BC177/8	20	BFR41/79	23	TIP32C	60	2N2476	50	2SC1307	220
BC179	20	BFR80/81	25	TIP33A	65	2N2483	27	2SC1449	85
BC182/2L	10	BFX29	28	TIP33C	78	2N2497	63	2SC1923	50
BC183/L	10	BFX81	45	TIP34A	74	2N2646	45	2SC1945	225
BC184	10	BFX84	26	TIP34C	88	2N2894	30	2SC1953	90
BC184L	10	BFX85/6	28	TIP35A	160	2N2904	28	2SC1957	90
BC187	26	BFX87/8	28	TIP35C	185	2N2905A	26	2SC1969	198
BC212	10	BFY50/1	23	TIP36A	170	2N2906/7	26	2SC2028	85
BC212L	10	BFY52	23	TIP36C	199	2N2926G	10	2SC2029	180
BC213	10	BRY39	40	TIP41A	55	2N3053	26	2SC2078	155
BC213L	10	BSX20	20	TIP41B	60	2N3054	58	2SC2091	85
BC214	10	BSY65	35	TIP42A	60	2N3055	48	2SC2314	85
BC214L	10	BSY95A	25	TIP42B	75	2N3121	30	2SC2166	165
BC307B	14	BU105	170	TIP120	90	2N3133	45	2SC1679	190
BC328	95	BU205	190	TIP121/2	99	2N3135	30	3N128	112
BC338	15	BU208	200	TIP142	120	2N3252	46	3N140	112
BC441	34	E113	45	TIP147	120	2N3442	140	40311	60
BC461	34	E176	50	TIP2955	60	2N3568	25	40313	130
				TIP3055	60	2N3663	15	40316	95
				TIS43	32	2N3702/3	10	40317	60

40324	100
40326	60
40327	70
40347	90
40348	120
40360	40
40361/2	50
40407	60
40408	70
40411	285
40412	65
40467	130
40468	85
40594	105
40595	110
40603	110
40636	175
40673	95

Entryphone

Protect yourself from a monster lurking outside your front door with this superb project. Do-it-yourself security at an affordable price

THE FRONT DOOR of your home can leave you vulnerable to unwanted visitors — particularly those intent on forcing an entry. You would be a lot safer if you could speak to your visitors and wait for a reply before opening the door.

The HE Entryphone gives you this facility. It's a two-way communication project which allows the householder to speak to visitors before opening the door. For our flat-dwelling readers there is an extra advantage — apart from providing a method of intercommunication, the project can be used with an electric latch such as that shown in this article (and also with the HE Combination Lock on page 21), to allow remote opening of a door lock. Thus, although you may live on the 100th floor of a block of flats, you don't have to rush downstairs to let in an unknown caller — you simply verify who the caller is with the Entryphone, and then open the door from the safety and comfort of your flat.

The project features battery operation and long battery life: in its standby mode, no current is used at all. When a caller presses the door button the Entryphone bleeps, at the master control and at the remote door terminal. Thus the owner is made aware of the caller and the caller knows that the Entryphone is working.

As the main control is switched from standby to on, a LED lights and the Entryphone is then used as an intercom, with the householder controlling who talks and who listens.

Finally, operation of a toggle switch will open a low-voltage solenoid-operated latch so that the caller can push open the door and enter.

Construction

Start construction by breaking the tracks, where indicated in **Fig.2**, underneath the Veroboard. (See Building Site this month if you're not too sure how it's done.)

Insert and solder all components individually, making sure you position all the polarised ones (eg, transistors, ICs,

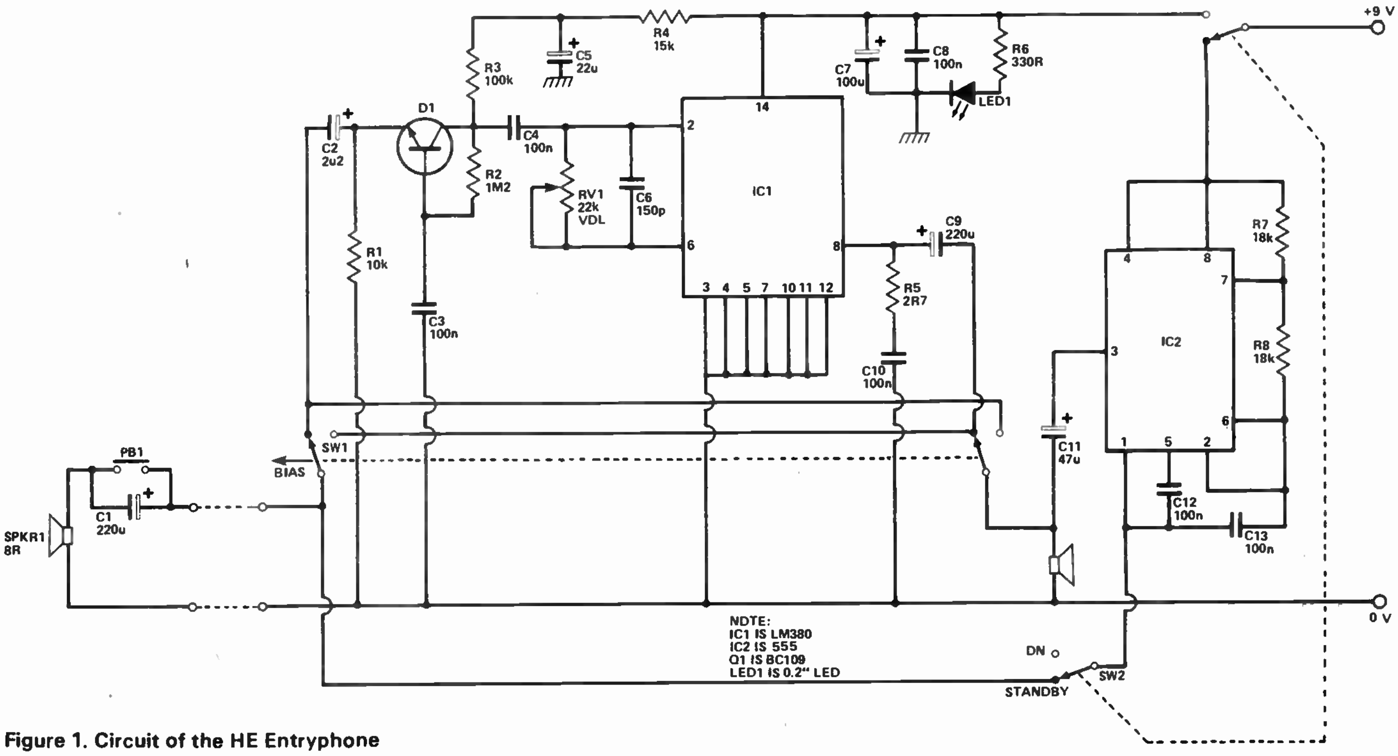


Figure 1. Circuit of the HE Entryphone

electrolytic capacitors) the right way round. Cut off all excess component leads underneath the board.

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

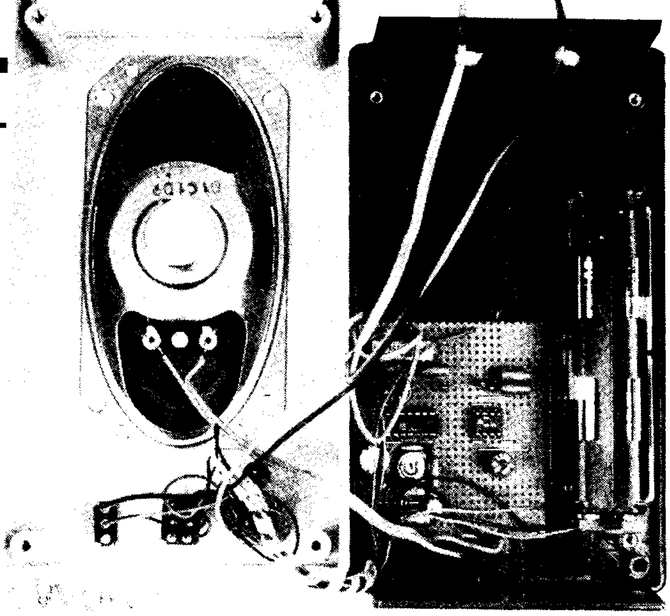
Now mark and drill the main case for the three switches, the LED, and a matrix of holes to act as a grille for the loudspeaker. Glue the loudspeaker to the inside of the case taking care to get no glue on the cone.

Fasten the three switches to the case, making sure the biased ones (the listen/talk, and the open switches) are biased in the 'up' direction.

Fit the LED in a panel clip. Using double-sided, self-adhesive pads, stick down the two sets of batteries and the Veroboard. Wire up your project, carefully following **Fig.2**.

Drill a matrix of holes in the remote small case to suit the loudspeaker, and a further one for a small push button switch. Mount the loudspeaker to the inside of the case with glue, and fasten in the push switch. **Figure 3** gives details of the wiring inside this case.

Finally, connect the main case to the electric lock and try the project out. If you use this project together with the HE Combination Lock and its electric solenoid-operated lock, *make sure you connect the earth side (0 V) of the batteries of both projects to the same terminal of the lock.*



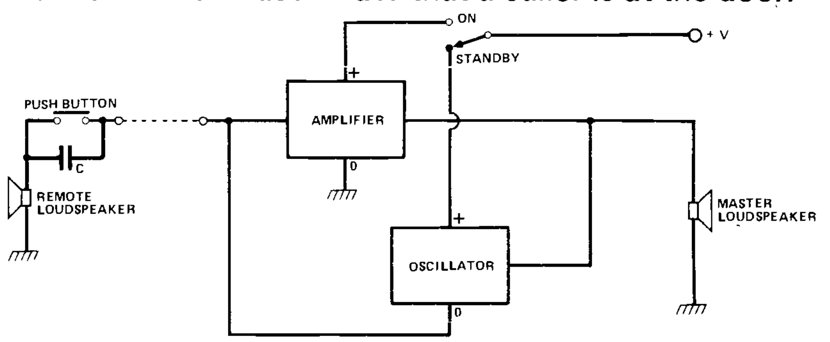
Layout of our prototype Entryphone

RESISTORS (All ¼ W, 5%)	
R1	10k
R2	1M2
R3	100k
R4	15k
R5	2R7
R6	330R
R7, 8	18k
POTENTIOMETER	
RV1	22k miniature horizontal preset
CAPACITORS	
C1,9	220u, 16 V electrolytic
C2	2u2, 16 V electrolytic
C3,4,8,1-0,12,13	100n polyester
C5	22u, 16 V electrolytic
C6	150p polystyrene
C7	100u, 16 V electrolytic
C11	47u, 16 V electrolytic
SEMICONDUCTORS	
IC1	LM380, 2 watt power amplifier
IC2	555 timer
Q1	BC109 NPN transistor
LED1	0.2" red LED + panel clip
MISCELLANEOUS	
LS1,2	8R, 2 watt loudspeaker
SW1	double-pole, double-throw biased toggle switch
SW2	double-pole, double-throw toggle switch
SW3	single-pole, double-throw biased toggle switch
PB1	push-to-make, release-to-break push button switch
8 x AA-sized cells + 2 x battery holders + 2 x battery clips	
Cases to suit	
Solenoid operated lock (5-8 VDC)	
2- or 3-core connecting lead	

When the push button switch is open, the oscillator's 0 V supply rail is coupled through the capacitor C. Because a capacitor does not pass direct current the oscillator is consequently inoperative.

However, a capacitor *does* pass alternating current so sound picked up by the loudspeaker is passed through to the amplifier and on to the master loudspeaker.

In the standby mode the amplifier is switched off. However, when a caller arrives and presses the push button the oscillator derives its 0 V supply rail through the switch and remote loudspeaker. Thus the oscillator generates a tone which drives the master loudspeaker and warns the householder that a caller is at the door.

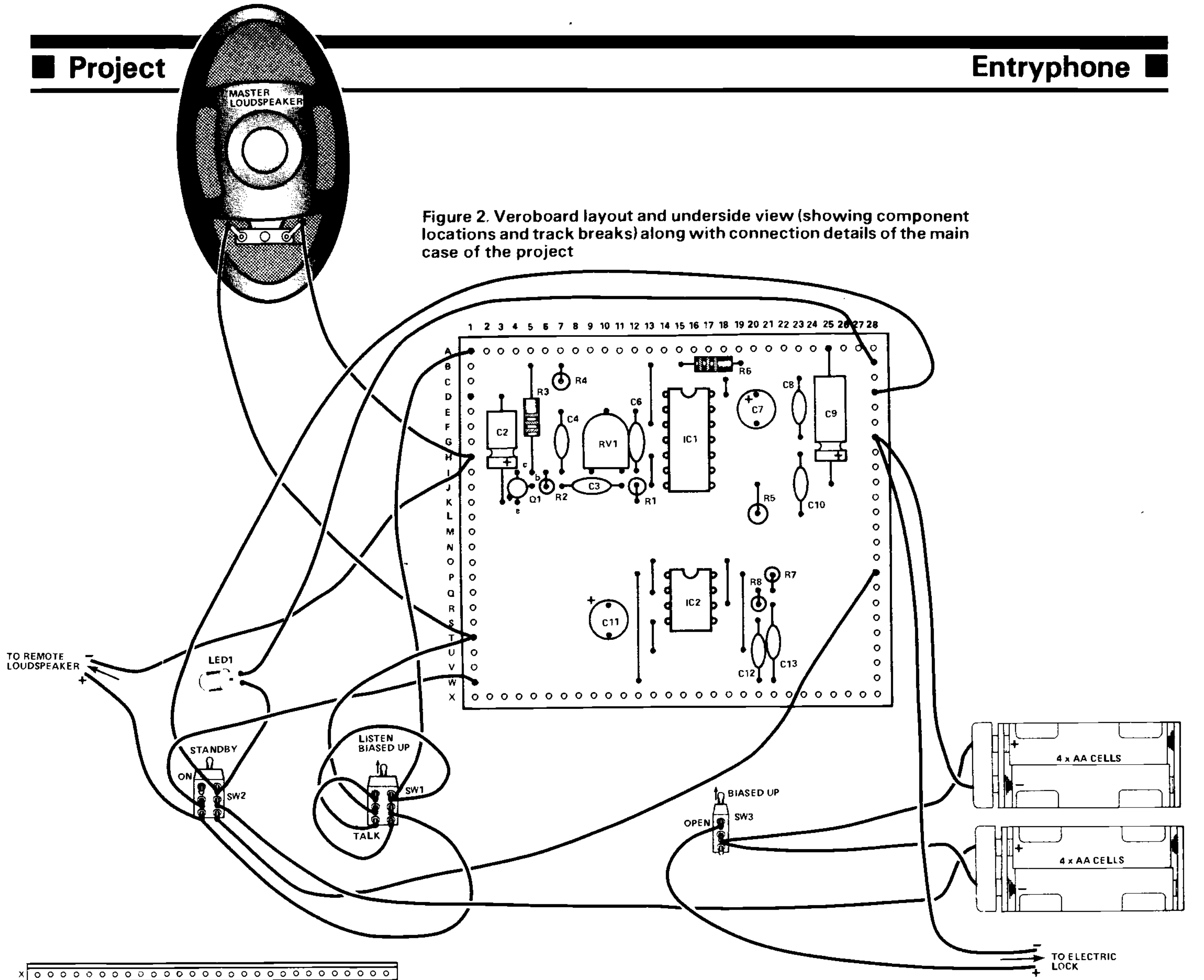


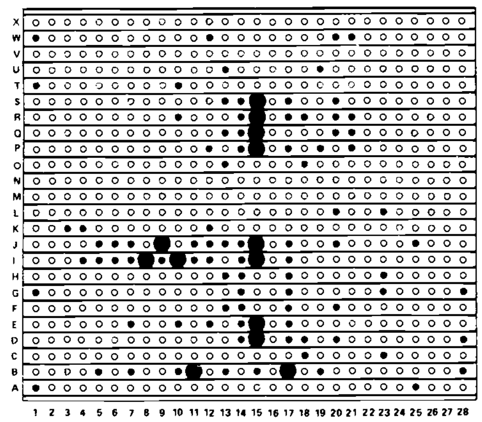
In the standby mode, switch SW2 connects the +12 V rail from the battery to IC2. The 0 V terminal of IC2 is connected to remote loudspeaker LS1 via push button PB1, in parallel with capacitor C1. The push button is open and C1 cannot pass the direct current necessary to turn on IC2. However, upon PB1 being operated the current is passed via LS1 to 0 V. Integrated circuit IC2 turns on — it is connected as a simple astable multivibrator, the output of which from pin 3 is connected to master loudspeaker LS2. A bleep is emitted from the master loudspeaker and the remote loudspeaker.

When switch SW2 is operated by the user, both 0 V and +12 V supply rails are disconnected from IC2 and power is instead applied to the remainder of the ciruit — an amplifier. Switch SW1 is biased so that the remote loudspeaker is connected to the amplifier input, and the amplifier output is connected to the master loudspeaker. Thus the user can hear the caller. Operating SW1 connects the loudspeakers in reverse, so that the user can talk to the caller.

The amplifier consists of two simple stages: a transistor pre-amplifier and an IC power amplifier. Transistor Q1 is in a common base configuration, which gives a low impedance input (to match the low impedance loudspeakers) and a high impedance output (to match the power amplifier IC). Preset RV1 controls volume and should be set so that neither user nor caller have to talk too close to their respective loudspeaker to be heard.

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





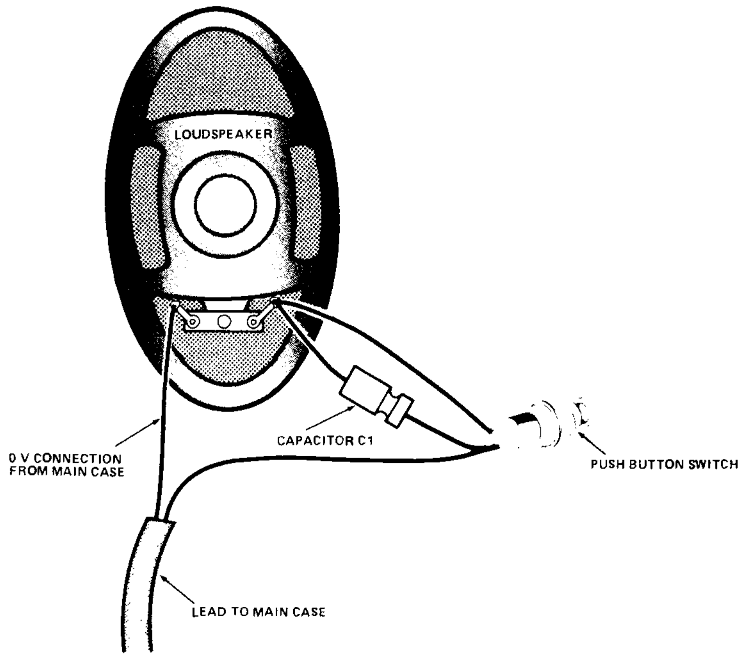


Figure 3. Connection details of the small case of the HE Entryphone project

HE

Buylines

All parts for this project are easily obtainable from most of the mail order companies advertising in HE. Approximate cost of components (excluding case, solenoid-operated lock and batteries) is £11.

The electric solenoid-operated lock (see also the Buylines section of the HE Combination Lock article) is obtainable from:

BSG(Security)Ltd
34/35 Dean Street
London W1V 5AP
(tel 01 439 4536)

AERIALS

As Ian Sinclair explains, for best results an aerial must be a good match to your receiver (or transceiver when legal CB arrives)

IF THERE'S ANY topic that can be guaranteed to baffle the beginner to radio, it's aerials. Looking into any book on the theory of aerials is enough to make any beginner drop it all in favour of something simple like five-dimensional chess. To the beginner, it always looks as if aerials are something quite apart from the rest of radio — and that's a pity, because a good grasp of what aerials are about is an essential part of radio. With CB about to become legal, it's more important than ever to know something about what an aerial does and how it does it. Fasten your seatbelts, then, and prepare for the HE guided tour round the world of the air waves.

Old-Timers

Way back in the pioneering days of radio, you just strung a long bit of wire, preferably nice thick stranded copper, between a pair of handy trees, using porcelain insulators to keep the wire from shorting against the trees. Next you hitched the output of your transmitter or the input of your receiver to the wire — and that was your aerial (see **Fig.1**). One alternative very popular among the pioneers was to use a kite to take the wire up almost vertically, but that way you needed wind and someone to handle the kite. Trees are much more co-operative.

Even using that simple system required some knowledge about aerials, and that knowledge, which is still the starting point for all aerial theory, is Maxwell's Theory of Electromagnetic Radiation.

Now we're certainly not getting into a full mathematical explanation which needs rather more than A levels in Maths and Physics but we do need to be clear about what this theory is. Maxwell had been working (in 1864) with equations of electricity and magnetism. He was doing something that mathematical physicists did before his time, and have done since — writing down a set of equations and looking for patterns of similarities. In particular, he was looking at the equation for the strength of magnetism that is produced by electric current flowing, and the equation for the amount of voltage that is generated when the magnetism around a material is changed. What he was looking for was some sort of pattern, and he thought he could see one — but with a piece missing. The missing piece was an equation containing a new type of electric current which could flow between two insulated conductors. Maxwell called this a 'displacement current', and constructed an equation under the assumption that such a current could exist.

Now there was no practical reason to suppose that such currents did exist, but like any good mathematician, Maxwell ignored this and continued to rearrange the equations. With the displacement current in place the equations formed a pattern which took on a familiar appearance — that of the equation of a wave. Any sort of wave, from water waves to sound waves, can be represented by the same type of equation, and there is one recognisable part of this which represents the speed of the waves. Looking at the new equation that he had worked out, Maxwell found the section that gave the speed of the waves. Since he had started with electrical equations, this section of the equation consisted of electrical quantities. A quick bit of arithmetic showed that the speed of the waves was the same as the measured speed of light.

There isn't much room for coincidences in mathematics, so Maxwell was convinced that this value wasn't accidental. But if it wasn't he had discovered something very important indeed, something that had been suspected: light was a wave that was both electrical and magnetic. As if that wasn't enough Maxwell went one step further, to predict that other waves must also exist which could travel in space at the same speed as light but which would be invisible to the human eye.

He called these 'electromagnetic waves' and in 1888 his theories were proved in practice when Heinrich Hertz succeeded in generating radio waves, and proved that they obeyed Maxwell's equations. Why should there be a whole family of waves? All waves are caused by oscillations which have a frequency, equivalent to the number of oscillations per second. In addition you can see, by looking at water waves, a definite distance between one wavepeak and the next — we call this the wavelength. All waves have a measurable wavelength, and when the two quantities frequency and wavelength are multiplied together, the result is the speed of the wave (**Fig.2**).

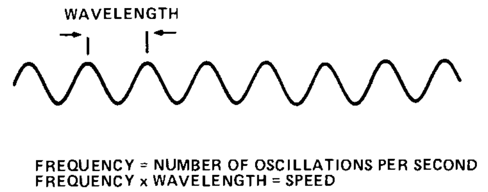


Figure 2. Wavelength, frequency and speed. The wavelength of visible waves, like water waves, can be measured easily, but wavelengths can also be measured even when the wave is not visible. The product of wavelength and frequency is the speed of the wave

In the middle of the 19th century, the idea of waves with different values of frequency and wavelength but with the same speed was familiar because of work with sound waves. A low-

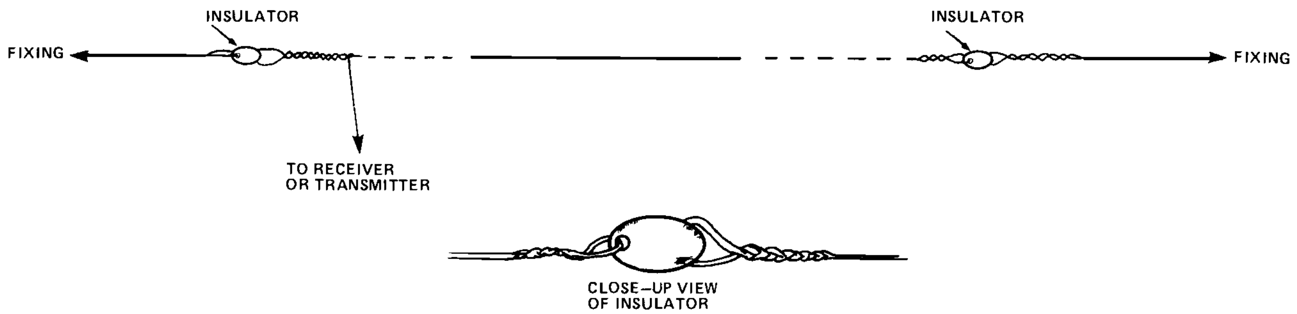


Figure 1. Classical aerial. The main aerial wire is supported by a wire at each side, insulated from the aerial and fastened to a tree or a tower. The line which joins the aerial to the receiver or the transmitter is fastened to one end of the aerial

pitched sound — a deep note — has a low frequency (perhaps around 50 hertz (Hz), meaning 50 vibrations per second) and has a long wavelength, around 6.6 m for a 50 Hz wave. A high-pitched note — a treble note — might have a frequency of 10 kHz (10,000 vibrations per second) and a wavelength of about 33 mm. These are both sounds that we can hear, and the other feature that they have in common is that the frequency multiplied by the wavelength of each wave gives the speed, which is 330 m per second for all these sound waves in air. This family of sound waves also includes ones which we can't hear, and which are called ultrasonic.

Maxwell knew from the work of Newton some two hundred years earlier, and from much that had been done since, that there must be a family of light waves, because the different colours of light are caused by waves with different frequencies and wavelengths. There seemed no reason why there should not be waves with very different values of frequency and wavelength, but with the same speed and, in particular, ones that could be generated by purely electrical methods.

Launching Voucher

Let's review the situation. A radio wave consists of two lots of oscillations, an electric and a magnetic-oscillation travelling through space together as a wave which we call an electromagnetic wave. Aerials serve two purposes: to launch these waves into space (transmitting them) and to recover them, so that we can receive the waves. The question is, what's so special about this piece of wire we call an aerial? Before we can answer that one, think about another question — what's so special about space? The answer, after you've got over the initial surprise of having electricity flow in the form of waves through space, is 'not very much'. When radio waves are transmitted, we can measure signal voltages at the aerial, and also signal currents. Now if we measured a voltage across a resistor and a current through it, we could take the ratio voltage/current, and call it the resistance — that's what we refer to (wrongly, in fact) as Ohm's law. Can we talk about the resistance of space? No, because resistance passes direct current (DC), and space doesn't, so we have to use a term borrowed from alternating current theory — *impedance*. An impedance is still the ratio of voltage/current, but for alternating current (AC) not DC, though its unit is the same as that of resistance, the ohm. When we measure this ratio for space, we come up with a consistent value of around 377 ohms (377R), and we call this quantity the 'characteristic impedance of free space'. What it means in practical terms is that launching a wave into space is pretty much the same thing electrically as launching it into a 377R resistor!

If you want to connect an amplifier so that its output goes into a 377R resistor, you just connect the resistor to the output. You will certainly get some signal flowing through the resistor, just as you will get some signal transmitted from any old piece of wire used as an aerial and connected to a transmitter. What you don't get is efficiency. The term efficiency means, in this context, getting as much signal power as possible into your 377R resistor, and it's a much more difficult business than just ensuring that the signal gets there. At the low frequencies (LF) which we use in audio amplifiers, the problem is solved by making sure that the output stage of the amplifier has a resistance much lower than the 8R impedance of a typical loudspeaker. When we work with high frequency (HF) waves, however, we have other problems on our hands, namely those of reflections and standing waves, as described further on in this article.

Waves And Counter Waves

What makes HF waves so different from LF waves? One of the actions common to all waves helps us to answer this question — that of reflection. Light waves bounce from any shiny surface, and we can see the reflections. Radio waves will bounce from conducting surfaces, such as metal plates or layers of conducting gases such as those which exist above the Earth's atmosphere, but the size of the reflector is important. There is hardly any reflection of radio waves from a metal plate the size of which (width or length) is only a fraction of the wavelength of the wave. Now the wavelength of a light wave is very small, only about a ten-thousandth of a millimetre, so we can see light reflected from mirrors large or small but we can't see very small objects, like viruses, using light, no matter how powerful a microscope we use because the light simply doesn't reflect from such small objects. The wavelengths of radio waves are much longer, ranging, for example, from about 11 m for the lower frequency that has been proposed for CB in this country all the way to several *kilometres* for the long-wave broadcasting stations. At the other extreme, the wavelengths of ultra high frequency (UHF) waves of television transmissions are only a few centimetres long.

These examples help to explain why we don't meet wave problems with audio amplifiers — the wavelengths of audio signals are so very much longer than any possible dimensions of audio equipment. (Ever seen an amplifier 300 km* across?) Even a high audio frequency of 20 kHz corresponds to a wavelength of 15 km.

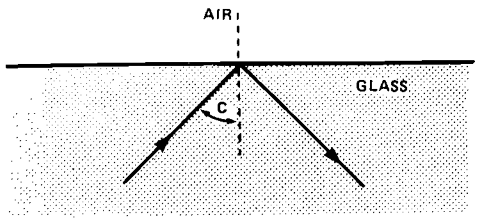


Figure 3. Reflection is not confined to mirrors — anywhere that light or any other wave passes from one material to another there will be reflection. This is total if the angle shown is greater than what is called the critical angle

On Reflection

Having established the importance of wavelength, we now have to look more closely at reflections. We are accustomed to seeing light reflected from mirrors, but light can also be reflected from air! A beam of light travelling through glass at more than a critical angle will be reflected from the glass-to-air surface just as if it had struck a mirror (see **Fig.3**). The reflection is the result of the change of material (from glass to air). Radio waves show very much the same kind of behaviour, as we might expect. Suppose, for example, we have a radio wave travelling along two parallel wires. Like space, this arrangement will have a characteristic impedance so that the ratio of signal voltage to signal current for the wave is a definite number of ohms. Let's assume that we've spaced the wires so that this value is 300R. (The distance between the two wires greatly influences the characteristic impedance.) If we have a 300R resistor at the end of the wires, the waves will travel down the wires and the resistor will have a voltage across it and a current through it. In this way the power of the waves will be converted to heat in the resistor. It's just like shining a beam of light into a block of dull-black material — there's practically no reflection, the material just soaks up the waves. If, at the end of our parallel wires we have a short circuit or an open circuit, however, things are very different. Either of these conditions will cause the waves to be reflected so that a set of reflected waves will also exist, travelling in the opposite direction to the original lot of waves on the wires.

There's a fair chance that when a wave has been reflected from one end of a pair of wires it will also be reflected from the other end, so you might imagine that the result would be a jumble of waves whizzing to and fro. In fact, it's not quite like that. As it happens, waves affect the space or material they travel through and don't affect each other. When waves meet, all we can detect is the combined effect of the waves. For example, if the waves meet with their peaks coinciding (see **Fig.4**) they reinforce to create a larger wave, but if they meet so that the peaks of one wave coincide with the troughs of the other, the result is nothing. The same occurs when a reflected wave meets the travelling wave that produced it, and the result is a pattern which we call a standing wave.

***This corresponds to an audio frequency of 100 Hz.**

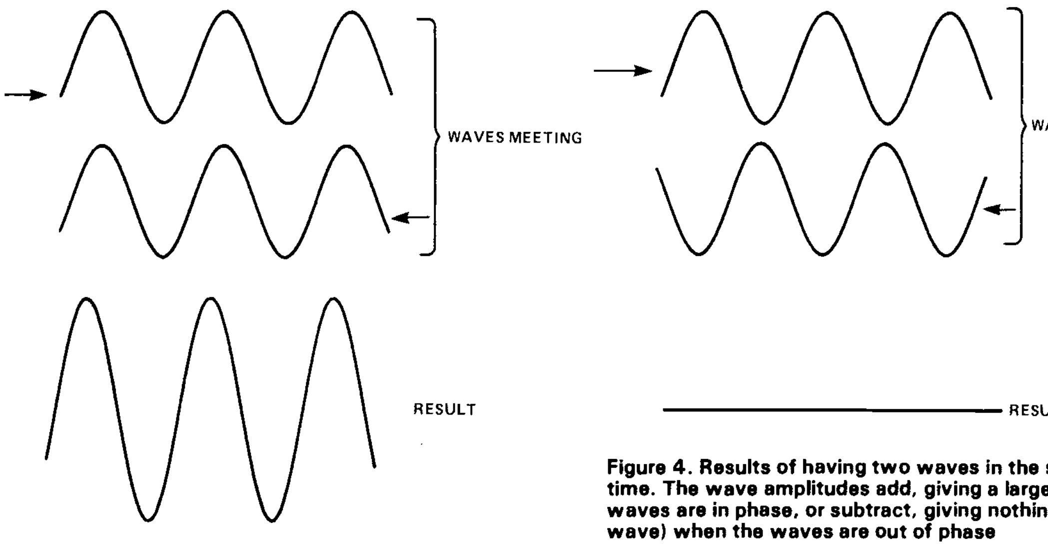


Figure 4. Results of having two waves in the same place at the same time. The wave amplitudes add, giving a larger wave when the waves are in phase, or subtract, giving nothing (or a very small wave) when the waves are out of phase

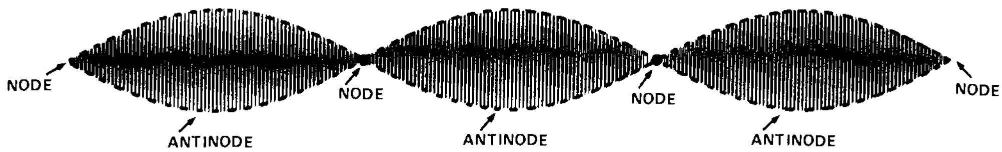


Figure 5. A standing wave. The nodes are points where there is no trace of wave at any time. At the antinodes, the amount of oscillation is a maximum. If the nodes can be detected, this is a convenient way of measuring wavelength, which is the distance from one node to the next-but-one

Waves Of Long Standing

Standing waves can be found wherever a wave can be reflected and, if the conditions are right, they will set up a pattern of waves which, as the name suggests, do not move (see **Fig.5**). In this pattern there will be places where the wave is permanently cancelled out (called nodes) and places where the oscillation is more pronounced than others (called antinodes).

In acoustic terms, the nodes and antinodes of standing waves help to determine the properties of sounds. For example, when you speak, the formation of standing waves in your throat affects the sound of your voice. You can change this sound drastically by altering these standing waves by, for example, speaking into the mouth of a bottle. The sound that you get from any acoustic musical instrument is also the result of the formation of standing waves in the material it is made from or the shape and size of its sound chamber.

These standing wave nodes and antinodes can have important consequences in the way they form in aerials and the wires, called lines or feeders, which connect transmitters to the aerials, as we shall see.

Nitty Gritty

With all these tedious but necessary preliminaries disposed of, we can now take a look at yer actual aerial. The aim of a transmitting aerial is to pass as much power to the space around it as possible, and as we have seen, the space behaves as if it were a 377R resistor. The receiving aerial is also connected to space, but its job is to gather as much power as possible from the space around it, and to send a signal down the connecting line to the receiver.

A very important part of the action of either type of aerial is matching. Suppose you have an aerial, and you connect it to a transmitter. The aerial is now acting as a connection to the 377R of the space around it, and the combination of aerial and space will have an impedance which can be more or less than 377R. This just means that there is signal current flowing to the aerial and a signal voltage across it, and the ratio of voltage to current as always is the impedance, measured in ohms. Now if the impedance of the aerial and the space around it, measured in this way, is 75R, then we have to make sure that anything connected to it also has an impedance of 75R otherwise there are going to be reflections. A wave going to the aerial isn't likely to travel smoothly into space under these circumstances, because the aerial and the space around it forms a path with a different impedance to that of the feeder line. It's like light being reflected where it passes from one material to another. The aerial and the feeder aren't matched, they have different values of impedance. This can have two effects. One is that standing waves can be formed on the feeder line, the other is that reflected waves will get back to the transmitter and overload its output stage.

One of the requirements of an aerial, therefore, is that it should match the transmission cables (the lines or feeders) which connect the aerial to the transmitter or receiver. One way of doing this is to make the aerial from several parallel wires or from a folded rod (**Fig.6**).

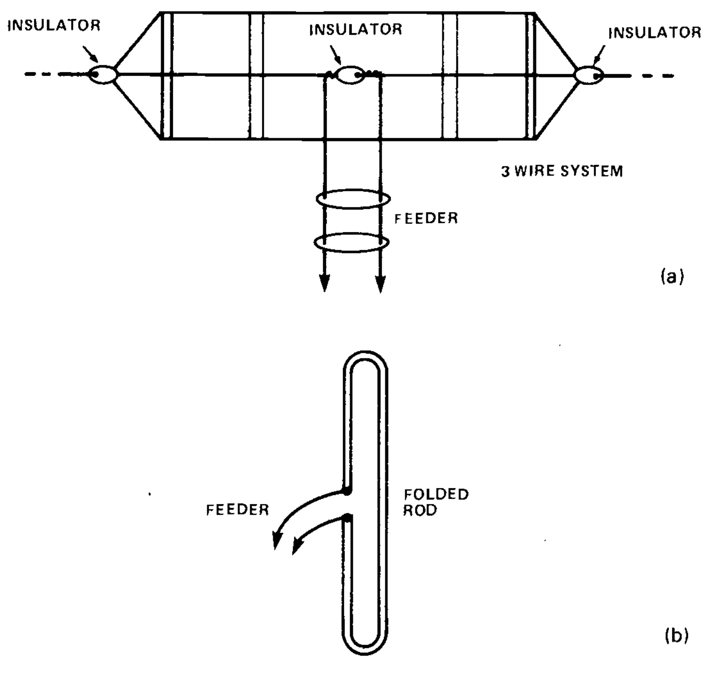


Figure 6. Matching aerial impedances to feeders by: a) using multiple lengths of wire, or b) by folding a tube. The second method is used for TV aerials ▶

To Tune Or Not To Tune

A second point is that aerials can be used 'tuned' or 'untuned'. A tuned aerial is cut to a length which is a definite fraction (often a half-wavelength or quarter wavelength) of the wavelength of the signal that is being transmitted or received, so that standing waves can form on the aerial itself. Tuned aerials are more efficient than untuned aerials, but only for a range of wavelengths close to the wavelength for which the aerial length was calculated. Tuned aerials are a familiar sight — all our TV and FM radio rooftop aerials are of this tuned type. We also use untuned aerials which are less efficient but more convenient — car radio aerials and 27 MHz aerials for CB are usually of this class.

We've already seen that aerials have to be connected to their transmitters or receivers by feeder cables. The ideal situation would be if the aerial, its feeder cable and the circuits of the transmitter or receiver all had the same value of impedance. This is usually impossible, so we have to use a variety of methods for matching one to another. The traditional method of matching one impedance to another is the use of a transformer (**Fig.7**), and transformers are normally used to match the cable to the receiver or to the transmitter. At the aerial end, however, it is more usual to use other methods for matching, particularly if the aerial is tuned. A tuned aerial will, because of the standing wave pattern which will exist on it, have different values of impedance at different positions along its length — least at a node and most at an antinode. This way, simply by connecting the feeder to the correct place on the aerial, matching is achieved! When this is inconvenient, matching stubs (**Fig.8**) can be used as a form of transformer to restore the standing wave pattern to its correct form.

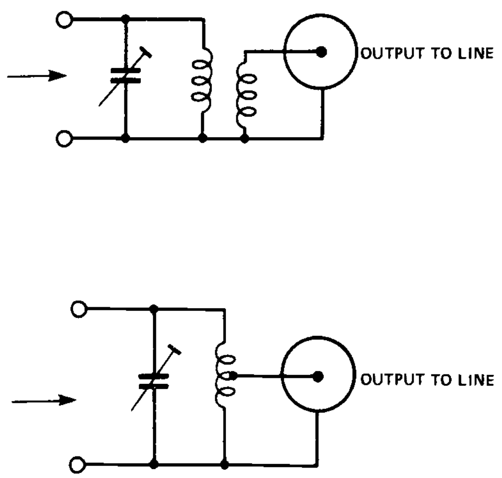
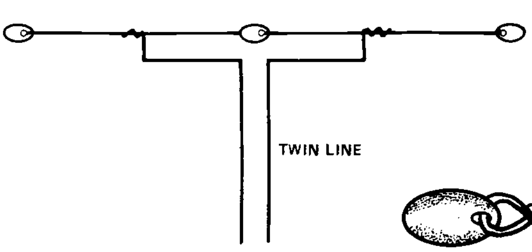


Figure 7. Transformers are used to match the output circuits of a transmitter or the input circuits of a receiver to the feeder. Both double-wound (a) and autotransformer (b) types can be used



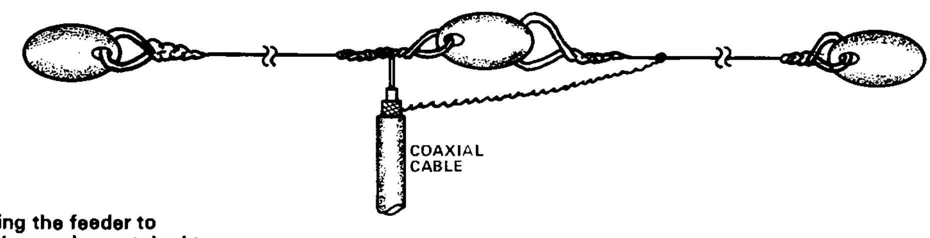


Figure 8. Using matching sections. By connecting the feeder to some point along the length of the aerial, a feeder can be matched to a tuned aerial. The position of attachment must be calculated, or found by trial and error, using readings of standing wave ratio to decide where to place the tapping

Taming Your VSWR

Very often, though, matching is a compromise — you get the design as near correct as you can and rely on a final adjustment, which is very often done by means of a variable capacitor somewhere in the aerial circuit. The quantity which we use to judge when this is correctly set for a transmitter is called the voltage standing wave ratio (shortened to VSWR).

Despite its fearsome name, VSWR is quite a simple idea. If there is any mismatch between transmitter and aerial (and that can mean between transmitter and feeder, or between feeder and aerial), then standing waves will appear on the cable instead of a steady flow of power up the feeder to the aerial and so to the space around it. The greater the amount of standing wave compared with the moving wave, the less efficient the system.

When standing waves exist on a cable we can measure the maximum voltage (Vmax) and also the minimum voltage (Vmin) at the antinode position, where the difference of voltage is greatest. The ratio of these, Vmax/Vmin, is defined as the VSWR, and the greater this quantity is, the more power is being lost rather than transmitted efficiently. A perfect non-reflecting system would have a VSWR value of 1, and the closer to 1 we can get the better — a VSWR of 3 is very often taken as being reasonably good. Measuring the standing wave ratio, either in voltage or current terms, is not quite so simple in theory, though the practical methods are comparatively straightforward. The usual method is to use a bridge circuit to measure the impedance of the line. The circuit is arranged to detect whether the measured value of impedance for waves travelling into the aerial is not the same as the value for waves that have been reflected back, and any difference produces a meter reading which can be calibrated in terms of VSWR.

How does all this affect you, if you're not the person who designs the aerial? One way it can affect you is if you are constructing an aerial to a published plan. Don't be tempted to make substitutions or to cut corners unless you really know what you are doing (and if you know as much as that, why not design it for yourself?). The other way is if you are just, like most of us, a user of aerials. If you are operating a receiver other than a simple tranny, then by using the recommended aerial correctly connected to the receiver you should get pretty good results. A few receiver aerials need some attention — for example, an aerial for a car radio will not work satisfactorily until its capacitance is balanced out by adjusting a capacitor inside the radio. This is usually done by adjusting a trimmer which can be reached (using a thin-bladed screwdriver) through a small hole in the front panel, until Radio 3 reception is as strong as you can get it.

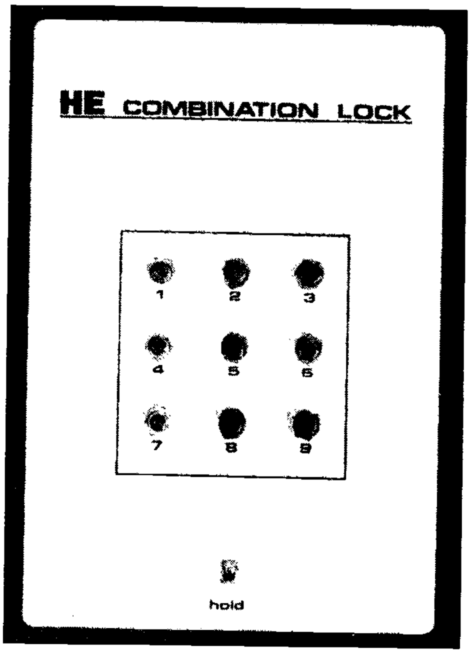
Implications For CB

The real crunch comes when you are operating a transmitter. When we get legal CB, it's certain that the legal requirements for minimum interference with other services will be at least as strict as they are in other countries. That probably means sealed tuning circuits, with perhaps a preset adjustment for standing wave ratio. The golden rule is quite definitely to use the aerial recommended for the transmitter — don't be tempted to hook up to any old length of wire — and to leave the aerial tuning circuits severely alone unless you have some way of measuring the effects of any adjustments. When CB is legal, it will be as a result of a long battle with the authorities, and a large bunch of interference complaints resulting from the use of incorrect aerials (or the use of power booster amplifiers) could easily result in the service being withdrawn. With that sombre note in mind, I'll sign off. May your VSWR always be low.

HE

Combination Lock

An ultra-secure lock project featuring a five-digit combination entry. Only you know the correct combination and it can be changed easily



INGENIOUS DESIGNS FOR electronic combination locks have been around for a long time and some can be all but impossible to 'crack'. A drawback of many designs, however, is that being so complex and hence costly, they are of doubtful advantage (probably costing more than the goods they protect)! This simple push button design is inexpensive to build as it is based on a single low-cost CMOS integrated circuit.

The project has nine numbered push button switches and a combination of five digits must be entered on five push buttons in the correct order and in fairly rapid sucession, or nothing will happen. Thus, although the right combination may be discovered it can still be impossible to open the door which the project is protecting unless the buttons are operated at sufficient speed.

The other four buttons act as 'dummy' buttons preventing operation and further enhancing the level of security provided by the lock. The circuit is reset to the off state by operating any one of these buttons.

As the circuit is built around a CMOS IC it has negligible quiescent current consumption, and the supply current is only about 25 mA when the lock is operated. The output circuit drives a relay which has heavy duty contacts that can switch most types of solenoid lock mechanism, such as the one used in the prototype.

Construction

Start by fitting all the resistors and capacitors into the printed circuit board (PCB), followed by the relay. The specified relay fits directly to the PCB, but if an alternative is used a mounting bracket may be required, and it may not be possible to mount it on the board.

Next fix the five diodes, being careful to fit them the right way round. Insert and solder the transistor next, and then the IC socket. As IC1 is a CMOS device it should be left in its protective packaging until this stage. Handle the device as little as possible when removing it from its protective packaging, and plug it into the socket, making sure it is the correct way round.

Finally, wire the board to the switches, and wire PB6-9 together. The project is now ready for installation in a case, and the required combination is obtained by arranging the push buttons on the front panel to give any combination required (although each digit can only be used once, of course!). If you require a different combination in the future simply rearrange the switches on the front panel.

Installation of the combination lock will vary considerably according to individual circumstances, but it should be installed in such a way as to leave no exposed wiring, and there should be no easy way of gaining access to the interior of the unit.

We mounted the whole circuit of our prototype into a Verobox which was bolted to the outside of the door to be safe-guarded (the HE office door, in fact). Lengths of threaded rod were used to hold the case from the inside of the door, and thus the case could not be opened or removed from outside.

Remember that if your project is to safeguard an outside door and if there is any chance of exposure to the elements, a weatherproof case and switches must be used. For neatness the switch panel could be mounted on the outside of the door with the wires from the switches brought through to the circuit mounted in a box on the inside.

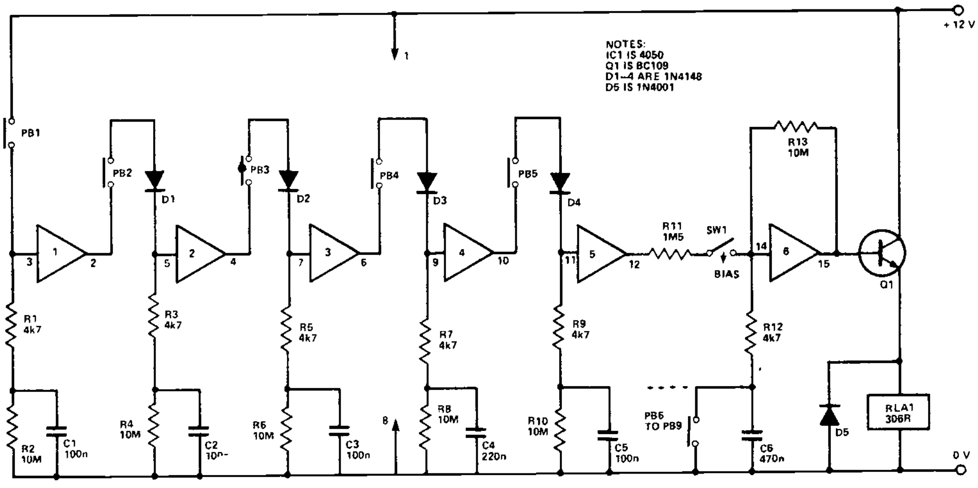


Figure 1. Circuit of the HE Combination Lock

Parts List

RESISTORS (All ¼ W, 10%)	
R1,3,5,7,9,12	4k7
R2,4,6,8,10,13	10M
R11	1M5
CAPACITORS	
C1,2,3,5	100n polyester
C4	220n polyester
C6	470n polyester
SEMICONDUCTORS	
IC1	4050 hex buffer
D1,2,3,4	1N4148 diode
D5	1N4001 diode
Q1	BC109 NPN transistor
MISCELLANEOUS	
PB1-9	push-to-make, release-to-break switch
SW1	single-pole double-throw biased toggle
Omron 12 V, 306R relay (see Buylines)	
16 pin DIL IC socket	
Case to suit (see Buylines)	
Electrically operated lock to suit (see Buylines)	

Lock Here

The solenoid-operated lock used with our prototype combination lock and with the entryphone project featured elsewhere is specifically designed for use with a basic night latch. The door can thus be opened by either key or combination.

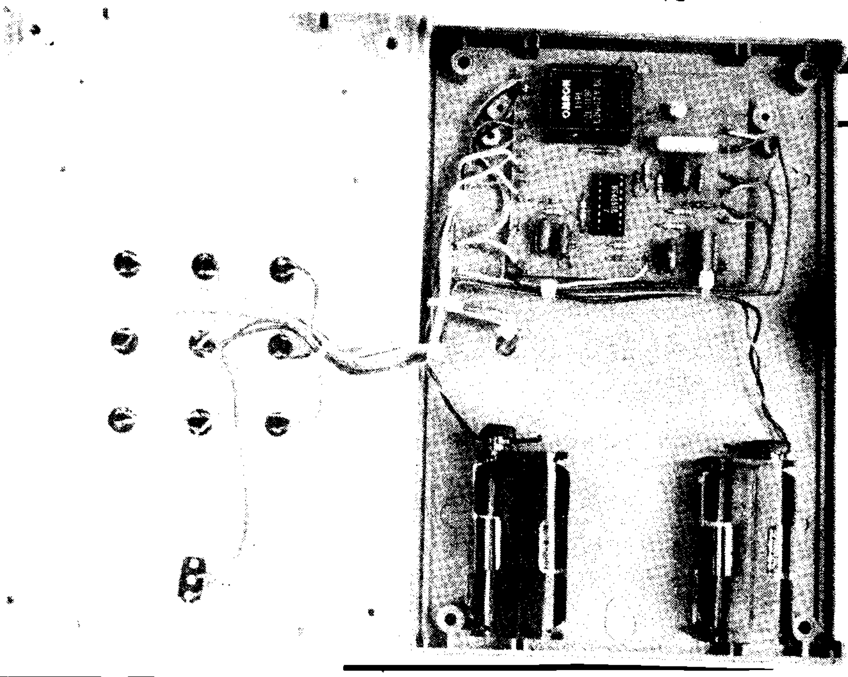
Operation of the solenoid is ensured with the application of a voltage of 5 to 8 V and a current of aproximately 750 mA. Other types of electrically operated locks are available (see Buylines) to suit other applications.

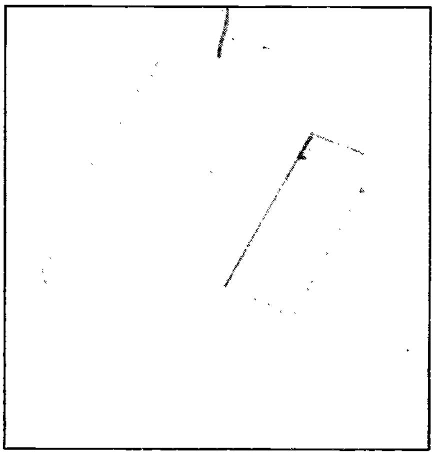
Operation

Provided you know the correct combination and the pre-set time allowed to press the buttons, activating the lock is quite straightforward. Simply press the five push buttons corresponding to the five-figure code, in quick succession.

If you want the solenoid to hold in the open state; when you hear the lock click as it opens, press the biased-up 'hold' switch SW1 down for as long as you need. Without holding this switch down, the solenoid will operate for about one second then the lock will turn off, saving battery energy. The door must be opened during the one-second period or it will be re-locked automatically.

Briefly pushing buttons PB6, 7, 8 or 9 will reset the combination lock.





Buylines

The relay used in our prototype can be obtained from Maplin Electronic Supplies (Relay Flat 12 V). The other components are all readily available.

A Vero plastic case, type 202-21034J, was used to house our circuit.

You can obtain a Model 11K, solenoid-operated door release similar to ours from the sole UK distributors of the lock:

BSG (Security) Ltd
34/35 Dean Street
London W1V 5AP
(tel 01 439 4536)

BSG (Security) claims to be the leading supplier of electronic locking devices in the UK and stocks a wide range of locks to suit most applications. The company tells us that telephone enquiries, or personal visits, from our readers with specific reference to the correct locking device for their applications will be welcomed.

Approximate price of components (excluding case, PCB, solenoid-operated lock) will be £12.

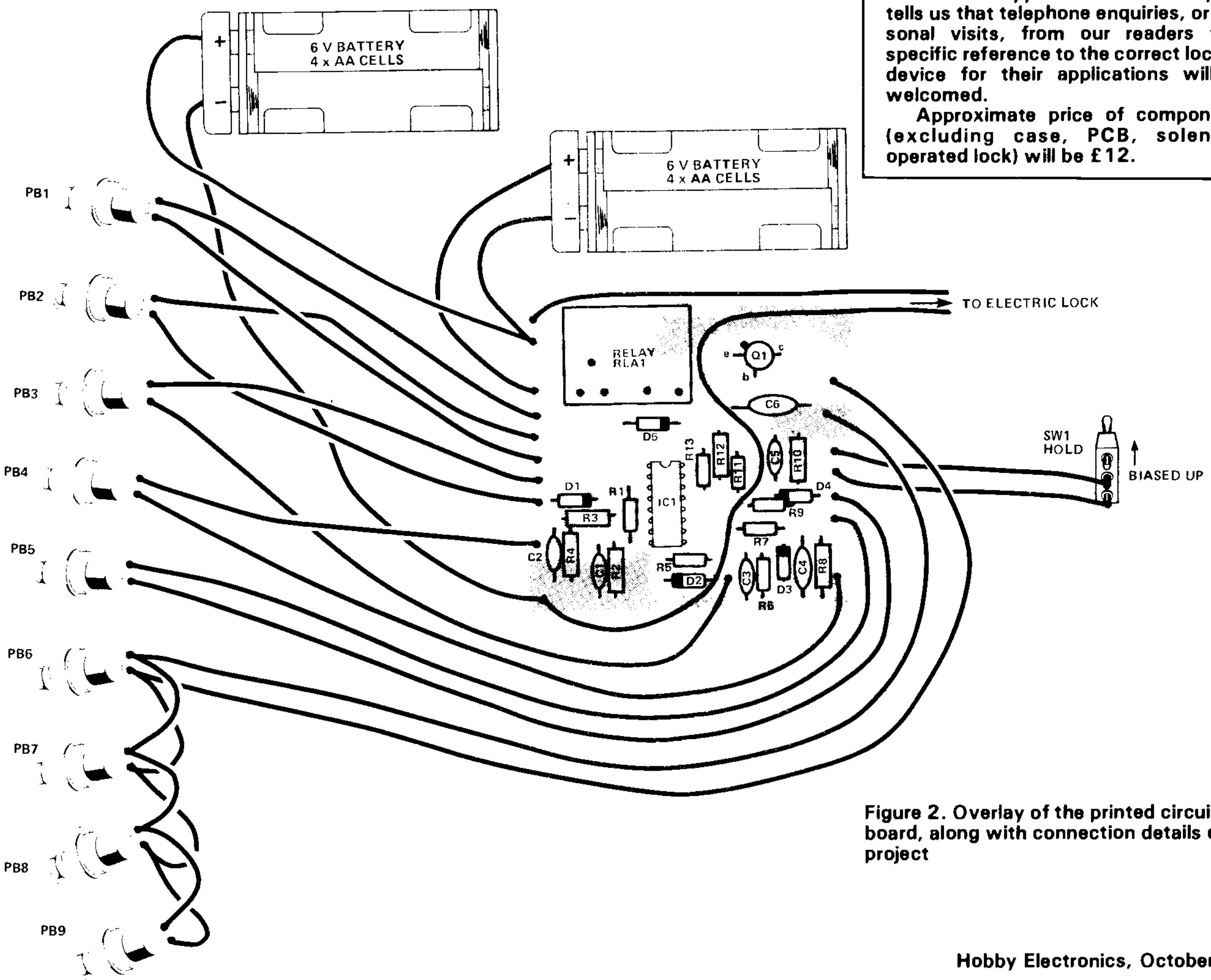
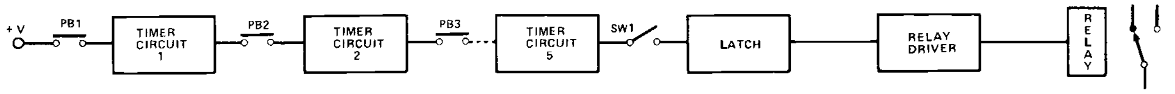


Figure 2. Overlay of the printed circuit board, along with connection details of the project

How It Works

The unit has nine push button switches, five of which must be operated in the correct sequence to activate the relay.

Operating PB1 causes the output of timer 1 to go positive for about one second. If PB2 is operated during this period the output of timer 2 is sent positive for about one second. This process is repeated along a total of five timer circuits until the output of timer 5 is positive. SW1 is biased closed so the output of a latch goes positive, activating a relay via a driver stage.



The circuit uses six CMOS non-inverting buffer stages, but these are all contained in a single IC — a 4050. Figure 1 shows the complete circuit diagram of the unit.

If PB1 is operated, the input of buffer 1 is taken high (to virtually the full supply voltage) and the output assumes the same state. Capacitor C1 charges rapidly to almost the full supply voltage through PB1 and R1, and it holds the input of buffer 1 high for a little under one second after PB1 is released. This hold on time is governed by the value of C1 and discharge resistor R2, since C1 does not lose a significant amount of charge through R1 and into the input of buffer 1 because of the ultra-high input impedance of this CMOS device.

If PB2 is activated while the output of buffer 1 is high, the input of buffer 2 will go high, as will its output. Capacitor C2 and resistor R4 provide a hold on so that the output of buffer 2 stays high for a while after PB2 is released, and D1 ensures that this hold on will not be removed if PB2 should still be closed when the output of buffer 1 returns to the low state (virtually equal to the 0 V supply potential).

Buffers 3 to 5 are used in identical timing stages, and these can be activated by operating PB3 to PB5 rapidly and in the correct sequence.

SW1 is biased closed so, when the output of buffer 5 goes high, C6 starts to charge by way of SW1 and R11, and this takes the input and output of buffer 6 high just before the output of buffer 5 returns to the low state. The output of buffer 6 is used to drive the relay through an emitter follower amplifier Q1. Holding switch SW1 against its bias (ie, holding it 'open') *after* the output of buffer 6 goes high, means the output is latched high (because of the positive feedback provided by R13). Releasing SW1 discharges C6 thus the output of the latch (buffer 6) will go low after about one second.

Of course, if the push buttons are operated out of sequence, each switch that is operated will simply connect on output in the low state to an input in the same state, and will have no effect on the lock. Pushing the buttons in the correct order, but with too long an interval between each operation, will be similarly unsuccessful for obvious reasons.

HE

Famous Names

Sixth famous name in this series is Karl Ferdinand Braun. Although not a household name, his inventions have been of benefit to the home and to the laboratory

NOW HERE'S A NAME you probably don't know at all, yet the discoveries and inventions of Braun rank as highly as those of many people whose names we remember much better. It's yet another example of our curiously selective memory processes. True, there wasn't a unit named after him, but neither was there one named after Edison, and most of us remember Edison.

Braun was born in 1850 and his career was that of an academic, researching into electricity and electromagnetism. After appointments at the Universities of Wurtzburg and Marburg, he was made Professor of Physics at Tuburgen in 1885. He held that post for 10 years before becoming Professor of Physics at Strasbourg in 1895, a post he held until his death in 1918.

So much for his academic career. It's possible for a man to have a distinguished academic career without contributing much of note to the future, but this certainly wasn't true of Karl Braun. Throughout his career he was at the forefront of discovery in the new topic of radio waves, so much so that he shared Marconi's Nobel Prize in 1909. It was Braun's work which had greatly extended the range of Marconi's transmitters, by using a more efficient aerial and earth to match the impedance of the crude spark oscillator better to that of the space around. Although that's not the reason we remember him.

The Cat's Whisker

It's not even for the invention of the 'cat's whisker' crystal detector that we remember him. The cat's whisker was the first known use of a semiconductor in radio, and such detectors were to be the most popular method of detection in early, and not-so-early, radios, right up until the time that valves started to become generally available. The semiconductor diode of today is a direct descendant of Braun's original device, so you'd imagine we'd remember him for that — but we don't.

First CRT Oscilloscope

What will keep Braun's name alive is that he invented the cathode ray oscilloscope (CRO) in 1897. It's hard now to imagine any sort of physics laboratory, any electronics workshop without an oscilloscope. In almost any branch of Science, oscilloscopes are an essential measuring instrument, because Science and measurement go hand-in-hand. Braun's invention could not have come at a better time, because the need for such an instrument was becoming more pressing each year at the end of the last century.

How were AC measurements made in Braun's time? Well, for low frequency AC (the 50 Hz of electrical engineers), there were a variety of meters, many based on the moving-iron principle, which could measure voltage, current, frequency and phase. If you had wanted to measure alternating currents at higher frequencies, then techniques become a bit more difficult. The only instruments which were available were variations on the galvanometer, using a light loop of wire which had a small mirror glued to it. This arrangement, called the Duddell oscillograph, could provide waveforms of AC currents when a light beam was directed towards the mirror, and the reflected beam from the mirror was directed onto a revolving drum coated with photographic film. The developed film would then show a trace of the waveform — eventually. There were many ingenious developments of the Duddell oscillograph, some of which dispensed with the revolving drum by scanning the light beam across the galvanometer mirror by another revolving mirror or prism. Remarkable mechanical contraptions they certainly were, and some of them had an extraordinarily long life — there was still one tucked away in one corner of the physics laboratory of my university in the early 50s! Like mechanical television, though, mechanical oscilloscopes were doomed to extinction from that day in 1895 when Braun announced his oscilloscope.

What made the invention so remarkable was the fact that cathode rays themselves were still a novelty — it was as if the home computer had arrived only a year or so after the first digital IC! At the time when Braun started work on his idea, all that was known of cathode rays was that they originated when electric current was passed through a gas which was at a low pressure, that they were deflected by electric or magnetic fields, carried energy, and could cause glass to glow where the 'rays' struck it.

No Moving Parts

Braun saw in the deflection of cathode rays a method of obtaining an oscillograph of greatly improved performance. The limitations of the Duddell type of oscillograph were in the mass of the moving parts — the loop of wire and the mirror. At high frequencies, no amount of current which was likely to be produced by an oscillator could shift these components, light as they were, fast enough. Braun saw that the cathode ray must be almost massless, and since it could be moved by the action of the magnetic or electric field alone, with no mechanical parts, it was a perfect method for measurements of high frequency currents and voltages. (Remember, incidentally, that in the 1890s 'high frequency' meant anything above 50 Hz.)

First of all, Braun knew that he had to improve the methods of making the effect of the cathode rays visible. The very faint glow which was observed when a beam of cathode rays struck glass was visible only in a dark room: not ideal conditions for making measurements. Braun had worked extensively on crystals and knew that certain crystals fluoresced (glowed) under ultraviolet light. Would they also glow when struck by cathode rays? They did, and his next action was to find what chemicals within the crystals were responsible.

First Fluorescent Screen

He soon found that a mineral called Willemite was the most efficient of all these fluorescent materials, and by grinding Willemite samples into a fine powder and coating this powder on a glass screen he was at last able to make the beam of cathode rays produce a bright spot of light. This, the invention of the fluorescent screen, was to be one of the two most significant contributions to the modern cathode-ray tube (CRT). The fluorescent screen, incidentally, soon came in for other uses, when Braun found that X-rays also caused the material to fluoresce — but that's another story.

Forerunner Of Modern CRT

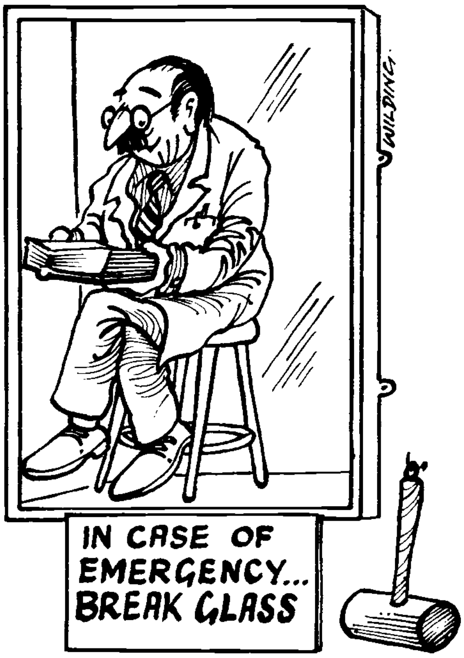
By another of these happy coincidences, around the same time, early attempts at producing thermionic emission were beginning to be successful. Thermionic emission, the release of electrons (cathode rays) from hot materials, had been discovered by Edison around 1883, but had not been pursued. Braun saw thermionic emission as the missing link he needed but the technology simply wasn't ready, and the first oscilloscope tube had to generate its electrons by the then accepted method of containing gas at low pressure.

For this reason, the first oscilloscope tubes were little more than curiosities, with a very short and uncertain life. Rapid development of vacuum pumps, however, coupled with the ability to use tungsten as a thermionic cathode, combined to produce a cathode ray tube much more like the familiar CRT of today. Braun's 1897 instrument had featured a gas-discharge timebase, and this sort of design persisted up to 1939.

The oscilloscope became a remarkably useful laboratory instrument — but no more. Its use was confined completely to research laboratories, and no attempts at mass production were made until the growing interest in electronics generally, and television in particular, forced manufacturers to take a serious view of the oscilloscope in the 1930s. From then on, Braun's baby made the spectacular progress that we all see today, surrounded as we are by the products of his genius. **HE**

Clever Dick

Readers are still guessing at who he is — but whoever he is CD continues to answer your letters on this page



WE RECEIVED a good response to the request from T. Winters (August CD), who wanted to know where he could obtain a solenoid type of lock which would operate from the 5 — 18 V output of his digitally coded lock.

By coincidence, *we* have an electronic combination lock project this month (see page 21) and D. T. Walker from Banchory recommended the same supplier as we do.

RE the 'Shut that door' letter on the Clever Dick page in HE, August '81, p29, I am informed that the following firm supplies solenoid locks down to at least 24 V.

BSG (Security) Limited, *
34/35 Dean Street,
London W1V 5AP
(phone 01 439 4536)

Even if they cannot supply to a lower voltage it does suggest a likely field of research for such items.
D. T. Walker
Banchory

I'll pass on the recommendations from other readers to T. Winters. (BSG (Security) Ltd, does supply locks with voltages down to 5 V.)

A quick query extracted from a letter from Fergus McDonald next.

Dear CD,
While reading through the August '81 edition of HE I noticed that RV1 was not listed in the components list for your Variable Bench Power Supply. Was it log or linear?
Fergus McDonald
Dublin, Eire

The quick answer is that RV1 is a *linear* carbon potentiometer.

Now a letter from Northants.

Dear Dick,
Firstly let me congratulate you and your team on producing a magazine that does not treat the inexperienced reader as a moron.

I would like to raise a few points concerning the August HE.
1. The FIRECRACKER is not in service with the RAF neither is it built by Britten Norman, but one of the original partners.
2. The HE Electronic Ignition has seemingly one major drawback. There is no facility for reverting back to the Kettering ignition should (heaven forbid) the HE unit fail in the middle of nowhere. Would it therefore be possible to incorporate a switchable by-pass from the cb to the coil? This I suppose will then raise the point that the cb capacitor has been removed to accomodate the ei, how about getting around this problem by mounting the cb cap on a small edge-connected piece of Veroboard with the facility of plugging in to a permanently placed piece of the same.
A point worth thinking about, and it may well provide the spur to make me build my first HE project, despite the fact that I have had HE from issue no 1, difficult to fit in between Hospital Radio (future special feature?) and scouts.
Mike Abbott
Kettering, Northants

I passed on your comments to Pete Christy, author of *Radio Control* in the August '81 issue, who was interested to hear what you had to say about the Firecracker.

On the question about the HE Electronic Ignition, we did consider an override switch but decided against it because of the additional wiring that would have been necessary. We may well give details of this in a future issue. If the circuit *did* fail it would not be a total disaster. All that would be necessary would be to re-insert the capacitor across the points (contact breaker if you prefer) — and the points remain undisturbed for this project — disconnect the HE Electronic Ignition and reconnect the points to the ignition coil.

S. D. Hopkins had a query about the HE Ultrasound Alarm (July '81, pp 11 to 13).

Dear Ed or CD,
I am currently considering a burglar alarm system for my house. Thus the article regarding the HE Ultrasound Alarm in the July issue of your magazine was read with great interest. However I would be most grateful if you could answer two questions.
1. What is the current consumption of the alarm?
2. Is a separate battery really necessary if all that is required is for the alarm to energise a suitable relay?
S. D. Hopkins
Telford, Salop

First point: the current consumption of the circuit is about 8 mA.

Second point: we missed out an explanation of the 'separate battery' (see also under Your Letters in this month's issue on page 55).

Unless a more substantial power supply is used in place of the PP3-sized battery shown (a 12 V car battery would be ideal for the job), the supply for the load must be derived from a separate supply.

'What's the load?' you may ask. Just bear in mind that the maximum current that can be drawn from transistor Q3 without a heatsink is about 300 mA. If you want to use a high-current or mains-operated alarm then the load must be a relay (a typical 9 — 12 V relay will require about 20 mA to activate it.)

Hope this information is helpful.

Last letter coming up.

Dear CD,
Is Monitor becoming Australian? The Rawlplug Rack is pictured upside down in the September '81 issue.
I've bought HE for two years (creep, creep), it's fantastic (grovel, grovel).
G. O'Dwyer
Thornton Heath, Surrey

PS Please may I have a binder, Sir?
PPS Like my initials (G.O'D)?
PPPS My brother's name's Stephen.
PPPPS Are you the window cleaner?

If you grovel any lower you'll end up in Aussie land yourself.

OK we printed the rack upside down (probably wouldn't have mattered if the rack was magnetic). We hope Rawlplug will excuse our error.

OK, we'll send you a binder (what do I care if your initials are G.O'D or if your brother's name is Stephen?).

No, I only clean windows part-time.

Look after yourselves — until next month at least. **HE**

---

*Formerly Baron Security Group

TECHNICAL ? TERMS

Membrane Switches

In the next few years equipment designers are likely to change from keyboards made up of dozens of individual pushbutton switches to keyboards based on the new technology of membrane switch panels. Bill Mitchell* describes these panels, which should soon become available to the hobbyist

ALTHOUGH THE contact-plate/actuator-button type of keyboard switch, with all its variations, is likely to be around for a while, it is now being replaced in some applications by a technique known as membrane switching. There is every likelihood that this will become the dominant keyboard technology during the next four to five years, with the market forecast to increase eight-fold by 1985. Principal advantages of the membrane switches are their ultra-thin profile and their ease of adaptability to domestic and professional custom design.

Keyboard Switch Panels

The most significant development in small, contact-switch technology during the past decade has undoubtedly been the miniature keyboard switches as used in calculators, electronic games and hand-held computer terminals. Although these switches are available in a wide variety of designs the principle of operation has remained unchanged; that is, with the contact layout printed onto a single-sided PCB and with three-point contact plates operated by activator buttons.

Recent variations of this basic design, typified by the Bowmar Instruments' 'Tactiflex' and Quiller Components' 'Microkey' designs, have included the replacement of the individual contact plates by a single, multi-dimpled actuator plate over which is placed a flat, spill-proof and puncture-resistant overlay sheet. Limitless variations of multi-coloured panel legends to suit customers' requirements can be printed on this sheet, with the 'button' layout corresponding to the positions of the dimples in the actuator plate. Tactile feedback (the ability to feel that a contact has been actuated) is inherent in this design, and the switch layout and assembly can be easily incorporated as an integral part of a complete printed circuit panel layout. Examples include visual display unit (VDU) operator panels, point-of-sales equipment and domestic cookers.

A further variation is the development by A B Electronics Products Group of more complex cross-over circuit layouts, on the one side of the PCB and passing under the arched contact plates, using cermet printing technology. This design enables the keyboard to perform direct logic switching sequences.

Membranes For Custom Designs

This established contact-plate/actuator-button type of design will remain with us for a number of years, but there is every indication that membrane switching will become the dominant technology by about 1985 particularly for custom design. With this technology, custom design becomes a simple proposition and the keyboard and overlay configurations are virtually limitless.

An established manufacturer of membrane switches is Bowmar Instruments whose 'Sensitouch' keyboard system consists of two flat sheets of polyester film with a special conductive composition circuit screen-printed onto each. These are separated by a few thousandths of an inch by a separator sheet, and as the area of the switch is touched the top sheet deforms through the separator to come in contact with the lower conductive circuit. By choice of the top surface and overlay materials, the actuation force can be varied to meet specific requirements, and the overlay itself can be made from a variety of materials ranging from metals to plastic film, onto which can be printed any chosen panel legend. Operating current is 100 mA maximum, and operating voltage is 30 VDC maximum with a minimum operational life of 10 million cycles. Typical overall thickness is 0.05 in.

A particular advantage of this type of keyboard switch is that it can be fully sealed, and hence can be used in applications where splashing by liquids is likely to be a problem (for example, on machine tools and domestic cookers).

A company which has announced its entry into this market within the past 12 months is Diamond H Controls Limited whose APC-405 membrane switch panel incorporates 405 individual switches on 0.75 in centres, together with their connections, on a 0.06 in fibreglass PCB backing. Because the backing board is double-sided with plated-through holes, the user has the opportunity to customise the display panel and the switching circuit. While the APC-405 exists in the form of linkable panels of 27 x 15 switches, the company undertakes guillotining of the panels to square-cut configurations, other requirements being undertaken by the user.

Once the panel has been cut to the required size and shape, connections can be made directly to the appropriate switches through their associated tracks on the reverse side of the PCB. Also, virtually any switch connection format can be obtained by the user simply by cutting and linking appropriate tracks on the reverse side of the board. A protective polyester film, already fitted, can be printed on, coloured or captioned by the user, and covered by a further protective polyester or polycarbonate film.

A development of this is Diamond H Controls' Full Travel Membrane (FTM) keyboard which includes full travel key tops as the means of switch activation. This effectively restores the keyboard feel which is absent from normal membrane keyboards.

The same company has also introduced a custom design membrane switch panel service known as TIP which offers a virtually unrestricted range of colour and dimensional possibilities. The entire switch system, including basic coding, logic, lighting and interconnections, can be incorporated into a sealed panel of 0.1 in thickness, the surface of which can be virtually any shape or size, and the panel is sealed completely against the ingress of liquids or dust.

Maximum ratings for the APC-405 and the TIP panel switches are 100 mA, 50 VDC, and for the FTM 20 mA, 30 VDC.

The most recent entrant to the field is Cherry Electrical Products Limited which has recently introduced a membrane keyboard with a five-layer laminated construction in a total thickness of 0.125 in (see Fig.1). The keyboard can be produced in a wide variety of configurations for panel applications as well as for standard data-input or editing keyboards. The keyboard is fully sealed, and switch ratings are 100 mA, 30 VDC maximum.

Inks For 'Intelligent' Switches

The heart of the membrane switch is the conductive composition circuit which is screen-printed onto the polyester film using a silver-carbon-based ink. The silver content can be as high as 60%, but one leading US ink manufacturer, Micro-Circuits Company of Michigan, has shown that an ink with 40% silver can give greater coverage, equal conductivity, and can be cured in 4 to 7 minutes at 160° F (10 to 15 minutes at 130° F) compared with up to 3 hours at 200 to 250° F for many of the ▶

*The author is Editor of Electrotechnology, Institution of Electrical and Electronics Technician Engineers

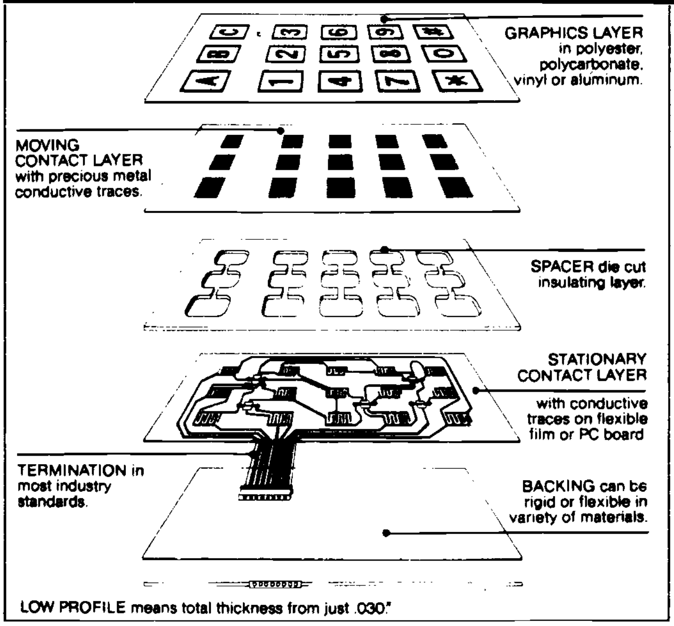


Figure 1. Cherry Electrical Products' membrane keyboard, showing the five-layer laminated construction

higher silver content inks. Currently Micro-Circuits is investigating inks with 10 to 20% silver which hold the potential of having higher conductivity than their present 40% silver ink.

Further developments in ink formulations could result in the introduction of a range of new membrane switching facilities, such as 'intelligent' switches which contribute actively to the circuit they control. They may also provide variable resistance effects such as switching without transients and interleaved contact fingers of different materials so that, for example, a power source could be connected simultaneously through silver-to-silver contacting surfaces to one circuit and through silver-to-pressure-sensitive contacts to another circuit. Means for connecting one circuit after another from the same pressure area have already been developed by Micro-Circuits. Also, potentiometer or analogue effects could be obtained by sliding a finger along an extended contact area in which silver or resistive switch surfaces make continuous or stepped contact along other silver or resistive surfaces.

Predictions

Membrane switches and keyboards are set for a great future, and the general consensus of opinion among the manufacturers is that the bulk of the applications will be in the areas of custom design where their flexibility and ease of construction render them ideal for the unique designs and layouts found in products for the home appliances, toys and games, and vehicle markets, as well as computers, business equipment and instrumentation. However, this does not rule out the availability of standard, off-the-shelf, panels that can be reworked by the user to meet one-off or short-run applications (for example, Diamond H Controls' APC-405 switch panel), which means that hobbyists, too, will also be able to take advantage of this latest form of keyboard switching. **HE**

Suppliers Of Membrane Switch Panels

Bowmar Instruments Limited,
43 High Street,
Weybridge,
Surrey KT13 8BB
Tel: 0932 51341

Cherry Electrical Products Limited,
Coldharbour Lane,
Harpenden,
Herts AL5 4UN
Tel: 05827 63100

Diamond H Controls Limited,
Vulcan Road North,
Norwich,
Norfolk NR6 6AH
Tel: 0603 45291

Quiller Components Limited,
St Leonards Road,
Bournemouth,
Dorset BH8 8PA
Tel: 0202 291015

Steatite Insulations Limited,
Hagley House,
Hagley Road,
Edgbaston,
Birmingham B16 8QW
Tel: 021 454 6961

Reference
Massive growth forecast for membrane switches, Electrotechnology (IEETE), October 1980.

MAGENTA ELECTRONICS LTD.

OUR PRICES INCLUDE VAT

PARTY GRENADE, Nov '80	**£8.77**
TRANSISTOR TESTER, Nov '80	**£6.12** inc. test leads
DOUBLE DICE, Nov '80	**£15.18**
GUITAR PRE-AMP, Nov 80	**£5.65** case (diecast) extra £2.99
BATTERY ELIMINATOR, Nov '80	**£16.36**
NOBELL DOORBELL, Oct. '80	**£11.98**
INTRUDER ALARM, Oct. '80	**£19.61**
FREEZER ALARM, Oct. '80 with probe	**£10.36**
TUG O'WAR, Oct. '80	**£17.57**
KITCHEN TIMER, Oct. '80 (2% resistors)	**£7.98**
MICROMIX, Sept. '80	**£8.60**
AUTO PROBE, Sept. '80	**£3.99** less case
TOUCH SWITCH, Sept. '80	**£2.57** less case & contacts
GUITAR PHASER, Sept. '80	**£15.22**
BENCH PSU, Sept. '80	**£31.35**
EQUITONE CAR EQUALISER, Aug. '80	**£16.47**
OP AMP CHECKER, Aug. '80	**£4.99**
MOVEMENT ALARM, Aug. '80	**£6.24**
RADIO TIMER, Aug. '80	**£7.67**
PASS THE LOOP GAME, Aug. '80	**£15.37**
SOUND OPERATED FLASH TRIGGER, July ,80, no skt.	**£4.99**
18W+18W CAR STEREO BOOSTER, July '80	**£29.98** (stereo)
FOG HORN, June '80	**£6.21**
SPEED CONTROLLER FOR R/C, April '80	**£16.41** (less case)
DIGITAL FREQUENCY METER, April '80	**£39.35**
HOBBYCOM: TWO WIRE INTERCOM, April '80	**£37.34** (Master)
Sub Station	**£3.71** each
ELECTRONIC IGNITION (CD), April '80	**£22.95**
WIND INDICATOR, Feb. '80 (with switches)	**£15.31**
DIGI-DICE, Jan. '80	**£10.97**
BARGRAPH CAR VOLTMETER, Dec. '79	**£7.98** less case
RING MODULATOR, Dec. '79	**£14.24**
GUITAR TUNER, Nov. '79	**£11.99**
HOBBYTUNE, Oct. '79	**£29.67**
ANALOGUE FREQUENCY METER, Oct. '79	**£16.98**
MULTI-OPTION SIREN, Oct. '79	**£17.57**
ULTRASONIC SWITCH, Sept. '79	**£31.73** less 3 pin mains socket
HOME SECURITY UNIT, Aug. '79	**£31.41** less siren
SIREN	**£5.59** less case
LED TACHOMETER, Aug. '79	**£19.77**
INJECTOR TRACER, Aug. '79	**£4.77**
CONSTANT VOLUME AMPLIFIER, Aug. '79	**£17.16**
LINEAR SCALE OHMMETER, July '79	**£17.57**
GSR MONITOR, June '79	**£10.59**
ENVELOPE GENERATOR, June '79	**£16.47**
WHITE NOISE EFFECTS UNIT, May '79	**£19.51**
TRANSISTOR GAIN TESTER, April '79	**£10.97**
PHOTOGRAPHIC TIMER, Mar. '79	**£18.09**
CAR ALARM, Feb. '79	**£12.07**
SCRATCH/RUMBLE FILTER, Feb. '79	**£28.02** Mono **£32.97** Stereo
PUSH-BUTTON DICE, Dec. '78	**£7.67**

INTO DIGITAL ELECTRONICS

Current H.E. series Part 1 in Sept. '80. Covers digital electronics from the basics. Circuits are built on a plug-in Eurobreadboard. Reprints of back issues available **45p each**. Eurobreadboard and components for series **£20.85** less battery. Components only **£13.98**.

INTO ELECTRONICS CONSTRUCTION

H.E. 6-part Series: Feb. '80 to July '80. COVERS THE BASICS OF ELECTRONICS – LOTS OF PRACTICAL WORK. Circuits are built on a plug-in Eurobreadboard. REPRINTS AVAILABLE, **45p each part**. Eurobreadboard and Components for Series **£17.19**. Components only **£10.37**.

INTO ELECTRONIC COMPONENTS

NEW SERIES: Eurobreadboard **£6.20**. Test Lead Kit Type IEC, parts for 2 leads, croc. clips to 4mm banana plugs **62p**. Solid core wire, ideal for making links on Eurobreadboard, 10 metre length, **50p**.

The INStructor
A FULLY CONSTRUCTIONAL PROJECT INCORPORATING AN INS8060 MICROPROCESSOR CHIP

The Instructor is a low cost assembly which provides a practical introduction to microprocessors and their functions. It is not a computer but it is a working circuit which allows microprocessor working to be followed, one program step at a time. Build the Instructor and you will gain microprocessor experience. The series is based on the INS8060 microprocessor IC, also known as the SC/MP Mk. 2. Circuits are built on a plug in Eurobreadboard. Kit is available with or without the breadboard. INSTRUCTOR COMPONENT PACK: Including Eurobreadboard £29.98; or less Eurobreadboard £23.82.
INSTRUCTOR COURSE NOTES AND OPERATING INSTRUCTIONS – **£2.96 extra.**

C106D	**56p**
TIC46	**49p**
OA47	**11p**
OA90	**9p**
OA202	**16p**
W0.05	**33p**
W06	**47p**
Z5J	**£2.92**
1N4001	**5½p**
1N4005	**6p**
1N4148	**5p**
1N5404	**18p**
1N5408	**19p**
BF244B	**45p**
MPF102	**69p**
TIS88A	**57p**
VN67AF	**£1.21**
2N3819	**28p**
2N3820	**78p**
2N5457	**58p**
2N5484	**63p**
40673	**98p**
AC128	**29p**
AC141	**38p**
AC142	**39p**
AC176	**37p**
BC182	**11p**
BC182L	**11p**
BC183	**11p**
BC184	**11p**
BC184L	**11p**
BC212	**11p**
BC212L	**11p**
BC213	**11p**
BC214	**11p**
BC214L	**11p**
BD131	**48p**
BFY50	**25p**
BFY51	**24p**
BFY52	**23p**
BFX88	**32p**
BRY39	**48p**
MPSA65	**39p**
RPY58A	**£1.16**
TIP31A	**52p**
TIP32A	**83p**
TIP33A	**94p**
TIP34A	**99p**
TIP121	**£1.12**
TIP2955	**69p**
TIP3055	**69p**
TIS43	**38p**
TPSA13	**35p**
2N3053	**25p**
2N3055	**59p**
2N3702	**11p**
2N3704	**11p**

LINEAR ICs

555	**32p**
556	**79p**
741	**28p**
748	**55p**
CA3080	**£1.21**
CA3085A	**£1.32**
CA3130T	**£1.12**
CA3140E	**57p**
HA1388	**£2.85**
ICL7611	**£1.04**
ICL8038CC	**£3.92**
ICM7555	**£1.19**
LF351	**58p**
LF353	**96p**
LF356	**99p**
LM301AN	**39p**
LM309K	**£2.99**
LM317K	**£3.56**
LM317T	**£2.55**
LM324N	**79p**
LM380N	**99p**
LM381N	**£1.98**
LM382N	**£1.62**
LM386N	**£1.04**
LM387N	**£1.39**
LM389N	**£1.29**
LM1830	**£2.32**
LM2917N	**£2.27**
LM3900N	**85p**
LM3909N	**79p**
LM3911N	**£1.55**
LM3914N	**£2.89**
LM3915N	**£2.98**
MC3340	**£2.15**
TBA820	**£1.05**
TL064	**£2.59**
U237B	**£1.69**
ULN2283B	**£1.47**
ZN1034E	**£2.19**
ZN414	**£1.09**
ZN419CE	**£2.59**
ZN424E	**£2.14**
ZN425E	**£5.98**

C.MOS

4001	**27p**
4011	**28p**
4013	**55p**
4017	**95p**
4020	**£1.20**
4024	**76p**
4069	**31p**
4081	**29p**
4093	**89p**
4522	**£1.79**
40174	**£1.50**
74C14N	**78p**

¼W, carbon film resistors, E12 series, 1R-10M, **1½p** each. Min. horiz. presets 100R-4M7, **12p** each. Midget pots, Linear, 470R-4M7, **37p** each. Log 4k7-2M3, **38p** each. Switched pots, 4k7-1M, Lin. **75p**. Log. **76p**.

Polyester (C280) capacitors 250V 10nF; 15nF; 22nF; 33nF; 47nF **7p** ea. 68nF; 100nF **8p**. 150nF; 220nF **12p**. 330nF **15p**. 470nF **20p**. 680nF **28p**. 1uF **33p**. 1.5uF **49p**. 2.2uF **65p**.

Sub miniature plate ceramics 63V. Values in pF: 2.2; 3.3; 4.7; 5.6; 6.8; 8.2; 10; 15; 22; 33; 47 & 56pF **7p** each. 68pF; 100pF **7p** each. 150; 220; 330pF **11p**. 390pF; 470pF; 1000pF **5p**. 2200pF **6p**. 3300pF; 4700pF **7p**. 10nF **13p**. 100nF **22p**. 47nF **14p**.

Electrolytic capacitors, AXIAL leads:– 1uF/16V **11p**; 1uF/63V, 1uF/100V **12p**; 2.2uF/63V, 3.3uF/63V, 4.7uF/63V **12p**; 10uF/16V **11p**; 10uF/63V **12p**; 22uF/25V **12p**; 22uF/63V **15p**; 33uF/40V, 47uF/25V **12p**; 47uF/25V **12p**; 47uF/40V **15p**; 47uF/63V **18p**; 100uF/16V **12p**; 100uF/25V **15p**; 100uF/40V **18p**; 100uF/63V **29p**; 220uF/10V **15p**; 220uF/25V **19p**; 470uF/16V **29p**; 470uF/25V **36p**; 470uF/40V **55p**; 680uF/16V **32p**; 1000uF/10V **30p**; 1000uF/16V **33p**; 1000uF/25V **46p**; 1000uF/40V **58p**; 1000uF/63V **79p**; 2200uF/10V **39p**; 2200uF/25V **64p**; 2200uF/63V **£1.10**.
RADIAL leads:– 0.47uF/25V **8½p**; 10uF/16V, 22uF/16V, 47uF/16V, 100uF/16V, 100uF/25V **12½p**; 220uF/63V **39½p**; 1000uF/16V **35½p**; 220uF/16V **64½p**.

Switches
Min. toggle: spst **59p**; spdt **69p**; dpdt **79p**. Min. push on **18p**; push off **22p**. Footswitch alt. action: spco **£1.39**; dpco **£1.88**. Rotary switches: 1p 12 way, 2p 6w, 3p 4w, 4p 3w **69p** each. 12V 185R dpco relay **£2.98**.

Soldering
Antex X25 soldering iron, 25W **£5.48**. Soldering iron stand **£2.40** spare bits (for X25) small, std, large **69p** each. How to solder sheet **12p**. Solder bobbin **30p**. Desolder pump **£6.48**. Desolder braid **69p**. Solder, handy size **98p**. Heat sink tweezers **29p**.

Opto

BPX25	**£2.24**	ORP12	**99p**
2N5777	**60p**	TIL32	**81p**
		TIL78	**74p**

I.c. sockets

8 pin	**16p**	18 pin	**22p**
14 pin	**17p**	24 pin	**48p**
16 pin	**18p**	28 pin	**45p**

L.e.d.s with clips
3mm: Red **15p**; Green **18p**; Yellow **20p**. 5mm; Red **18p**; Green 19p; Yellow **21p**. Flashing l.e.d. **78p**. Rectangular red **58p**. Mains panel neon **32p**.

Zener diodes 400mW, BZY88. Range 2V7 to 33V **12p** each.

Denco Coils
DP Green Range 3, Range 4, Range 5 **£1.99** each. B9A valveholder **59p**.

Jackson
300pF dilecon **£2.56**. 500pF dilecon **£3.28**. C804 var. capac. 10pF **£2.28**; 25pF **£2.46**; 50pF **£2.48**; 100pF **£2.83**; 150pF **£3.48**; '01' 365pF **£3.48**; '02' 365pF **£4.49**; '02' 208+176pF **£3.98**. 4511 DAF 6.1 drive **£1.74**.

Low cost cutters **£1.69**. Low cost long nose pliers **£1.68**. Wire strippers and cutters **£2.69**. P.c.b. etching kit **£4.98**. Plastic tweezers **69p**. Eurobreadboard **£6.20**. Bimboard 1 **£6.48**. S. Dec **£3.98**.

Speakers miniature, 8 ohm **87p**; 64-75 ohm **89p**. Crystal earpiece **65p**. Magnetic earpiece **15p**. Mono headphones **£2.98**. Stereo headphones **£4.35**. Telephone pick-up coil **72p**. FM aerial **49p**. Min. buzzers 6V **50p**; 9V **£1.10**; 12V **65p**.

PP3 clips **10p**; PP9 clips **11p**. Panel meters 60x45mm **£4.99** each. 50uA, 100uA, 1A, 25V, 1mA.

Veroboard 0.1" copper
10 strips, 24 holes **£1.20** per 5. 24S 37H **78p**. 24S 50H **89p**. 36S 37H **89p**. 36S 50H **99p**. Terminal pins **48p**/100. Pin insertion tool **£1.69**. Spot face cutter **£1.23**.

Multimeter type 1. 1000opv with proves, 2"×3½"×1"	£6.66
Multimeter type 2. 20.000opv inc. transistor tester	£14.75
Croc clip test lead set. 10 leads with 20 clips	99p
Connecting wire pack, 5×9yd coils	65p
Resistor colour code calculator	21p
Towers International Transistor Selector	£10.35
AM-FM aircraft band portable radio	£8.98
2 station desk intercom £7.48 3 station	£8.98
Plug-in power supply, 4.5V, 6V, 9V, 300mW	£3.89
Dimmer switch	£3.98
PVC tape – 3 reels	34p
Dentists inspection mirror	£2.85
Jewellers eyeglass	£1.50
Hand magnifier, 3"	£2.99
Illuminated magnifier, 1½" £1.14 3"	£3.19

MAGENTA ELECTRONICS LTD.

HM13, 135 HUNTER ST., BURTON-ON-TRENT, STAFFS. DE14 2ST
0283-65435. 9-4 MON.-FRI. MAIL ORDER ONLY

ADD 40p P&P TO ALL ORDERS

All prices include 15% VAT
Official orders welcome

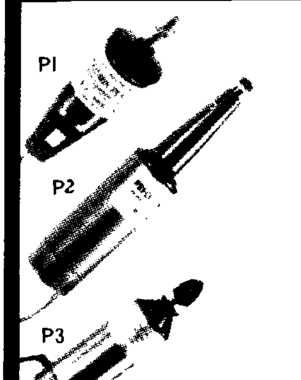
Irish Republic & B.F.P.O. Europe deduct 10% from prices shown. Payment must be in sterling.

Access and Barclaycard (Visa) orders accepted by 'phone or post.

PRECISION PETITE

MINIATURE DRILLS AND ACCESSORIES

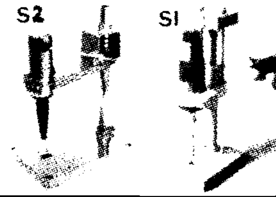
for all your modelling needs



A choice of three power drills that fit snugly in the hand, so light they enable you to carry out the most intricate tasks — drilling, shaping, cutting, polishing, etc., in the minimum of time.

There are two types of drill stand, plus all the necessary accessories in a range that fills every need.

Send 9" x 4" S.A.E. for full details.



BARCLAYCARD
ACCESS

Sole UK Distributors PRECISION PETITE LTD., Dept. H.E.

119a HIGH ST. TEDDINGTON, MDX. Tel: 01-977 0878

RADIATION DETECTORS

BE PREPARED

VIEW THRU LENS ▸ R

Ideal for the experimenter

- THIS DOSIMETER WILL AUTOMATICALLY DETECT GAMMA AND X-RAYS
- UNIT IS SIZE OF FOUNTAIN PEN & CLIPS ONTO TOP POCKET
- PRECISION INSTRUMENT
- MANUFACTURERS CURRENT PRICE OF A SIMILAR MODEL OVER £25 EACH

British design & manufacture

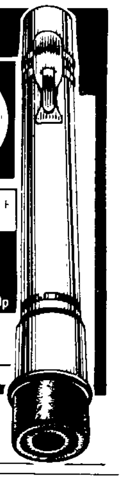
Tested and fully guaranteed. Ex-stock delivery.

FREE RECHARGE SERVICE AFTER PURCHASE

£6.95

inc. VAT Post & Pack 60p

COMPLETE WITH DATA



HENRY'S 01-723 1008/9

404 EDGWARE ROAD, LONDON W2 1ED

SUPER VALUE PACKS AND COMPONENTS

P1. 50 Ass. Electrolytics Caps..... **80p**
P2. 80 Polyester, Polycarbonate, Polypropylene **80p**
P3. 100 Small Cer. Discs **80p**
P4. 80 Square Cer. Plates **80p**
P5. 50 Polystyrene Caps. 5.6pf-3900pf **80p**
P6. 45 Polystyrene Caps. 4700pf-.047uf **80p**
P7. 20 Silver Mica 5.6pf-220pf.... **80p**
P 8 18 Silver Mica 270pf-0047uf **80p**
P 9 20 High Voltage Discs. 1KV-8KV. **27pf-470pf** **80p**
P10 18 High Voltage Discs 1KV-8KV 1000pf-.01uf **80p**
P11 10 20mm in line fuse holders **80p**
P12 10 5 pin din chassis sockets **80p**
P13 150 Axial ¼ watt resistors..... **80p**
P14 5 100K Multitone trimmers for Thorn Varicap tuners **80p**
P15 One of each Tant Bead Cap. as listed below. Qty. 20 **£3.50**

DIODES 1N4001; **.04p.** 1N4002; **.04p.** 1N4003; **.04p.** 1N4004; **.05p.** 1N4005; **.05p.** OA90: **.06p.** OA91; **.06p.**

TANT BEAD CAPACITORS

.1/35v .22/35v .33/35v .47/35v .68/35v 1/35v .... **10p** each
2.2/16v 3.3/16v 4.7/6v .... **.12p** 4.7/35v 6.8/25v .... **.14p**
6.8/35v.... **.15p** 10/16v .... **.16p** 22uf/6.3v .... **.16p** ....22/10v .... **.20p**
22/16v.......... **.25p** 33/10v .... **.25p** 47/6v .... **.25p** 47/16v .... **.50p**
100/16v .... **.65p**

Polystyrene Caps .... from **.03p** Low Voltage discs .... from **.03p**
Silver Mica .... from **.10p** Etc., etc. Lists enclosed with first order or S.A.E.
Post and packing add .20p per pack or .20p on orders for components only.

Orders over £5.00 post free. VAT inclusive

C.H.J. SUPPLIES, 4 STATION ROAD, CUFFLEY, HERTS. Tel: 01-440 8959

Team Up With TK Electronics

for top quality components, innovative kits

FAST SERVICE AND LOW, LOW PRICES

Prices do not include VAT. Add 50p P&P + 15% VAT to total. Overseas customers add £1.50 (Europe) £4 (elsewhere).
Access and Barclaycard welcome. Send sae for price list and with enquiries.
Shop Open: 9-5 (Mon.-Fri.) 10-4 (Sat.)

11 BOSTON ROAD, LONDON W7 3SJ

Tel: 01-579 9794/2842

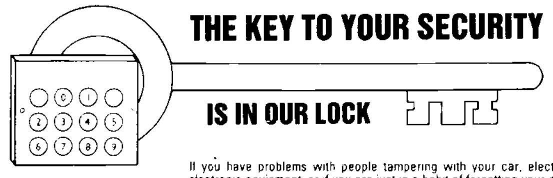
CMOS

4000	.14	4019	.38	4069	.18
4001	.14	4023	.22	4070	.24
4002	.14	4025	.18	4071	.22
4007	.14	4026	1.05	4077	.24
4011	.15	4027	0.40	4081	.22
4012	.17	4028	.50	4093	.45
4013	.35	4040	.68	4501	.24
4015	.70	4049	.30	4511	.85
4016	.30	4050	.30	4514	1.80
4017	.65	4060	.90,		

INTEGRATED CIRCUITS

555 Timer	.21
556 Dual 555 Timer	.40
741 Op. Amp	.19
AD590 Constant current Temperature Sensor	2.75
AY-5-1224 Clock	2.60
AY-5-1230 Clock/Timer	4.50
AY-3-1270 Thermometer	8.20
CA3080 Transconductance OpAmp	.72
CA3130 CMOS Op. Amp	.75
CA3140 CMOS Op. Amp	.43
ICL7106 DVM (LCD drive)	7.00
ICM 7555 CMOS 555 Timer	.79
LM377 Dual 2W Amp	1.45
LM379S Dual 6W Amp	3.50
LM380 2W Audio Amp	.80
LM382 Dual low noise pre-amp	1.00
LM386 250mW low voltage amp	.75
LM1830 Fluid Level Detector	1.50
LM2917 F-V converter (14-pin)	1.60
LM3909 LED Flasher/oscillator	.60
LM3911 Thermometer	1.20
LM3914 Dot/Bar driver (linear)	2.10
LM3915 Dot/Bar driver (log.)	2.20
LS7220 Electronic Combination Lock with "Save" feature	2.75
LS7225 Electronic Combination Lock with tamper output	2.60
MM74C911 4-digit display controller	6.50
MM74C915 7-segment BCD converter	.96
MM74C926 Counter/7 seg. output	4.50
S566B Touchdimmer	2.50
SL440 AC Power Control	1.75
SL441 Burst Fire Controller	1.35
SN76447 Complex Sound Generator	1.75
TBA800 5W Audio Amp.	.68
TBA810AS 7W Audio Amp	1.00

THE KEY TO YOUR SECURITY



IS IN OUR LOCK

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

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

At only £10.50 + VAT, it will make a smaller hole in your pocket than a bunch of keys!

LOCK I.C.s

LS7220 with SAVE memory **£2.75**
LS7225 with latched and momentary outputs and a tamper output **£2.60**
Data only **10p**
Electric Lock Mechanism suitable for use with existing door locks and the above electronic lock kit **£12.50**

DVM/THERMOMETER KIT

Based on ICL7106 DVM chip and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter only a few additional switches and resistors required (details supplied) or make a sensitive digital thermometer (-50°C to 150°C) reading to 0.1°C. The basic kit has a sensitivity for full scale of 200mV, automatic polarity and runs from a 9V PP3 battery.

TRIACS

400V Plastic Case (Texas)	
3A TIC206D	48p
8A TIC226D	58p
12A TIC236D	85p
16A TIC246D	96p
25A TIC263D	190p
6A with trigger Q4006LT	80p
8A isolated tab TXAL226B	65p
Diac	18p
Opto Isolated Triac MOC3020 0.6A/400V.	

DISCO LIGHTING KITS

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

DL 1000K

This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control **£14.60**

DLZ1000K

A lower cost version of the above featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossover points to reduce radio interference to minimum **£8.00**

Optional Opto Input
DLA1 **60p**

YOU MUST HAVE BETTER THINGS TO DO

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

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

We also still sell our highly popular TD300K Touch Dimmer Kit at **£7** and the LD300K rotary controlled Dimmer Kit at only **£3.50** (plus VAT to above prices).

All kits contain all necessary components and full assembly instructions. You only need a soldering iron, cutters and a few hours.

GADGETS GAMES & KITS

On test this month Ian Graham features an 'Easy-check' test unit for your domestic electrical appliances, a simple and safe-to-use brain wave sensor, a handy PCB construction aid and two new radio/cassette recorders. We start with a review of the Casio FX-602P programmable calculator, by guest reviewer Leon Goodfriend

Son Of 502 From Casio

Two years ago, Casio brought out the FX-502P, an up-market programmable calculator which gained universal praise. Now this has been superseded by the FX-602P with alphanumeric capability and this is the subject of our review.

The FX-602P has the same case as its predecessor, made of brushed aluminium alloy and measuring 141 x 71 x just 9½ mm. Thirty small keys handle scientific and programming functions, while 20 larger ones cover numbers and basic operations. All the keys give a quiet click when pressed.

The LCD display is an 11-digit dot-matrix type (each character is formed by lighting up selected dots on a 5 x 7 grid). This is necessary for the production of alphanumerics, but in any case makes for much clearer digits than the usual 7-segment displays. The display also includes an exponent, which doubles as a step counter in program mode, and 11 annunciators for status of operation.

The instruction book, which has been thoroughly revised and doubled in size, gives a comprehensive understanding of programmed and manual operation, while the program library contains over 80 programs in various fields including games.

Function Check

As one might expect the calculator has a wide range of functions, the less common of which include hyperbolics, standard deviation, rectangular/polar co-ordinate conversions, random number generation and percentages. Results are displayed to 10 significant figures plus exponent, with two extra digits being maintained internally for accuracy. For some reason unknown to us memory registers do not hold these extra digits, and this results in an annoying loss of accuracy. An engineering key allows movement of the decimal point in any direction and it is possible to round the displayed figure to any number of decimal places or significant figures, but there is no facility for setting the display to constantly round its output as is possible with most good scientifics.

The 602 has definable memory allocation, ranging from 22 memories and 512 program steps to 88 memories with just 32 steps. Repartitioning memory is simple; all you have to do is tell the calculator how many memories you want and it replies by telling you how many program steps that leaves. It is also possible to check the allocation without changing it. The calculator will not let you erase programs by turning them into memories. Both memories and programs are held when the calculator is turned off.

A Display With Character

The FX-602P can produce no less than 86 different alpha characters! It is the only calculator which allows the production of lower case as well as upper case letters. The keys are labelled in alphabetical order and in alphanumeric mode each key produces the character marked underneath it. To produce small letters it is necessary to use the inverse function key (a 'shift lock' key would be useful here). Numbers from the display or memory registers can be incorporated into alpha displays and the user can decide whether a message replaces the previous one or continues on its end. If a displayed message is longer than 11 characters it is scrolled along at two characters per second, so the only limit to the length of a message is the amount of memory available; is the age of the electronic book upon us?

TTLs by TEXAS

7400	11p
7401	11p
7402	12p
7403	14p
7404	14p
7405	18p
7406	27p
7407	27p
7408	16p
7409	16p
7410	15p
7411	20p
7412	20p
7413	25p
7414	35p
74C14	60p
7416	25p
7417	25p
7420	17p
7421	30p
7422	20p
7423	22p
7425	28p
7426	30p
7427	25p
7428	30p
7430	15p
7432	25p
7433	27p
7437	27p
7438	30p
7440	17p
7441	70p
7442A	50p
7445	60p
7446A	93p
7447A	45p
7448	45p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	30p
7474	23p
7475	38p
7476	30p
7480	50p
7481	100p
7482	70p
7483A	45p
7484	100p
7485	90p
7486	25p
7489	210p
7490A	30p
7491	60p
7492A	30p
7493A	30p
7494	50p
7495A	50p
7496	45p
7497	120p
74100	85p
74107	30p
74109	40p
74116	90p
74118	75p
74119	90p
74120	70p
74121	30p
74122	45p
74123	48p
74125	40p
74126	40p
74128	40p
74132	45p
74136	32p
74141	65p
74142	200p
74145	70p
74147	100p
74148	75p
74150	80p
74151A	45p
74153	45p
74154	70p
74155	50p
74156	50p
74157	50p
74159	100p
74160	60p
74161	60p
74162	60p
74163	60p
74164	65p
74165	60p
74166	70p
74170	180p
74172	300p
74173	75p
74174	70p
74175	70p
74176	50p
74177	70p
74178	100p
74180	60p
74181	160p
74182	90p
74184A	90p
74185	120p
74186	500p
74188	325p
74190	70p
74191	70p
74192	70p
74193	70p
74194	70p
74195	60p
74196	60p
74197	60p
74198	100p
74199	100p
74221	75
74251	70p
74278	150p
74279	80p
74283	75p
74284	200p
74285	200p
74290	100p
74293	100p
74298	100p
74365	55p
74366	55p
74367	55p
74368	55p
74390	100p
74393	100p
74490	120p

74LS SERIES

74LS00	12p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	15p
74LS05	15p
74LS08	16p
74LS09	15p
74LS10	15p
74LS11	15p
74LS13	25p
74LS14	45p
74LS20	15p
74LS21	15p
74LS22	20p
74LS26	20p
74LS27	18p
74LS30	15p
74LS32	16p
74LS37	16p
74LS38	16p
74LS42	40p
74LS47	40p
74LS51	15p
74LS55	30p
74LS73	25p
74LS74	20p
74LS75	28p
74LS76	20p
74LS83	45p
74LS85	65p
74LS86	24p
74LS90	35p
74LS92	40p
74LS93	35p
74LS95	45p
74LS96	110p
74LS107	45p
74LS109	30p
74LS112	34p
74LS113	30p
74LS114	30p
74LS122	42p
74LS123	50p
74LS124	120p
74LS125	30p
74LS126	30p
74LS132	45p
74LS133	30p
74LS136	30p
74LS138	36p
74LS139	38p
74LS145	75p
74LS147	160p
74LS148	90p
74LS151	70p
74LS153	60p
74LS154	200p
74LS155	40p
74LS156	40p
74LS157	35p
74LS158	36p
74LS160	40p
74LS161	40p
74LS162	40p
74LS163	40p
74LS164	48p
74LS165	100p
74LS166	90p
74LS170	120p
74LS173	70p
74LS174	60p
74LS175	50p
74LS181	140p
74LS190	50p
74LS191	50p
74LS192	50p
74LS193	60p
74LS195	50p
74LS196	60p
74LS197	65p
74LS221	60p
74LS240	90p
74LS241	90p
74LS242	90p
74LS243	80p
74LS244	80p
74LS245	90p
74LS247	70p
74LS251	40p
74LS253	40p
74LS257	45p
74LS258	45p
74LS259	90p
74LS266	25p
74LS273	90p
74LS279	45p
74LS283	45p
74LS298	180p
74LS323	260p
74LS324	150p
74LS348	150p
74LS352	100p
74LS353	100p
74LS365	38p
74LS367	38p
74LS368	50p
74LS373	80p
74LS374	80p
74LS375	50p
74LS377	90p
74LS378	70p
74LS390	55p
74LS393	50p
74LS399	200p
74LS540	135p
74LS541	135p
74LS670	170p

4000 SERIES

4000	12p
4001	14p
4002	16p
4006	65p
4007	18p
4008	60p
4009	35p
4010	40p
4011	14p
4012	18p
4013	35p
4014	60p
4015	60p
4016	30p
4017	45p
4018	60p
4019	32p
4020	60p
4021	65p
4022	70p
4023	20p
4024	40p
4025	20p
4026	130p
4027	32p
4028	60p
4029	75p
4030	40p
4031	170p
4034	160p
4035	80p
4036	295p
4039	295p
4040	55p
4041	70p
4042	55p
4043	60p
4044	70p
4046	70p
4047	75p
4048	55p
4049	27p
4050	27p
4051	60p
4052	80p
4053	80p
4054	130p
4055	125p
4056	120p
4059	500p
4060	90p
4063	100p
4066	35p
4067	400p
4068	18p
4069	18p
4070	18p
4071	18p
4072	18p
4073	20p
4075	20p
4076	60p
4081	16p
4082	20p
4086	72p
4089	150p
4093	40p
4094	150p
4095	95p
4096	95p
4097	340p
4098	90p
4099	120p
40085	90p
40097	£120p
40098	120p
40102	180p
40103	180p
40106	50p
40109	100p
40163	100p
40173	120p
40174	90p
40175	100p
40193	120p
40257	180p
4502	75p
4503	50p
4507	40p
4508	200p
4510	65p
4511	50p
4512	65p
4514	150p
4515	150p
4516	75p
4518	45p
4520	70p
4521	150p
4526	75p
4527	90p
4528	75p
4532	90p
4534	500p
4536	300p
4538	120p
4539	110p
4543	100p
4553	290p
4555	50p
4556	60p
4560	180p
4569	180p
4572	30p
4583	100p
4584	45p
4585	100p
4724	150p
14411	700p
14412	900p
14599	290p

INTERFACE ICs

AD561J	1400p
AD7524	600p
OM8131	375p
DP8304	450p
DS8835	250p
DS8836	150p
DS8838	225p
MC1488	65p
MC1489	65p
MC3446	300p
MC3480	850p
25S10	350p
75107	160p
58174	£12
75107	160p
75110	160p
75114	180p
75150	140p
75154	150p
75182	230p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75491/2	70p
8T26	120p
8T28	140p
8T95	140p
8T97	140p
81LS95	120p
81LS96	120p
81LS97	120p
81LS98	140p
9602	220p

93 SERIES

9301	160p
9302	175p
9308	318p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	380p
9368	250p
9370	300p
9374	200p

74S SERIES

74S00	60p
74S04	60p
74S05	75p
74S08	75p
74S10	60p
74S20	60p
74S30	60p
74S32	90p
74S37	90p
74S64	60p
74S74	90p
74S85	300p
74S86	180p
74S112	120p
74S114	120p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S163	300p
74S174	250p
74S175	320p
74S194	350p
74S241	450p
74S260	70p
74S373	400p
74S374	400p

LINEAR ICs

AN103	200p
AY1-0212	650p
AY1-1313	668p
AY1-1320	320p
AY1-5050	90p
AY3-1270	840p
AY3-8910	700p
AY3-8912	625p
CA3046	70p
CA3048	225p
CA3080E	60p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	45p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	300p
CA3280	160p
DAC1408-8	200p
HA1388	280p
ICL8038	300p
ICM7555	80p
LC7120	600p
LC7130	475p
LF351	48p
LF356P	90p
LM10C	425p
LM301A	27p
LM311	70p
LM318	200p
LM319	225p
LM324	45p
LM339	65p
LM348	75p
LM358P	50p
LM377	175p
LM380	75p
LM381AN	180p
LM386	80p
LM393	100p
LM709	36p
LM710	50p
LM725	350p
LM733	75p
LM741	18p
LM747	70p
LM748	35p
LM2917	200p
LM3302	100p
LM3900	55p
LM3909	70p
LM3911	130p
LM3914	225p
LM3915	225p
LM3916	225p
LM13600	125p
MB3712	200p
MC1310P	150p
MC1458	40p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3403	75p
MM57160	620p
NE531	150p
NE555	18p
NE556	55p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE571	425p
NE5534A	250p
PLL02A	500p
RC4136	60p
S566B	240p
SAD1024A	1250p
SFF96364	800p
SN76013N	170p
SN76477	175p
SP8515	750p
TA7120	200p
TA7204	250p
TA7205	200p
TA7222	200p
TA7310	200p
TBA231	150p
TBA641B11	300p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	300p
TCA220	350p
TCA940	175p
TDA1004	300p
TDA1008	320p
TDA1010	225p
TDA1022	570p
TDA1024	100p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2020	320p
TL071/81	45p
TL072/82	75p
TL074	130p
TL084	110p
UAA170	175p
ULN2003	100p
UPC1156H	300p
XR2206	300p
ZN414	90p
ZN419C	225p
ZN424E	135p
ZN425E	350p
ZN427E	650p
ZN1034	200p

VOLTAGE REGULATORS

Fixed Plastic TO-220

	+ve		−ve	
1A				
5V	7805	50p	7905	55p
12V	7812	50p	7912	55p
15V	7815	55p	7915	55p
18V	7818	55p	7918	70p
24V	7824	55p	7924	70p
100mA	TO-92		79L05	60p
5V	78L05	30p	79L12	60p
12V	78L12	30p	79L15	60p
15V	78L15	30p		

OTHER REGULATORS

LM309K	135p	78HGKC	600p
LM317T	200p	78H05KC	550p
LM323K	500p	78MGT2C	135p
LM723	37p	79HGKC	600p
		TL497	300p

OPTO-ELECTRONICS

2N5777	45p	ORP60	120p
OCP71	180p	ORP61	120p
ORP12	120p	TIL78	55p

OPTO-ISOLATORS

ILD74	130p	TIL111	90p
MCT26	100p	TIL112	90p
MCS2400	190p	TIL116	90p

LEDS

0.125"		0.266	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p	NSB5881	570p
		TIL311	600p
		TIL312/3	110p
		TIL321/2	130p
		TIL330	140p
		7750/60	200p

DISPLAYS

3015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	110p
FND507	110p
MAN3640	175p
MAN4640	200p

DRIVERS

9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116	50p
AD149	70p
AD161/2	45p
AU107	200p
BC107/8	13p
BC109	14p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	15p
BC461	36p
BC477/8	30p
BC516/7	40p
BC547B	16p
BC548C	9p
BC549C	18p
BC557B	16p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	38p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFX29	40p
BFX30	34p
BFX84/5	40p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
E300	50p
E308	50p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	60p
MJE2955	100p
MJE3055	70p
MPF102	45p
MPF103/4	40p
MPF105/6	40p
MPS6531	50p
MPS6534	50p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
OC28	130p
OC35	130p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	130p
TIP147	130p
TIP2955	78p
TIP4055	70p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	25p
2N2484	30p
2N2646	45p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	54p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4061/2	18p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5194	90p
2N5245	40p
2N5296	55p
2N5401	50p
2N5457/8	40p
2N5459	40p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6041	160p
2N6044	160p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
2SC1172	150p
2SC1306	150p
2SC1307	250p
2SC1957	90p
2SC1969	200p
2SC2028	120p
2SC2029	250p
2SC2078	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	250p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

ZENERS
2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

THYRISTORS

1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
BT106	110p
C106D	40p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

HEATSINKS
For TO220 Voltage Regs. and transistors 22p
For TO5 12p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p

LOUDSPEAKERS

Size		
2½	64R	80p
2½	8R	80p
2	8R	90p
1½	8R	100p

MODULATORS
6MHz UHF 375p
8MHz UHF 450p

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4	300p
2112-4	300p
2114L	130p
2114-2L	160p
4027-3	300p
4044	700p
4116	200p
4118	500p
5101	300p
6116 (150ns)	£11
6514-45	£4
6810	200p

ROM/PROMs

71301	700p
74S188	225p
74S287	350p
74S471	650p
74S571	850p

CPUs

1802CE	750p
2650A	£16
6502	400p
6800	370p
6802	500p
6809	1280p
8080A	450p
8085A	550p
TMS8060	1000p
TMS9980A	£20
Z80	370p
Z80A	550p

EPROMs

1702A	500p
2708	300p
2716 (+5V)	400p
2532	800p
2732	600p

SUPPORT DEVICES

3242	800p
3245	450p
6522	500p
6532	775p
6821	180p
6845	£10
6850	180p
6852	370p
6875	600p
8154	950p
8155	800p
8205	320p
8212	180p
8216	180p
8224	250p
8226	250p
8228	250p
8251	400p
8253	400p
8255	400p
8257	800p
8259	800p
8279	950p

TMS9918	POA
Z80P10	400p
Z80AP10	450p
Z80CTC	400p
Z80ACTC	500p
Z80ADART	£8
Z80ADMA	£12
Z80S10-1	£20

UART

AY-3-1015P	400p
AY-5-1013P	350p
IM6402	450p

CHARACTER GENERATORS

RO-3-2513 U.C.	750p
RO-3-2513 L.C.	700p
SN74S262AN	£10

KEYBOARD ENCODER

AY-5-2376	700p
74C922	500p

CRYSTALS

32.768KHz	250p
100KHz	300p
200KHz	370p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	250p
2.00MHz	250p
2.45760MHz	250p
3.276MHz	250p
3.5795MHz	175p
4.00MHz	250p
4.194MHz	250p
4.43MHz	125p
5.0MHz	250p
6.0MHz	250p
6.144MHz	250p
7.0MHz	250p
7.168MHz	250p
8.00MHz	250p
8.867MHz	250p
10.00MHz	250p
10.7MHz	250p
1p.0MHz	350p
16.00MHz	250p
18.00MHz	250p
18.432	250p
19.968MHz	390p
26.690MHz	300p
27.145MHz	250p
38.6667MHz	350p
48.0MHz	300p
55.5MHz	400p
116MHz	350p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

ZERO INSERTION FORCE SKT 24 pin £6

WIRE WRAP SOCKETS BY TEXAS

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

HEADER PLUGS

14 pin	40p
16 pin	50p
24 pin	90p
40 pin	250p

COUNTERS
74C925 550p
74C928 600p
ICM7216B £20
ZN1040E £7

TTL & ECL
MC4024 325p
MC4044 325p
10116 70p
10231 350p

DISC IC
FD1771 £20
FD1791 £30
WD1691 £15
WD2143 550p

★ SPECIAL OFFERS ★

	1-24	25-99	100
2114L (450ns)	1.10	1.05	1.00
2716 (+5V)	2.75	2.50	2.25
4116 (200ns)	0.90	0.85	0.80

ACORN ATOM. Supplied with full size QWERTY Keyboard, 8K ROM, 2K RAM and can be expanded to 12K ROM, 12K RAM. Included are UHF Modulator for connection to domestic TV and Free manual on Programming in BASIC or Machine Code.
Kit **£129.** Built **£150.** P&P £2.50.

UK 101/OHIO II TWO BOARD HARDWARE INTERFACE

DECODING BOARD plugs into UK 101/OHIO II socket to provide 16 bit user port plus a wide variety of decoded lines for interfaces (inc. full decoding for AY3-8910/12 PSG) and a 40-pin socket for further expansion. Kit **£27.50.**
Analogue Board plugs into decoding board to provide D/A converter, 8-channel multiplexed A/D converter, AY3-8910 PSG plus 6522 timer IC allowing complex timing and counting functions, plus 16-bit port. Kit **£39.95.**
Reprint of 'P.E.' articles **£1** + SAE.

SOFTY: INTELLIGENT EPROM PROGRAMMER

Ideal software/hardware tool. Develop your programmes, debug/verify and then commit them to EPROM.
Ready-built for +5V EPROMS, **£169.**

NANOCOMP II

A microprocessor trainer based on powerful state-of-the-art 6809. Facilities for further expansion (to be published in WW). An excellent system for training centres and especially useful to control application engineers. Complete Kit (inc. PCBs, case, prog. 2716, etc), **£80.**
(As described in "W.W." July '81.) 6809 Prog. Ref. Manual, **£5.**

ADD SOUND TO ZX80/81 PLUS RELAY CONTROL AND LIGHT DETECTION

★ ZX80/81 USER PORT ★

(as described in "P.C.W." Oct. '81)

Port module plugs directly into ZX80 or ZX81 to provide 8 input and 8 output lines. These allow input of data from switches, photocells, joy-stocks, etc., and control of up to 8 relays. Also 7-segment LED displays or LED lamps may be used and solid-state buzzers may be directly connected to the port. Variable tone audio output may be produced. The port is accessed by simple PEEK and POKE commands. The port kit includes plugs, sockets, double-sided PCB and all components. Price **£11.50.** Software and application sheet 40p + SAE.

SEE US AT "P.C.W." EXHIBITION IN EARLY SEPTEMBER FOR ABOVE AND OTHER PROJECTS

NEW RETAIL SHOP
305 Edgware Road, W2
Open: 9.30–5.30

Please add 30p P&P & VAT 15%
Government Colleges etc Orders accepted
CALLERS WELCOME
Mon–Fri 9.30–5.30
Saturday 10.30–4.30

TECHNOMATIC LTD.

17 BURNLEY ROAD, LONDON NW10
(2 minutes Dollis Hill tube station) (ample street parking)
Tel: 01-452 1500/01-450 6597 Telex: 92280?

The 602's alphanumerics allow a range of prompts, so for instance, if you press the M + key, the display responds with M + -- showing that a two-digit number is needed. The calculator has limited error messages, differentiating for example between arithmetic error, jumping error and parenthesis nesting error. There are no facilities for inputting strings (string is computer terminology for a series of alphanumeric characters) or for storing them in memory registers, so programs like hangman are not possible.

The alphanumerics are obviously intended to be incorporated into programs, but it is possible to experiment with them in manual mode.

602 Programming

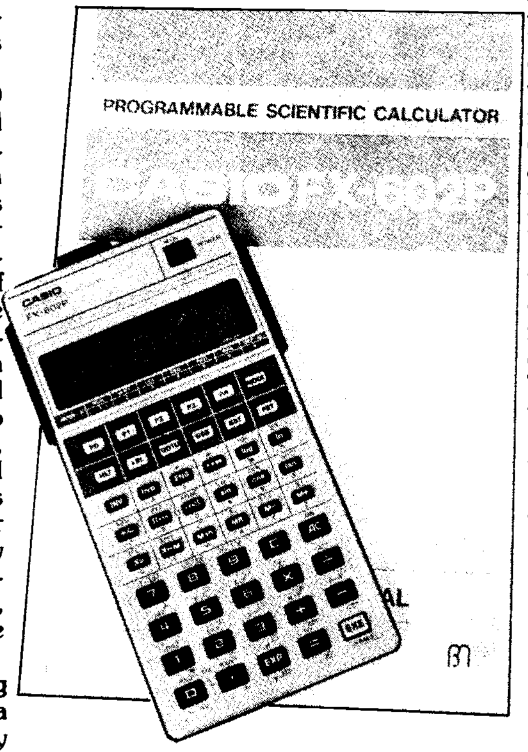
The FX-602P has a number of features which are useful for programming, including the familiar absolute value and integer/fraction part extraction. The commands ISZ and DSZ (increment/decrement, skip on zero) can be used for loop control and indirect addressing is possible for all memory functions, jumps, loop control and subroutine calls. Four conditional tests are possible: x = 0, x = 0, x = F and x = F (F is a memory register) which execute the next step if the condition is met and skip it otherwise.

The calculator can store up to 10 programs and any program can call another as a subroutine, to a maximum depth of nine levels. Each program can contain up to 10 labels which are the destinations for jumps. In one or two longer programs, I found myself running out of labels and Casio should either have provided more labels or absolute addressing — the ability to jump to a step number. A pause command stops execution temporarily to display a result or take in a number, then starts again automatically. I found this useful for real-time games although the pause times is rather short at 0.75 seconds and I usually had to use it twice running. An ordinary halt function is, of course, also provided for those of us whose reactions are not quite so sharp.

Program editing and debugging are well provided for. When listing a program, functions are identified by name, using alphanumerics, rather than the usual keycodes. It is possible to step forwards or backwards through a program at two speeds and steps may be inserted deleted or changed. Programs may be executed one step at a time, checking the name of each function as it is executed. Program numbers can be changed and programs can be cleared individually or all together.

A password feature is included, allowing the user to assign a four character code to a program. The password does not affect the running of the program, but the calculator will not let you list, alter or clear it without first entering the password. The instruction book gives a method for clearing a program, the password of which you do not know, so there is no possibility of getting a program 'stuck' in the calculator because you have forgotten its password. The password features will be of little use to most people, although it can be used to stop you accidentally erasing your programs.

The 602 is a very fast machine indeed, much faster than the top models from Texas Instruments and Hewlett Packard. A program to find the sines of the numbers 1-90 took just 25 s to run. In manual mode, scientific functions are calculated virtually instantaneously. The only penalty to be paid for such a high operating speed is increased power consumption — the 602 requires two lithium batteries which last for 660 hours.



FA-1 Adaptor

This allows storage of programs and data on tape for later reloading into the calculator. The FA-1 is a brown ABS plastic cradle into which the 602P fits, and we found that it scratched the back of the calculator quite badly. A skimpy 75 cm lead is terminated in two 3½ mm plugs for mic and earphone sockets. There is no facility for on/off control of a cassette recorder via its 'remote' socket, but in most cases, when only one file is being handled, this will be of little consequence.

Three types of file can be created: data files which hold the contents of all memory registers, program files storing one or all programs, and program/data files which are simply combinations of the other two. Each file is given a three-digit code number and the calculator will search through a cassette for the right number and type of file. The FX-602P will accept files made by the FX501/2P although the reverse does not apply. In use we experienced some loading problems with both ear and mic plugs connected, but with only one plug in place, the problem disappeared and both loading and saving were totally reliable. A file check feature is included, which listens to a cassette file and compares it with the original in the calculator for errors.

An unusual feature of the FA-1 is its ability to synthesise music. Music is programmed into the calculator using memory commands. The length of the note played is determined by the memory command used and its pitch is dependent upon which memory is addressed. Dotted notes are produced using the decimal point key and slurs and ties are also possible. Tempo is variable in 10 steps over a range of 10 to 1. Programming directly from a score is simple, but composing is almost impossible because the piece can only be played back in its entirety rather than in small sections and changing one note takes about 15 s. The 602P reproduces its music through the microphone socket (and loudspeaker!) of a cassette player. The sound is not of good quality and the only use we could find for this feature was as a sound effects generator.

Conclusions

The FX-602P is without doubt the best calculator in its price range. It has a good, though not exceptional, range of functions. Programming is flexible, efficient and fast, and is well augmented by the calculator's alphanumerics and editing facilities. The calculator is well documented and presented. Minor criticisms are the lack of a 'shift lock' for alphanumerics and the rounding error caused by storing a number.

The FA-1 is a useful peripheral, ▶

Vero has countless reasons to celebrate 20 years of Veroboard.
That's how Vero began and many of you started.
Twenty years ago Vero introduced Veroboard to the designer and hobbyist market.
It was then unique in its concept and is still one of the basic boards for the electronics industry. Such is the influence that Veroboard has had, and is still having, that the very name has become part of general vocabulary. Twenty years is a long time in a new industry and Vero have been in the forefront with their standards, quality control and customer service throughout that time.
From Veroboard through Card Frames to Vero Cases, we are proud to be of service and hope that you will agree that sales of millions of Veroboards is a suitable cause to celebrate our twentieth birthday.
Please Telephone for further information about Veroboard and our other products.
Phone: Chandler's Ford
(04215) 62829
vero
Vero Electronics Ltd., Retail Department, Industrial Estate, Chandler's Ford, Hampshire. SO5 3ZR.

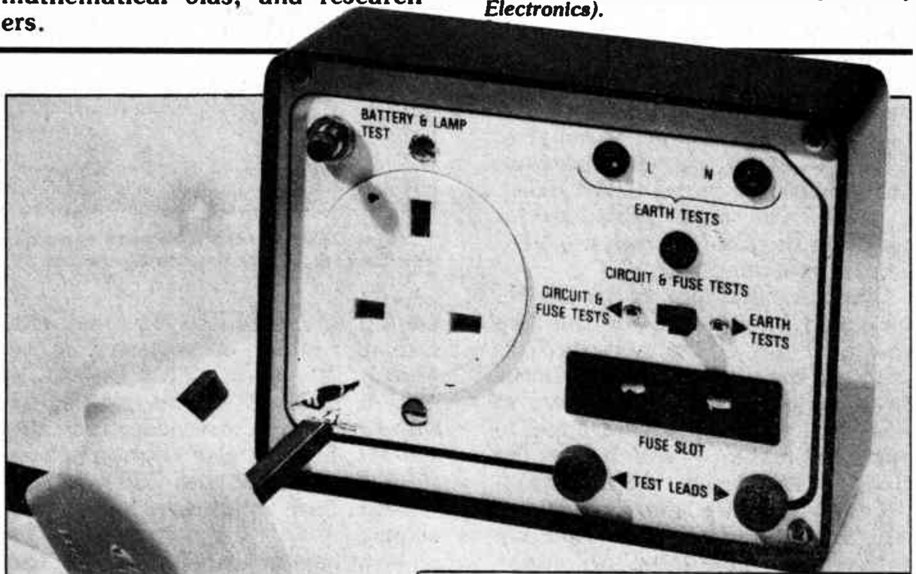
but not a necessity. It is simple to use and reliable. Even disregarding the music feature (as most people will!) the FA-1 represents good value. Casio must now work on a printer to produce hard copy of the calculator's excellent alphanumerics.

Despite its limited statistical functions, the 602P will appeal to statisticians because of its flexible memory and the fact that the program library contains 19 statistics programs. The calculator will also be of interest to university students, computer programmers with a mathematical bias, and researchers.

You can expect to pay £74.95 for the FX-602P, £19.95 for the FA-1 and £54.95 for the FX-601P with 11 memories and 128 steps (prices supplied by Tempus).

(Guest reviewer Leon Goodfriend also evaluated the Casio FX-502P calculator for us in the August edition of Hobby Electronics).

The Easy-Check Mains Test Unit



Picture the scene — you get up the morning after the night before and with trembling hands switch on the electric kettle in anticipation of a strong, black, life-saving coffee. An hour later the water is still stone cold. What do you do? Has the fuse blown? Has the kettle element blown? Is there a broken wire in the mains cable?

You can test it (or any other domestic electrical appliance) with the Easy-Check Test Unit from Turnstone Products. Typically, test one determines whether or not the mains plug is wired properly. If the 'L' or 'N' LED lights then either the plug is wired incorrectly or a foreign body has found its way inside or the flex is badly worn or the fault is inside the appliance itself.

Next test: Generally speaking, all appliances with exposed metal parts must be earthed. With the appliance plugged into the checker, touch a test lead against one of the exposed metal parts. The 'L' LED should light. If not, there's a serious fault somewhere. Check the earth lead in the mains plug.

Test three checks for blown fuses, broken wires, burnt out elements, etc. Again correct operation is shown by a simple LED on or LED off indication. There can't be any confusion.

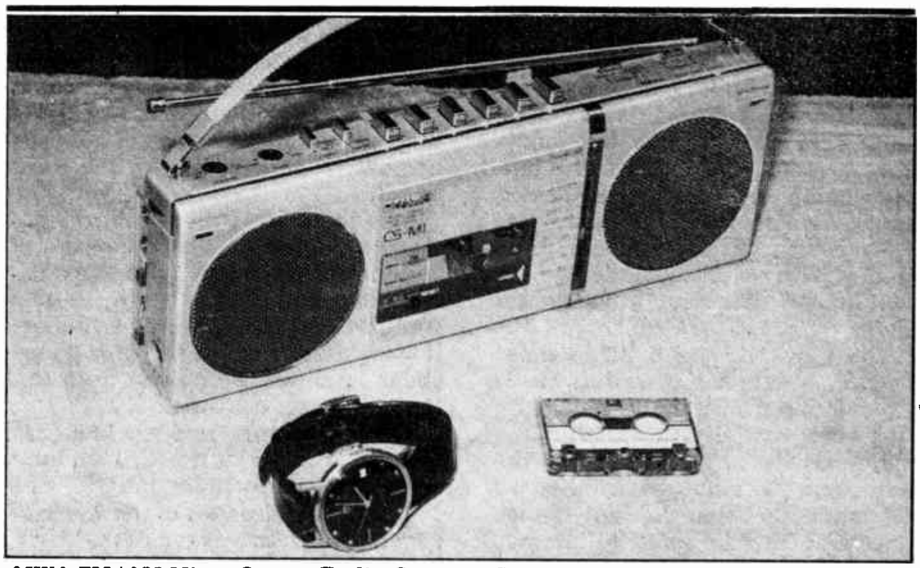
In addition, the Easy Check unit can be used to test cartridge fuses, bulbs, flex, etc. Fuses are simply pushed onto two contacts on the front panel. It couldn't be simpler. Power is supplied by a single PP3. There's no on-off switch as the unit only draws current while testing. As it can't be switched off you must be careful not to leave test leads plugged in or place anything on top of the case that could operate the test buttons or touch the test contacts.

Driving Test

The Easy-Check can also be used on your car to find blown fuses, a break in the ignition coil, etc. However, the unit is not designed to measure voltages, so disconnect the car battery before you do any work.

The straightforward manual comes complete with a supplement dealing with car electrics. It also sensibly points out that the Easy-Check is not intended to replace the qualified electrician. It merely allows you to eliminate the most common faults before, if necessary, you have to call in an experienced (and expensive) professional.

The Easy-Check Test Unit is available from Turnstone Products, 12 Robinson Close, Bishop's Stortford, Herts, for £13.89 including VAT.



AIWA FM/AM Micro Stereo Radio Cassette Recorder compared for size with a watch and a microcassette tape

Two Radio/Microcassette Combinations

No sooner had one radio/microcassette recorder arrived in the HE office (AIWA FM/AM Micro Stereo Radio Cassette Recorder, previewed under Monitor in the September '81 issue of HE) than another one came through the door — this time from Philips.

Aiwa CS-M1

As reported last month, the CS-M1 has case dimensions of only 230 mm wide by 80 mm high by 36 mm deep. Most of the controls ▶

are situated on the top panel, and these consist of: volume, tone, tape, radio select, metal/normal tape select, cassette function push buttons, stereo/mono switch and AM/FM band switch. Balance control, microphone/line switch, oscillator frequency shift switch and various sockets are down the left-hand edge while you have to reach for the right-hand edge for the tuning knob — you need dexterity on these micro machines!

Power for the CS-M1 is supplied by four AA-size 1.5 V cells (these are tucked behind a panel on the base). A socket is also provided for operating the CS-M1 from a 6 VDC adaptor (not supplied).

When you first look at the CS-M1 you could be excused for thinking 'how do I get at the cassette?' Instead of the usual panel-mounted flip-open loader, first you have to slide back part of the front panel to reveal the loader — which does flip open at the touch of a button. Although a little more awkward than the usual direct press-and-flip method, the additional protection given by the sliding panel must help to prevent dust from entering the cassette drive mechanism.

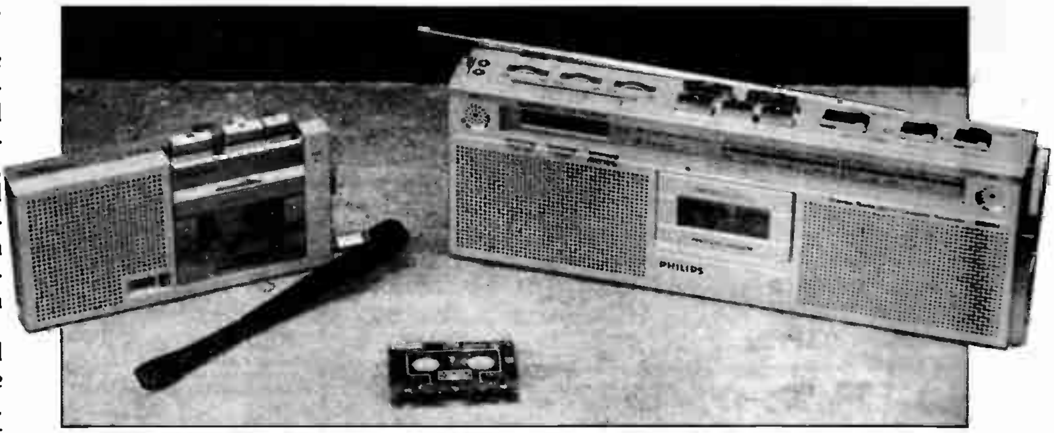
The radio covers medium wave and stereo VHF, and station tuning is indicated on a vertical strip panel next to the right-hand speaker grille. Signal strength is indicated by a red LED above this strip and a red LED situated above a 'battery' LED lights up on stereo broadcasts.

Two microphones, one above each speaker grille, can be used for 'live' recordings. (Recordings can be made from microphones, line inputs or from radio.) Cassette control button line-up is: pause, stop/eject, rewind/review, play, forward/cue and record. A mechanical tape counter with reset is included on the front panel. The tape runs at 2.4 cm/s.

The CS—M1 has a 'sleep timer system' — but it is a rather crude one compared with that provided on the Philips model. You simply run a microcassette while listening to the radio, and the radio is switched off automatically when the tape comes to an end (that is, after 30 minutes for an MC-60 cassette).

A metallic carrying strap clips on to the case, which is made of metallised plastic. An extendable telescopic antenna is fitted to the case.

Recommended retail price (RRP) for the CS-M1 is £109.95.



Philips D8000 radio/cassette recorder (right) compared with its predecessor, the D6710 Microcassette Recorder

Philips D8000

The styling of the D8000 Stereo Radio Micro Cassette Recorder is similar to the D6710 Microcassette Recorder which we reviewed in the March '81 issue. The D8000 is *slightly* larger (240 mm wide by 87 mm high by 36 mm deep) than the CS-M1, but it is also slightly lighter (690 g compared with 750 g for the CS-M1, both weights including batteries).

Most significant advantage of the D8000 over its rival is the inclusion of a digital clock/alarm. (This requires a separate 'button' nicad cell.)

The LCD display shows time in 24-hour form and doubles as the tape log counter. (We found that the display was too deeply recessed to receive sufficient illumination and was awkward to read.) You can choose between an electronic bleep or a radio broadcast for the alarm. An alarm stop/reset bar is mounted conveniently on the top panel, while time set, sleep and zero set controls are within easy reach on the front panel.

Like the CS-M1 most controls are on the top, and these consist of volume, balance and tone controls, cassette function buttons, tape/AM/FM and mono/stereo switches. It was puzzling to see the tape pause slider mounted well away from the main cassette controls.

Other controls and sockets are similar to those of the CS-M1 (and are in similar positions too).

The radio, like that of the CS-M1, covers medium wave and VHF bands but it has a clearer tuning scale along the top of the front panel. Tuning/recording and FM stereo LEDs are mounted on the tuning scale.

The two microphones are in places similar to those on the CS-M1 and the cassette specification is practically the same — with the exception of two tape speeds on the D8000: 2.4 cm/s or 1.2 cm/s (double playing time). Like the D6710, the cassette is held in a flip-open loader.

Power for the radio and cassette is supplied by four AA-size 1.5 V cells which are inserted behind a panel on the back of the case. The nicad battery for the clock/alarm is popped in under a twist-to-open cap on one edge.

The case, which has a built-in extendable telescopic antenna fitted to it, is made of metallised plastic. A carrying strap can be attached to one corner.

Approximate RRP of the D8000 is £139.95, including VAT. It is due for release in September.

Comparisons

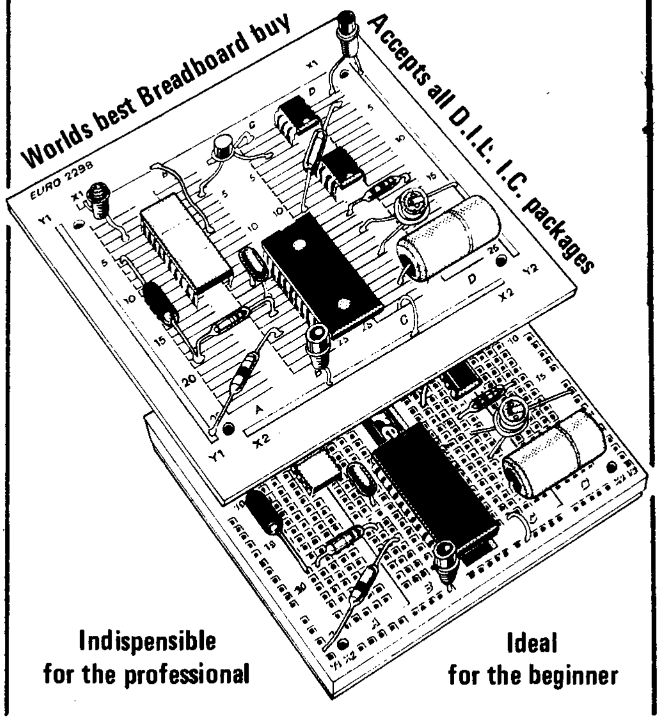
We placed the D8000 and the CS-M1 side-by-side on a table and compared the two. Everyone was impressed by the small size of each model but the most noticeable comments were those about the sound quality. Although hi-fi quality is impossible to obtain from such tiny combinations (could this statement be disproved over the next few years?) the general view was that the CS-M1 out-performed the D8000 on sound quality. The Philips model seemed somewhat flat and lacking in bass response. Also, more background hiss was produced by the D8000 (this was particularly noticeable when headphones were used, with the radio playing at a low volume).

So if you want better quality sound — but don't need a built-in clock/alarm — then the CS-M1 seems a better buy.

One final comment about both models: because of their small size, both have little space for control knobs. As a result, knobs, buttons and sockets are spread around four or five sides of the case, which can make operation (particularly in the dark) rather fiddly.

HE

First the EuroBreadBoard
Now the EuroSolderBoard



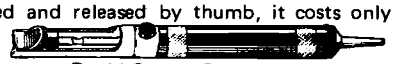
Indispensible for the professional — **Ideal for the beginner**

Design on a EuroBreadBoard — Instal on a EuroSolderBoard

First the EuroBreadBoard
Will accept 0.3" and 0.6" pitch DIL IC's, Capacitors, Resistors, LED's, Transistors and components with up to .85mm dia leads.
500 individual connections PLUS 4 integral Power Bus Strips along all edges for minimum inter-connection lengths.
All rows and columns numbered or lettered for exact location indexing (ideal for educational projects)
Long life, low resistance (<10m ohms) nickel silver contacts
£6.20 each or £11.70 for 2

Now the EuroSolderBoard
New 100mm square, 1.6mm thick printed circuit board with pre-tinned tracks identically laid out, numbered and lettered to Euro-BreadBoard pattern.
Four 2.5mm dia fixing holes.
£2.00 for set of three ESB's

And don't forget the EuroSolderSucker
Ideal for tidying up messy solder joints or freeing multi-pin IC's, this 195mm long, all metal, high suction desoldering tool has replaceable Teflon tip and enables removal of molten solder from all sizes of pcb pads and track. Primed and released by thumb, it costs only £7.25 including VAT & PP



Snip out and post to David George Sales,
Unit 7, Higgs Industrial Estate, 2 Herne Hill Road, London SE24 0AU

David George Sales, HE10
Unit 7, Higgs Ind. Est., 2 Herne Hill Rd., London SE24 0AU
Please send me:—

	1 EuroBreadBoard	@ £ 6.20	O	
or	2 EuroBreadBoards	@ £11.70	O	Please
or	3 EuroSolderBoards	@ £ 2.00	O	Tick
or	1 EuroSolderSucker	@ £ 7.25	O	

All prices are applicable from Jan. 1st, 1981 and include VAT and PP but add 15% for overseas orders.

Name . . . .
Company . . . .
Address . . . .
. . . .
. . . .
Tel. No. . . . .
Please make cheques/P.O. payable to David George Sales and allow 10 days for cheque clearance and order processing

GREENWELD
443F Millbrook Road, Southampton, SO1 0HX
All prices include VAT @ 15% — just add 40p post

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

"STARBIRD"
Gives realistic engine sounds and flashing laser blasts – accelerating engine noise when module is pointed up, decelerating noise when pointed down. Press contact to see flash and hear blast of lasers shooting. PCB tested and working complete with speaker and batt. clip (needs PP3 battery). **Only £2.95 – 2 for £5.** For details of other games, send SAE.

1N4002 DIODES
Lowest ever price!! – full spec by Motorola. Pre-formed leads for horiz. mntg., 10mm pitch. 100V 1A rating. 100 **£1.75; 500 £7.50.** 1k **£14**, 5k **£65.**

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

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

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

UHF TUNERS
Mullard ELC1043/05 Channels 21-69. Brand new, supplied with data, **£4.**

VHF TUNERS
Type F3720 (CCIR) by Sylvania. Bargain at only **£3.**

Enamelled copper wire: 28swg on former, approx. 20m long. **15p.**

TV COILS. AT4040 series, AT4041/2, etc. All cheap. SAE list.

OPTO/REGS/OP-AMPS
FNA5220 2 digit ½" 7-seg. display on PCB. CC. With data. **£1.50**
7-seg. displays: FND360, 367, 501, all **50p**; 530, 847, 850, all **£1.50.**
Regs, TO3 case: 7924 **120p**, 7885 **100p**, 7808 **100p**, 7912 **100p**, 78CB **230p**. Others on B/L 13
Op-Amps: uA4136 **130p**; uA776 **145p**; uA777 **300p**; uA318 **245p.**
Isolators: FCD831, IL15, TIL118, all **60p.**
TIL311 Hexadecimal display with decoder, 0-9 and A-F. With data. **£3.50.**

COMPONENT PACKS
K503 150 wirewound resistors from 1W to 12W, with a good range of values **£1.75**
K505 20 assorted potentiometers, all types including single ganged, rotary and slider **£1.70**
K511 200 small value poly, mica, ceramic caps from a few pF to .02uF. Excellent variety **£1.20**
K514 100 silver mica caps from 5pF to a few thousand pF. Tolerances from 1% to 10% **£2**
K516 Transistor Pack. Small signal NPN/PNP transistors in plastic package. Almost all are marked, full spec. devices, but some have bent leads. Over 30 different types have been found by us, inc. BC184/212/238/307/328 BF196/7; ZTX107/8/9/342/450/550, etc. Look at the low price! **100 for £3; 250 for £7.**
K520 Switch Pack, 20 different, rocker, slide, rotary, toggle, push, micro, etc. Only **£2.**
K521 Heatsink Pack, 5 different sizes each 200mm, **50p.**

PANELS
Z521 Panel with 16236 (2N3442) on small heatsink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. **60p**
Z482 Potted Oscillator Module works from 1.20V, can be used as LED flasher (3V min.). Supplied with connection data, suitable R, C & LED **£1**
Z527 Reed relay panel – contains 2 x 6V reeds, 6 x 2S030 or 2S230, 6 x 400V rects + Rs **50p**
Z529 Pack of ex-computer panels containing 74 series ICs. Lots of different gates and complex logic. All ICs are marked with type no. or code for which an identification sheet is supplied. 20 ICs **£1**; 100 ICs **£4.**
A504 Black case 50 x 50 x 78mm with octal base. PCB inside has 24V reed relay, 200V 7A SCR, 4 x 5A 200V rects, etc. **60p**
Z535 RAM panel – 36 2102A-4 static RAMs, also 28 other chips inc. 7 x LS75, 4 x 74368, 3 x 74180 etc. **Only £5**
Z536 As above, but extra 15 74LS chips **£6**

4 TERMINAL REGS
uA78MG in power mini-dip case 5-30V at ½A **£1**
uA79MG Negative version of above **£1.20**
Only 4 extra components required (50p extra) to make a fully variable supply! Data supplied.

1W AMP PANELS
A011 Compact audio amp intended for record player on panel 95×65mm including vol control and switch, complete with knobs. Apart from amp circuitry built around LM380N or TBA820M, there is a speed control circuit using 5 transistors. 9V operation, connection data supplied **ONLY £1.50.**

VU METERS
V006. Very attractive 55×48mm scaled 20 to +5dB, 250uA movement. Only **£1.75** or **£3** pr.

THE SPECTACULAR 1981 GREENWELD Component Catalogue
Bigger and better than ever!!!
★ 60p discount vouchers
★ First Class reply paid envelope
★ Free Bargain List
★ Priority Order Form
★ VAT inclusive prices
★ Quantity prices for bulk buyers

SEND 75p FOR YOUR COPY NOW!!

DISC CERAMICS
0.22uF 12V 9mm dia. Ideal for decoupling. 100 for **£2.75**; 1000 **£20.**
0.5uF 12V 15mm dia. 100 **£1.50**; 1000 **£12.**
Pack of disc ceramics, assorted values and voltages – 200 for **£1.**

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

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

DEVELOPMENT PACKS
These packs of brand new top quality components are designed to give the constructor a complete range so the right value is to hand whenever required. They also give a substantial saving over buying individual parts.
K001. 50V ceramic plate capacitors, 5%, 10 of each value 22pF to 1,000pF, total 210. **£4.80.**
K002 Extended range 22pF to 0.1. Values over 1000pF are of a greater tolerance. 10 of each value 22 27 33 39 47 56 68 82 100 120 150 180 220 270 330 390 470 560 680 820 1000 1500 2200 3300 4700 6800 .01 .015 .022 .033 .047 .1. **PRICE: £7.66.**
K003 C280 or similar Polyester capacitors, 10 each of the following: .01, .015, .022, .033, .047, .068, .1, .15, .22, .33 and .47μF. **PRICE: £5.40.**
K004 Mylar capacitors. Small size, vertical mounting 100V. 10 each of the following: .001, .0012, .0015, .0018, .0022, .0027, .0033, .0039, .0047, .0056, .0068, .0082, .01. Total 130 capacitors. **PRICE: £4.70.**
K007 Electrolytic capacitors 25V working small physical size axial or radial leads. 10 each of the following: 1, 2.2, 4.7, 10, 22, 47, 100μF. Total 70 capacitors. **PRICE: £3.59.**
K008 Extended range, as above, also including 220, 470 and 1000μF all at 25V. Total of 100 capacitors. **PRICE: £6.35.**
K021 CR25 resistors or similar, miniature ¼ watt carbon film 5%, as used in nearly all projects. 10 of each value from 10 ohms to 1M, E12 series. Total 610 resistors. **PRICE: £5.95.**
K041 Zener diodes 400mW 5%. 10 of each of all the values from 2V7 to 36V. Total 280 zeners. **PRICE: £15.95.**
K051 LEDs – pack of 60, comprising 10 each red, green and yellow 3mm and 5mm, together with clips. **PRICE: £8.95.**

BARGAIN LIST No. 13
10 A4 pages!! Hundreds of different items!! Switches, pots, relays, Cs, Rs, semis, connectors, panels, etc., etc.
Send **9x4** SAE for your FREE copy of never to be repeated bargains!!

AD563KD D-A converter. **Only £3.50.**

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

TV TEST GEAR
Wobbulators, Calibration Gens., Modulators, Sync. Generators, Encoders, Converters, etc. All cheap. SAE List.

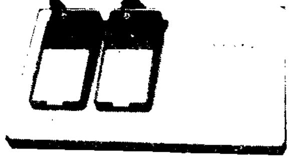
VDU CRTs
Approx. 250 12" and 15" 110° tubes available for callers only. All **£15 each.**

ELECTRONIC GAMES

COLOUR CARTRIDGE T.V. GAME

SEMI-PROGRAMMABLE T.V. GAME + 4 Cartridges + Mains Adaptor
Normal Price £73
NOW REDUCED TO: **£39.50** inc VAT

DATABASE T.V. GAME

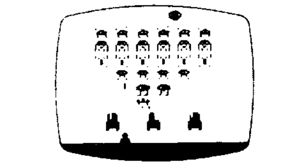


FULLY PROGRAMMABLE CARTRIDGE T.V. GAME
14 Cartridges available
Normal Price £87.86
NOW REDUCED TO: **£59** inc VAT

ATARI T.V. GAME

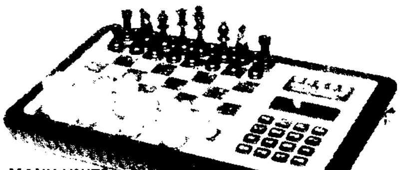
The most popular T.V. Game on the market with a range of over 40 cartridges including SPACE INVADERS with over 112 games on one cartridge. **£95.45** inc VAT

SPACE INVADERS



Hand-held Invaders Games available **£19.95**
+ Invaders Cartridges available to fit *ATARI RADOFIN ACETRONIC PHILIPS G7000*
+ Cartridges also available for *MATTEL TELENG ROWTRON DATABASE/INTERTON*

CHESS COMPUTERS



MANY UNITS ARE COVERED BY THE EXCLUSIVE SILICA SHOP 2 YEAR GUARANTEE

We carry a range of over 15 different Chess computers:

Electronic Chess	£29.95
Chess Traveller	£39.95
Chess Challenger 7	£79.00
Sensory 8	£119.00
Sensory Voice	£259.00

SPECIAL OFFERS:
VOICE CHESS CHALLENGER
Normal Price £245 NOW £135.00
SARGON 2.5/BORIS 2.5
Normal Price £273.70 NOW £199.95
All prices include V.A.T.

TELETEXT

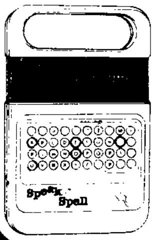
ADD-ON ADAPTOR £199 inc VAT

THE RADOFIN TELETEXT ADD-ON ADAPTOR

Plug the adaptor into the aerial socket of your colour T.V. and receive the CEEFAX and ORACLE television information services

THIS NEW MODEL INCORPORATES:
- Double height character facility
- True PAL Colour
- Meets latest BBC & IBA broadcast specifications
- Push button channel change
- Unnecessary to remove the unit to watch normal TV programmes
- Gold-plated circuit board for reliability
- New SUPERIMPOSE News Flash facility

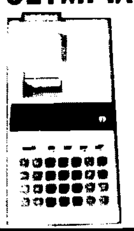
SPEAK & SPELL



Normal Price £49.95
NOW REDUCED TO: **£39.50** inc VAT

Teach your child to spell properly with this unique learning aid. Fully automatic features and scoring. Additional word modules available to extend the range of words.

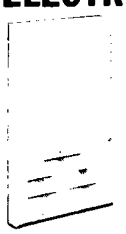
ADDING MACHINE
OLYMPIA HHP 1010



Normal Price £57.21
NOW REDUCED TO: **£34** inc VAT

Uses ordinary paper!
No need to buy expensive thermal paper!
Fast add listing PRINTER CALCULATOR 2 lines per second 10 digit capacity. Uses normal adding machine rolls. Battery or mains operated.
Size 9¼"x4⅝"x2⅜"
(Mains adaptor extra)

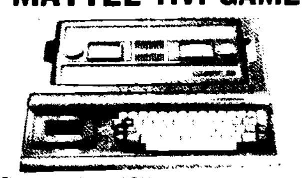
24 TUNE ELECTRONIC DOOR BELL



Normal Price £19.70
NOW REDUCED TO: **£12.70** inc VAT

Plays 24 different tunes with separate speed control and volume control. Select the most appropriate tune for your visitor, with appropriate tunes for different times of the year!

MATTEL T.V. GAME



The most advanced T.V. game in the world. 20 cartridges available. Add on KEYBOARD coming soon to convert the MATTEL to a home computer with 16K RAM fully expandable and programmable in Microsoft Basic. Other accessories will be available later in the year. **£199.95** inc VAT

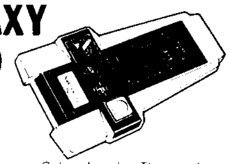
HAND HELD GAMES

EARTH INVADERS

These invaders are a breed of creature hitherto unknown to man. They cannot be killed by traditional methods - they must be buried. The battle is conducted in a maze where squads of aliens chase home troops. The only way of eliminating them is by digging holes and burying them. **£23.95** inc. VAT

HAND HELD GAMES

GALAXY 1000



The 2nd generation Galaxy Invader. The invaders have re-grouped and have a seemingly endless supply of spacecraft whilst the player's arsenal is limited to just 250 missiles to be launched from 3 missile stations. You have to prevent the invaders landing or from destroying your home defences. **£19.95** inc VAT

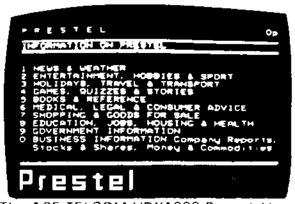
THE OLYMPIA — POST OFFICE APPROVED TELEPHONE ANSWERING MACHINE
WITH REMOTE CALL-IN BLEEPER

This telephone answering machine is manufactured by Olympia Business Machines, one of the largest Office Equipment manufacturers in the U.K. It is fully POST OFFICE APPROVED and will answer and record messages for 24 hours a day. With your remote call-in bleeper you can receive these messages by telephone wherever you are in the world. The remote call-in bleeper activates the Answer Record Unit, which will at your command repeat messages, keep or erase them and is activated from anywhere in the world, or on your return to your home or office. The machine can also be used for message referral if you have an urgent appointment, but are expecting an important call simply record the 'phone number' and location where you can be reached. With optional extra bleepers (£13 each) this facility can be extended to colleagues and members of the family. Using a C90 standard cassette you can record as many as 45 messages. The announcement can be up to 16 seconds long and the incoming message up to 30 seconds long.

The machine is easy to install and comes with full instructions. It is easily wired to your junction box with the spade connectors provided or alternatively a jack plug can be provided to plug into a jack socket. Most important of course, is the fact that it is fully POST OFFICE APPROVED.
The price of £135 (inc VAT) includes the machine, an extra-light remote call-in Bleeper, the microphone message tape, A.C. mains adaptor. The unit is 9½"x6"x2½" and is fully guaranteed for 12 months. The telephone can be placed directly on the unit - no additional desk space is required.

£135 inc VAT

PRESTEL VIEWDATA

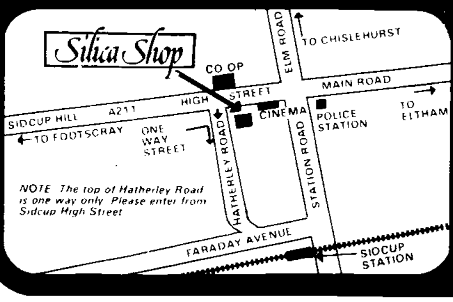


The ACE TELCOM VDX1000 Prestel Viewdata adaptor simply plugs into the aerial socket of your television and enables you to receive the Prestel Viewdata service in colour or black & white.

Features —
- Simplified controls for quick easy operation
- Special graphics feature for high resolution
- State-of-the-art microprocessor controller
- Standard remote telephone keypad with Prestel keys * #
- Auto dialler incorporated for easy Prestel acquisition
- True PAL colour encoder using reliable IC chroma filter and dela line incorporated for minimum picture interference maximum fidelity
- Includes convenient TV - Prestel switchbox
- Easily connected to standard home or office telephone lines
- Fully Post Office approved

SPECIAL PRICE **£228.85** inc VAT

FOR FREE BROCHURES – TEL: 01-301 1111



For free illustrated brochure and reviews on our range of electronic games please telephone 01-301 1111. Free delivery service available. To order by telephone please quote your name, address and ACCESS/BARCLAYCARD number and leave the rest to us. Post and packing free of charge. Express 48hr delivery service available.
- CALLERS WELCOME — Demonstrations daily at our Sidcup shop open from 9am-6pm Monday-Saturday (Early Closing Thursday 1pm — Late Opening Friday 8pm)
- 2 YEAR GUARANTEE — All goods are covered by a full year's guarantee and many are further covered by our exclusive Silica Shop 2 year Guarantee
- MONEY BACK UNDERTAKING — If you are unsatisfied with your purchase and return it within 7 days we will give you a full refund
- AFTER SALES SERVICE — Available on all machines out of guarantee
- COMPETITIVE PRICES — We are never knowingly undersold
- HELPFUL ADVICE — Available on the suitability of each machine
- CREDIT FACILITIES — Full credit facilities available over 12, 24 or 36 months at competitive rates of interest
- PART EXCHANGE SCHEME — available on second hand machines
- CREDIT CARDS WELCOME — Access, Barclaycard, Diners Club, American Express

SILICA SHOP LIMITED DEPT. HE10/81
1-4 The Mews, Hatherley Road, Sidcup, Kent DA14 4DX
Telephone: 01-301 1111 or 01-309 1111

SILICA SHOP

Baby Alarm

This simple baby alarm is easy to build and, despite the use of a battery as a power source, is inexpensive to run

A BABY ALARM is one of the simplest of telecommunications systems — it is a one-way communication device which allows parents to monitor the sounds of their baby's activities while they are not actually in the baby's room. The HE Baby Alarm uses a microphone in the baby's room, a loudspeaker in the parent's room, and an amplifier. The amplifier has sufficient gain for the parents to hear the sound of the baby's breathing. For the HE Baby Alarm the emphasis has been placed on meeting three requirements: simplicity of design, low battery drain and low cost. As a result, no attempt has been made to make a 'hi-fi' project, simply one incorporating a functional amplifier with high sensitivity. With the amplifier set to pick up low-level sounds of breathing, it will obviously tend to overload if the baby cries or screams. But even if the sound becomes distorted under these conditions, the project will still be fulfilling its function — that of an alarm.

Construction

Insert and solder the components into a 24 hole by 10 strip piece of 0.1" Veroboard, following the layout shown in Fig.2. There are just six breaks to be made in the strips and the two mounting holes can be for 6BA or M3 clearance (3.3 mm diameter is suitable for either). Be careful to connect the transistors, diodes, and electrolytic capacitors the right way round.

Make a grille for the loudspeaker in the case — you can do this by drilling a matrix of small holes in the case front. It is unusual for small speakers to have provision for screw fixing, and it will almost certainly be necessary to glue this component in place using a good quality general purpose adhesive. Be careful not to smear adhesive onto the speaker's diaphragm.

It is obviously necessary for either the microphone or the loudspeaker to be remotely located from the main circuitry, and it is normal for the microphone to be the one that is situated away from the main unit. If this is your choice, to minimise stray pick up of mains hum and other interference it will then be necessary to use a screened connecting cable. However, if the loudspeaker is fitted away from the main unit in its own case, ordinary twin cable is perfectly adequate. In either case the cable can be as much as 10 or 20 m long without causing any problems.

If you use a high impedance loudspeaker as a separate microphone, mount it in a small case situated in the baby's room, again making a grille by drilling a matrix of holes.

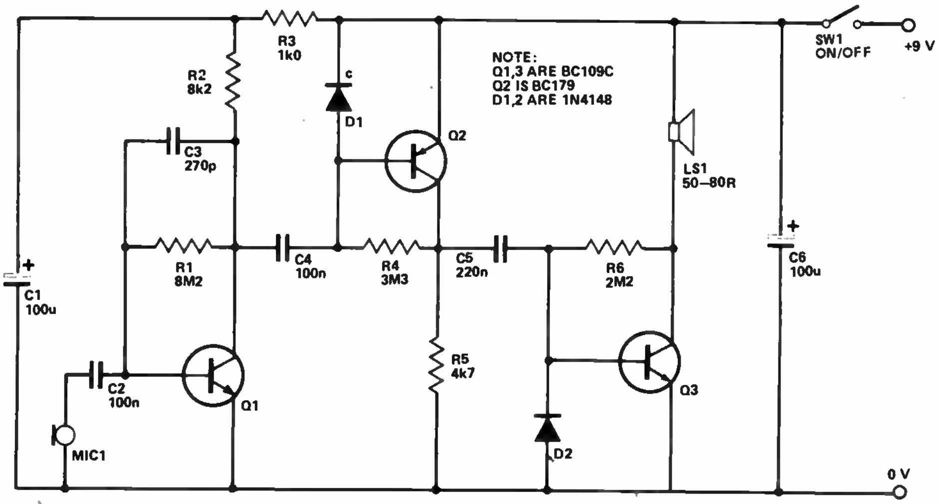
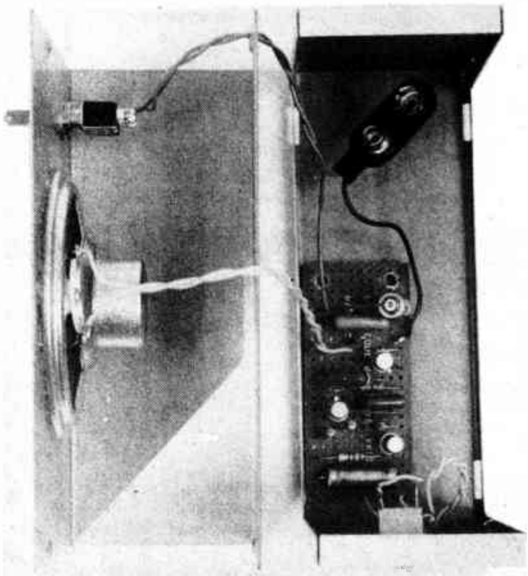


Figure 1. Circuit of the HE Baby Alarm



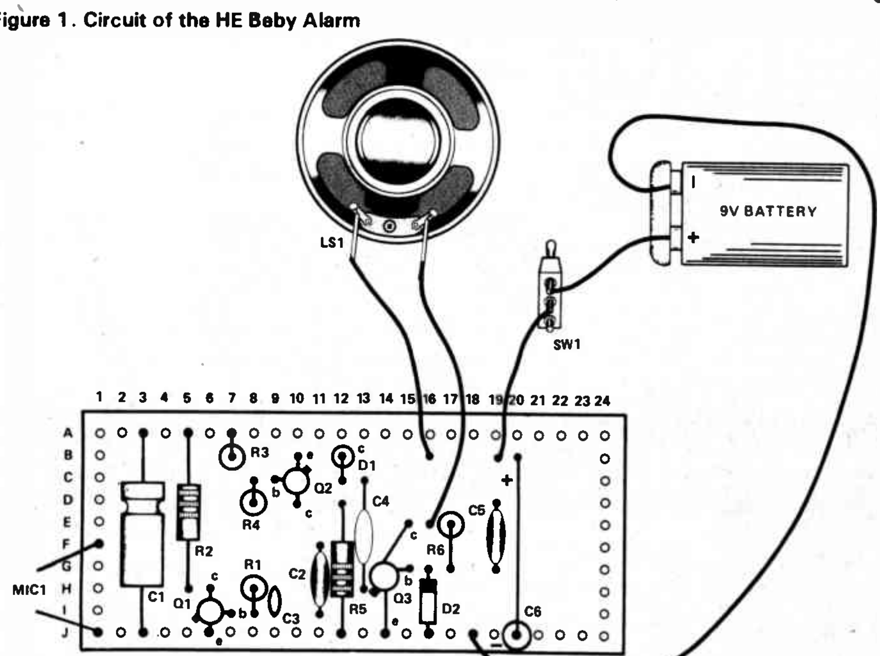
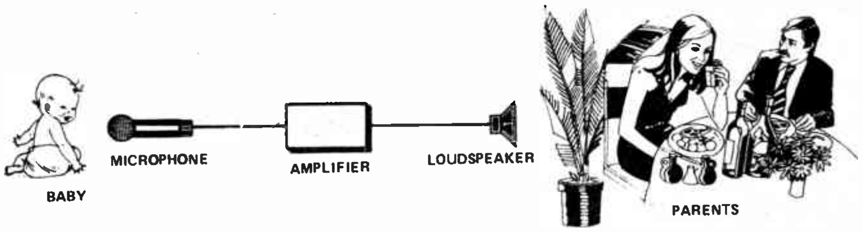


Figure 2. Veroboard layout, underside tracks breaks and connection details of the project

How It Works

Sound in the baby's room is picked up by the microphone and converted into electrical signals which are amplified and passed on to the loudspeaker in the parents' room. The loudspeaker reconverts the signal to sound.

The amplifier can be situated either with the microphone or with the loudspeaker.



As can be seen from the circuit diagram in Fig.1, the circuit is based on three common-emitter amplifiers. The first is built around transistor Q1 and resistor R1 provides the biasing. Resistor R2 is the collector load.

The input signal is from a low impedance microphone and is fed to the amplifier through capacitor C2. The microphone can be an inexpensive cassette recorder type, or a high impedance loudspeaker. Capacitor C3 reduces the high frequency response of the circuit and helps to prevent instability.

Capacitor C4 couples the output from Q1 to a similar amplifier which uses a PNP transistor Q2, and C5 couples the output from this to the third stage which uses Q3. The latter has the loudspeaker as its collector load. Three high gain amplifier stages are needed because of the low output voltage from the microphone (typically less than a millivolt).

Parts List

RESISTORS (All ¼W, 5 or 10%)

R1	8M2
R2	8k2
R3	1k0
R4	3M3
R5	4k7
R6	2M2

CAPACITORS

C1,6	100u, 10 V electrolytic
C2,4	100n polyester
C3	270p ceramic
C5	220n polyester

SEMICONDUCTORS

Q1,3	BC109C NPN
Q2	BC179 PNP transistor
D1,2	1N4148 diode

MISCELLANEOUS

SW1	single-pole, single-throw toggle switch
LS1	50-80R miniature loudspeaker
MIC1	Low impedance (cassette type) microphone or high impedance loudspeaker (similar to LS1)

Veroboard, 24 hole x 10 strips
Battery + clip
Cases to suit

Buylines

All components are readily available types and their approximate total price (excluding case) will be £5.

HE

Building Site

To many people, the term 'circuit board' probably conjures up the scene of a group of people, sitting around a table, discussing the length of an athletics track.

Keith Brindley tells you what a circuit board means to an electronics engineer or enthusiast

ALL THE PROJECTS published in HE (with a few odd exceptions) are built up on circuit boards. It helps to simplify construction and makes the layout of components neat. A circuit board consists of a solid layer (about 1.5 mm thick) of an insulating layer such as fibreglass or bonded plastic. On one side of the insulating material are very thin copper 'tracks' which are used to make connections between components mounted on the plain side of the board. In the tracks and through the board are drilled holes, through which the component leads go from the other side (see **Fig. 1**) — the leads are then soldered to the tracks.

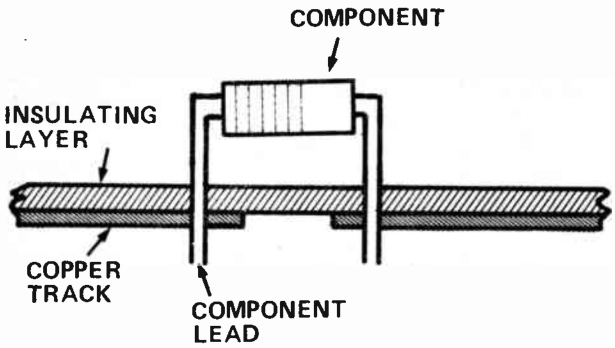


Figure 1. Section of a circuit board showing the insulating layer, thin copper strips and a component

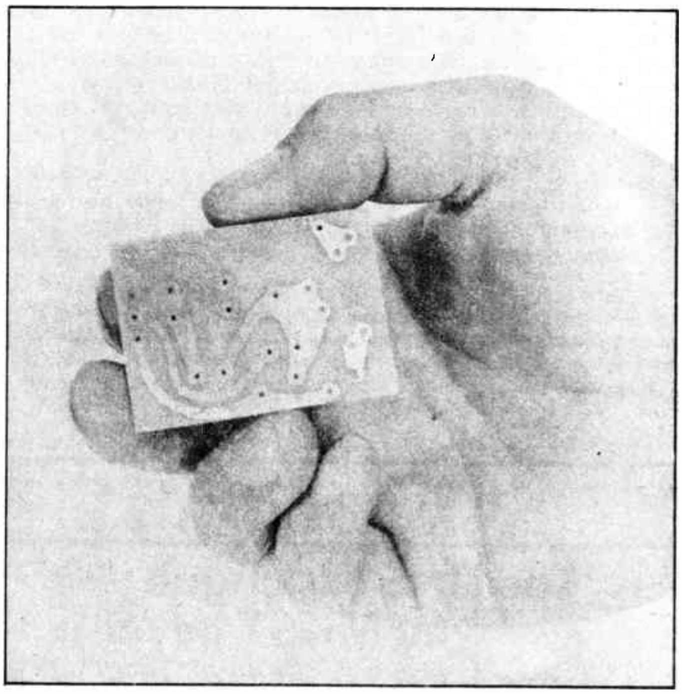


Figure 2. Underneath a printed circuit board (PCB). Each track is used to connect between two or more components

Two main types of circuit board are used for HE projects: printed circuit board (PCB) or Veroboard. Both types are similar in that they have an insulating layer with copper tracks, but there the similarity ends. You see, a PCB is designed to suit only one circuit — the copper tracks and holes are positioned on the underside of the board (see **Fig. 2**) to make only the correct connections for *that* circuit. Veroboard, on the other hand, has rows (called strips) of copper tracks, spaced at 0.1" intervals, and each strip has holes again spaced at 0.1" intervals apart. **Figure 3** shows a piece of Veroboard such as we might use for an HE Project. Using these strips of holes a variety of circuits can obviously be made up. In this respect, Veroboard has an advantage over PCB, because it's easily obtainable and any piece of Veroboard, providing it's big enough, can be used to build any circuit. Building a project up on PCB means you have to either make the board yourself (a subject of a future Building Site) or you have to buy the board ready-made (something which, in the past, hasn't been easy.

This gives me an opportunity to mention the HE PCB Service, details of which were first given in last month's issue. This service enables you to rapidly obtain ready-made, ready-drilled and, in fact, ready-to-use PCBs for HE projects (see page 61 for details).

Once you have a PCB, making it up is easy: you simply follow the overlay diagram given with the project. The distances between holes are correct for the specified components and the components will simply plug into the board, ready for soldering. Usually, each hole on the board will correspond to a component lead (this is a convenient self-check warning — if any holes are left when you think you've finished, you've forgotten a component!) and none of the tracks will be so close together that short

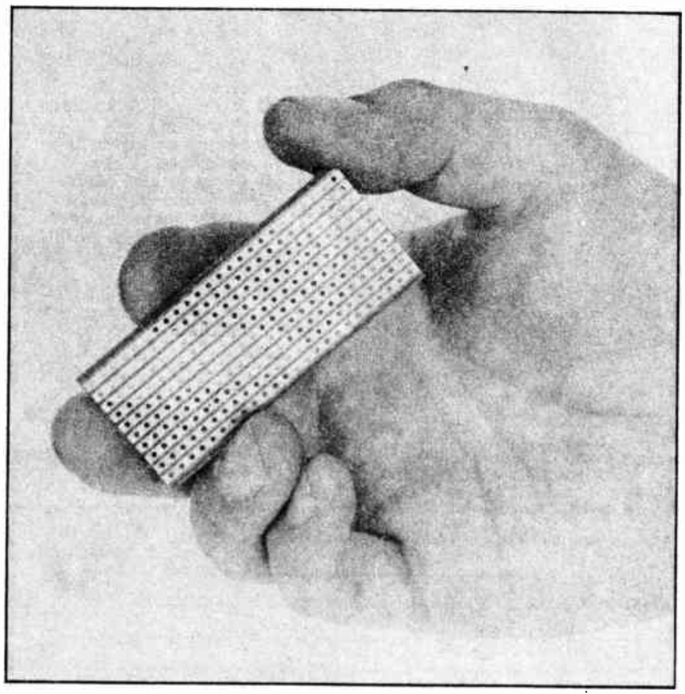


Figure 3. Underneath Veroboard. The pre-drilled copper strips, on a 0.1" matrix, join components

circuits from solder 'bridges' will be a problem. Veroboard requires a little more thought and care than ready-made PCB. Because of its standard 0.1" by 0.1" matrix of holes, it is necessary to make a careful check that the component leads have been inserted in the correct holes before soldering them into place. Care is also required during the soldering to avoid solder bridging (flowing across) from one strip to an adjacent one. Providing that these simple points are put into practice circuits (even some of the simpler PCB circuits) can be reliably constructed on Veroboard.

One job to do on Veroboard, which never occurs with PCB, is the cutting or breaking of the Veroboard strips. The reason why it's done is to split a strip into smaller lengths. The reason for this is that one strip of Veroboard track may have something like 60 linked holes, depending on the size of the board, and you might have only a couple of components in that track. This leaves a lot of empty, unused holes. If the copper strip can be broken, the remainder of the strip can then be used for connections to other components. **Figure 4** shows this being done, with a cutting tool, but a small hand-held drill bit works just as well. The operation is easy: gently push the tool onto a hole and twist the tool clockwise until the copper 'breaks' into a clean circle. One final thing to do is to check that no loose copper swarf from the cut strip acts as a bridge to an adjacent one, causing a short circuit.

In the end, its down to personal choice whether you use PCBs or Veroboard as circuit boards. Used correctly, both can give excellent results.

See you next month!

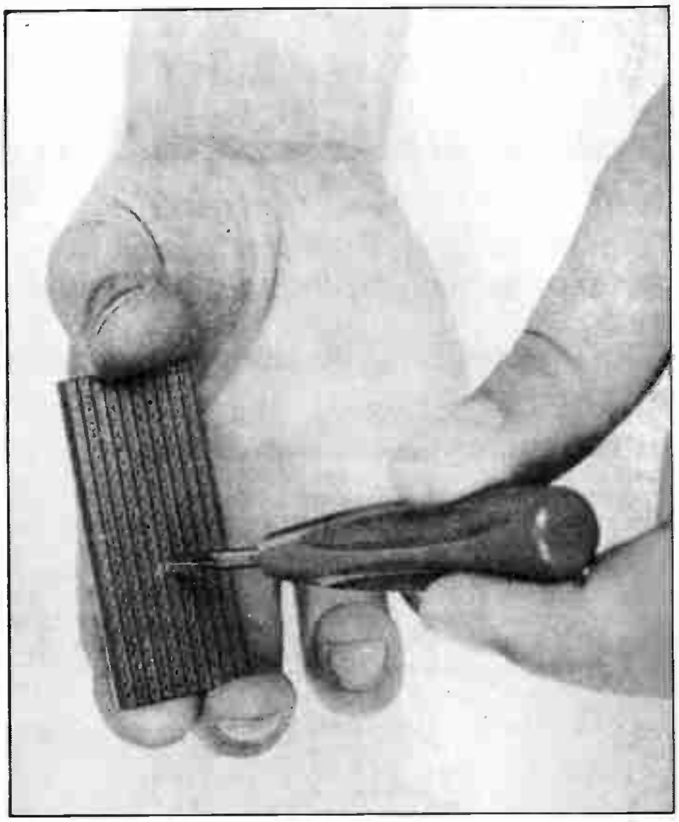


Figure 4. Using a cutting tool to break one of the copper strips of a piece of Veroboard. Alternatively, a small, hand-held drill bit can be used

HE

• HE Reader Offer • HE Reader Offer • HE Reader Offer •

TWO Digital Multitesters at special low prices for HE readers

SK-6110 only £72.95 including VAT, p & p

READERS — choose between two high-accuracy digital multitesters on special offer this month.

WHY DIGITAL? The main advantage of digital test meters over analogue test meters is that they offer direct readout of measured values. Because the instruments are all-electronic, no significant load is placed on circuits under test, resulting in more accurate readings. The absence of moving parts (apart from switches) makes these meters more rugged than moving-coil instruments — and the HE Digital Multitesters are supplied in high-impact ABS cases.

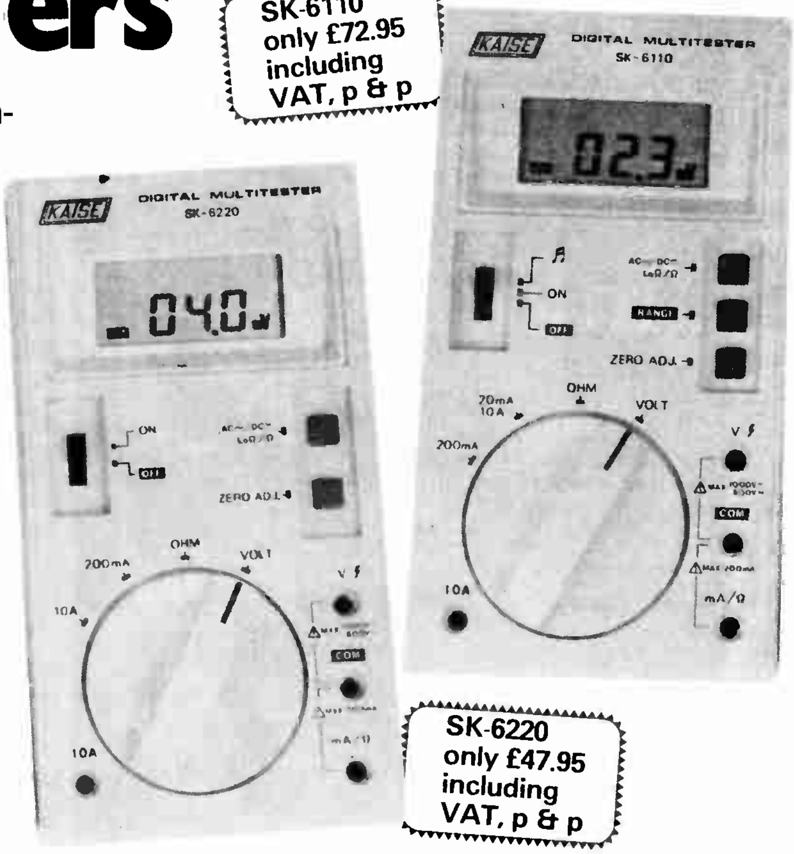
Both models, the Kaise SK-6110 and the SK-6220, offer:

- ★ **Auto-ranging on voltage and resistance ranges**
- ★ **DC and AC current measurement up to 10 A**
- ★ **Easy-to-read 3½-digit liquid crystal display (LCD), 10 mm high**
- ★ **Automatic display of units and ranges**
- ★ **Long battery life: 200 hours of continuous use**
- ★ **'Zero adjust' key to correct for test lead resistance**
- ★ **'Low battery' indication**

Model SK-6110 offers in addition:

- ★ **Audible continuity test function**
- ★ **Range hold function**
- ★ **Audible over-range indication**
- ★ **Higher accuracy (see specification below)**

So make your choice between these two today: each Multitester comes complete with batteries, test leads, instruction manual and carrying case. Prices include VAT, postage and packing.



SK-6220 only £47.95 including VAT, p & p

SPECIFICATION

General
Sampling rate: 2 Hz
Power supply: two AA-size 1.5 V cells
Size: 155 x 85 x 28 mm
Weight: 250g

DC Voltage
100 mV to 1000 V
Accuracy: ± 0.5% rdg ± 0.2% Fs (SK-6110)
± 0.8% rdg ± 0.2% Fs (SK-6220)
Input impedance: ≅ 10M
(200 mV range: ≥ 100M)
Max input voltage: 1000 V all ranges

AC Voltage
1 mV to 600 V
Accuracy: ± 1% rdg ± 0.4% Fs (SK-6110, 2 V range)
± 1% rdg ± 0.25% Fs (SK-6110, ≥ 20 V range)
± 1% rdg ± 0.4% Fs (SK-6220) all ranges
Input impedance: ≃ 10M
Max input voltage: 750 VRMS all ranges
Frequency response: 40 Hz to 500 Hz

DC Current
10 uA to 10 A (SK-6110)
100 uA to 10 A (SK-6220)
Accuracy: ± 1% rdg ± 0.2% Fs (SK-6110)
± 1.2% rdg ± 0.2% Fs (SK-6220)
Input impedance: 10R (20 mA range, SK-6110)
1R (200 mA range)
0.01R (10 A range)

AC Current
10 uA to 10 A (SK-6110)
100 uA to 10 A (SK-6220)
Accuracy: ± 1.3% rdg ± 0.25% Fs (SK-6110)
± 1.4% rdg ± 0.4% Fs (SK-6220)
Input impedance: 10R (20 mA range, SK-6110)
1R (200 mA range)
0.01R (10 A range)
Frequency response: 40 Hz to 500 Hz

Resistance (0.1R to 2M)
Accuracy: ± 0.5% rdg ± 0.2% Fs (SK-6110)
± 1.8% rdg ± 0.25% Fs (SK-6110, 2M range)
± 0.8% rdg ± 0.25% Fs (SK-6220)
± 2% rdg ± 0.25% Fs (SK-6220, 200k range)
Max input voltage: 250 VDC, 250 VAC
Max test voltage (open circuit): 1.5 V (200R range) 0.65 V (≥ 2k ranges)

Resistance at Low Test Voltage (1R to 2M)
Accuracy: ± 1% rdg ± 0.5% Fs (SK-6110)
± 2% rdg ± 0.5% Fs (SK-6110, 200k range)
± 1.2% rdg ± 0.5% Fs (SK-6220)
± 2% rdg ± 0.5% Fs (SK-6220, 2M range)
Max input voltage: 250 VDC, 250 VAC
Max test voltage (open circuit): 0.4 V

To: HE Digital Multitester Offer, Modmags Limited, 145 Charing Cross Road, London WC2H 0EE.

Please send me:

........SK-6220 Multitester(s) at £47.95 each ....

........SK-6110 Multitester(s) at £72.95 each ....

....

Total ....

(Prices include VAT, postage and packing)

I enclose a cheque made payable to Modmags Limited for.

or

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

BARCLAYCARD VISA .... Access

Signature ....

Name ....
(BLOCK CAPITALS)

Address ....
(BLOCK CAPITALS)

....

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

All these advantages...

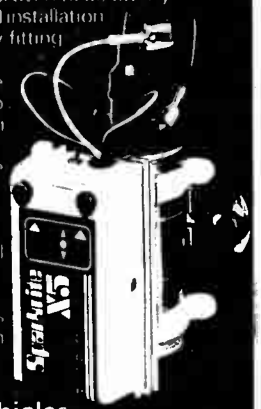
- Instant all-weather starting
- Smoother running
- Continual peak performance
- Longer battery & plug life
- Improved fuel consumption
- Improved acceleration/top speed
- Extended energy storage

..in kit form

SPARKRITE X5 is a high performance, top quality inductive discharge electronic ignition system designed for the electronics D.I.Y. world. It has been tried, tested and proven to be utterly reliable. Assembly only takes 1-2 hours and installation even less due to the patented 'clip on' easy fitting.

The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current by 95% of the norm.

There is also a unique extended dwell circuit which allows the coil a longer period of time to store its energy before discharging to the plugs. The unit includes built in static timing light, systems function light, and security changeover switch. Will work all rev counters.



Fits all 12 v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED

Die pressed case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips and accessories. All kit components are guaranteed for a period of 2 years from date of purchase. Fully illustrated assembly and installation instructions are included.

Roger Clark the world famous rally driver says "Sparkrite electronic ignition systems are the best you can buy."

Sparkrite

HIGH PERFORMANCE ELECTRONIC IGNITION

Electronics Design Associates, Dept. HE/10/81
2 Bath Street, Walsall WS1 3DE Phone: (0922) 614791
Phone: (0922) 614791

Name ____________________

Address ____________________

Phone your order with Access or Barclaycard

Inc. V.A.T. and P.P	QUANTITY REQ'D.
X5 KIT £16·95	
ACCESS OR BARCLAY CARD No.	

I enclose cheque/PO's for £ ________

Cheque No. ________

Send SAE if brochure only required.

R.P.M. Meter	ZD125	August'81	£13.75
Electronic Ignition	ZD124	August'81	£18.90
Variable Bench Power Supply	ZD123	August'81	£22.50
Treble Boost	ZD122	July'81	£10.25
Voice Operated Switch	ZD120	May'81	£10.50
Audio Millivoltmeter	ZD121	May'81	£17.25
Super Siren	ZD116	April'81	£16.95
Guitar Tremolo	ZD117	April'81	£11.50
*Russian Roulette Game	ZD118	April'81	£7.95
Windscreen Washer Alarm	ZD119	April'81	£5.50
Fuzz Box	ZD115	March'81	£9.00
Steam Loco Whistle	ZD114	March'81	£11.50
Windscreen Wiper Controller	ZD113	March'81	£6.50
Public Address Amp (no mike/spkrs)	ZD112	March'81	£16.50
Heart Beat Monitor	ZD108	Feb'81	£20.25
Audio Signal Generator	ZD109	Feb'81	£16.00
Background Noise Simulator	ZD110	Feb'81	£6.00
*Two-Tone Train Horn	ZD111	Feb'81	£5.00
Bench Amplifier	ZD107	Jan'81	£8.85
Nicad Charger	ZD106	Jan'81	£6.75
Car Rev Counter	ZD104	Jan'81	£26.80
Digital Speedometer	ZD100	Dec'80	£35.25
Battery Charge Monitor	ZD101	Dec'80	£5.00
Model Train Controller	ZD102	Dec'80	£15.25
Stereo Power Meter	ZD103	Dec'80	£19.25
Double Dice	ZD99	Nov'80	£14.00
Guitar Pre-Amplifier	ZD97	Nov'80	£8.90
Watchdog Intruder Alarm	ZD89	Oct'80	£18.25
Freezer Alarm	ZD91	Oct'80	£9.75
Nobell Doorbell	ZD93	Oct'80	£11.25
Light Dimmer	ZD88	Oct'80	£6.35
Guitar Phaser	ZD85	Sept'80	£12.00
Auto Probe	ZD83	Sept'80	£4.00
Equitone Car Equaliser	ZD52	August'80	£15.30
Car Booster (no speakers)	ZD50	July'80	£23.50
Hazard Flasher	ZD48	July'80	£12.50
Fog Horn	ZD44	June'80	£5.75
*Egg Timer	ZD43	June'80	£9.35
Track Cleaner	ZD12	May'80	£9.65
*R/C Speed Controller	ZD3	April'80	£13.50
Electronic Ignition	ZD2	April'80	£21.45
Digital Frequency Meter	ZD9	April'80	£32.75
Crosshatch Generator	ZD4	Jan'80	£13.85
Digi-Die	ZD5	Jan'80	£7.75
Ring Modulator	ZD1	Dec'79	£11.55
Bargraph Car Voltmeter	ZD40	Dec'79	£8.50
Guitar Tuner	ZD38	Nov'79	£10.50
*R2 D2 Radio	ZD37	Nov'79	£10.35
Multi Option Siren	ZD36	Oct'79	£13.50
*Starburst	ZD30	Sept'79	£16.75
Injector Tracer	ZD27	Aug'79	£4.75
LED Tachometer	ZD26	Aug'79	£17.55
G.S.R. Monitor	ZD19	June'79	£10.65
Envelope Generator	ZD20	June'79	£14.50
Drill Speed Controller	ZD21	June'79	£8.75
White Noise Effects Unit	ZD18	May'79	£18.00
Digibell Project	ZD16	May'79	£6.35
Car Alarm	ZD70	Feb'79	£10.40
Graphic Equaliser	ZD62	Jan'79	£30.50
Audio Mixer	ZD14	Dec'78	£24.00

*ITEMS MARKED NO CASE
REPRINTS OF ABOVE 40p EXTRA
ALL PRICES INCLUDE POST AND 15% VAT
PERSONAL CALLERS PLEASE RING TO CHECK AVAILABILITY OF KITS.

IONISER KIT (MAINS OPERATED)

This negative ion generator gives you the power to saturate your home or office with millions of refreshing ions. Without fans or moving parts it puts out a pleasant breeze. A pure flow of ions pours out like water from a fountain, flling your room. The result? You air feels fresh, pure, crisp and wonderfully refreshing.

All parts, PCB and full instructions **£12.50**

A suitable case including front panel, neon switch, etc. **£10.50**

Hours Mon-Friday 9-5.30 p.m. Sat. 9-4.30 p.m.
Callers by appointment only.
Telephone: 01-226 1489

T. POWELL

Advance Works, 44 Wallace Road, London N.1.

Visa/Access cards accepted
Minimum telephone Orders £5
Minimum Mail Order £1

Quick Project: 7-Segment Display

If you've never used a 7-segment display before, now's your chance. Build this month's Quick Project and find out for yourself how they work

YES, WE ADMIT that we have cheated somewhat with this project — it's not really a project at all, in that it has no *specific* purpose. However, it *is* a very good introduction to the use of 7-segment displays and you *can* use it in many projects which need 7-segment displays, so we think you'll forgive us.

A LED (light emitting diode) is a semiconductor component frequently used in electronics where an indication of part of a circuit's state is needed. For instance, you might use a LED to show that one of your projects is turned on or off.

Now of course, because they are semiconductor devices, LEDs are small — small enough to allow them to be mounted close together in one body. By positioning seven LEDs together in the form shown in **Fig.1**, the 7-segment style common to many calculators, digital watches, etc, is obtained. All 7-segment displays have the same array of LED elements — only the connection pinouts differ. Connection pinout details of the display specified for this project (the DL704) are given in **Table 1**. The body of the DL704 has connecting pins which emerge in the standard DIL (dual in line) format, common to most ICs. The display thus fits neatly into a standard IC socket. This is a useful feature because LEDs can be easily damaged by heat if they are soldered into circuits.

PIN	FUNCTION
1	anode F
2	anode G
3	no connection
4	common cathode
5	no connection
6	anode E
7	anode D
8	anode C
9	decimal point anode
10	no connection
11	no connection
12	common cathode
13	anode B
14	anode A

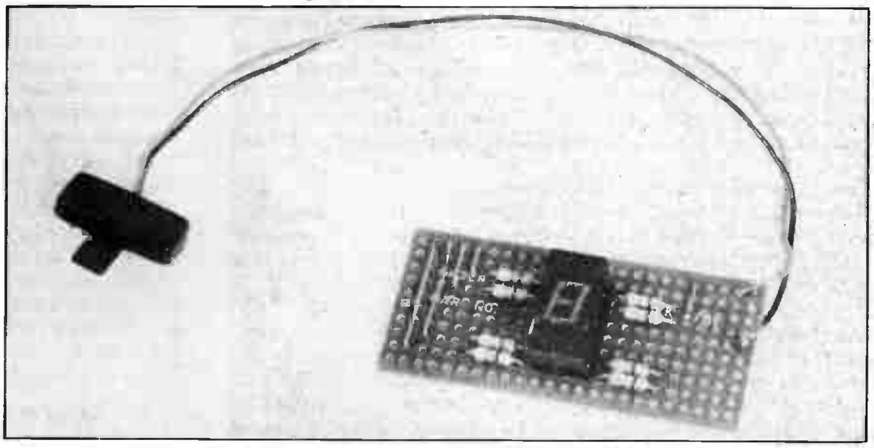
Table 1. Connection pinout details of the DL704 7-segment LED display

LEDs can also be damaged if too large a current is passed through them. For this reason any LED must only be connected to a power source (eg, a battery) in series with a resistor, to limit the current flow. A 470R resistor is a good general choice.

Figure 2 shows the Veroboard layout and track break details of this project. However, none of the LED elements will light up if the project is tested at this stage. The anodes of any element you require lit need to be linked via the series 470R resistors, on the board, to +9 V. The DL704 is a common cathode device (ie, the cathodes of all the internal LEDs are joined together) and in this project are taken to O V.

The photograph of the prototype shows five links on the Veroboard to connect the anodes of elements A, D, E, F and G, via 470R resistors, to +9 V. Thus the letter E is displayed by the device. By connecting links to other combinations of anode limiting resistors, other letters and numbers can be displayed. By experimenting you will find that all the numbers form 0-9 can be displayed but not all letters of the alphabet.

HE



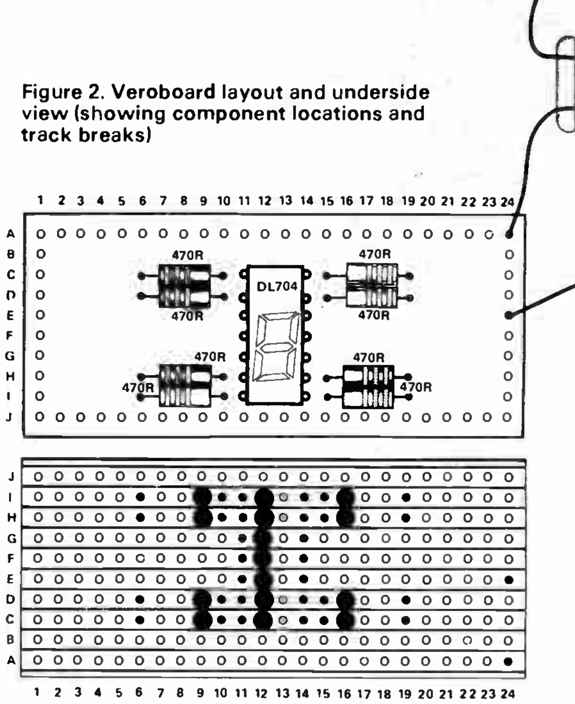


Figure 2. Veroboard layout and underside view (showing component locations and track breaks)

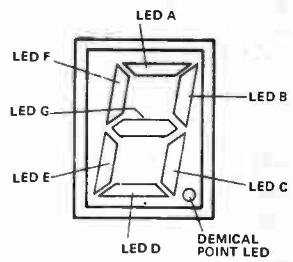


Figure 1. Typical 7-segment element array

Into Electronic Components

You'll encounter some resistance in this third part of our Into Electronic Components series. Ian Sinclair talks about fixed resistors and movable ones and how they are used in circuits

A RESISTOR is made from a conducting material the size, shape and conductivity of which is arranged to give the amount of electrical resistance we need. A short fat piece of material which conducts electricity has less resistance than a long thin piece, even when they weigh the same. Also, some substances conduct electric current much better than others: silver is better than copper, copper better than iron, and practically all metals better than carbon. For making resistors, we want the materials which are poor conductors because if we pick good conductors, we will have to use a lot of material to make a resistor of high value.

One material used to make resistors is manganin, made up of a mixture of the metals nickel, chromium and iron. Manganin can be made into wire, the wire being insulated by an enamel coating. It is then wound over ceramic (china) rods. The wire is usually wound in two sections, starting from the centre and going outwards (**Fig.1**) so that the two halves are wound in opposite directions. That way, the resistor has only a very small amount of inductance (we'll deal with inductance later in the series). For any reasonable value of resistance (10 ohms or more), a long length of thin wire must be used, and values of around 50k represent the upper limits of what can be achieved by this method. The advantage of making a wire-wound resistor of this type is that a precise value of resistance can be obtained just by measuring out the correct length of wire, assuming that the composition of the material and the thickness can be held to close limits by the manufacturer. Also, the length of wire that is needed can be calculated, and resistors made in this way will operate at quite high temperatures without coming to grief.

Most resistors, however, are carbon composition types or film types. The film resistor is made by evaporating metal or carbon onto ceramic rods, on which the vapour condenses like steam on a cold window. By cutting tracks in this conducting film, resistors of whatever value we want can be made with more precision than can be obtained when the carbon composition method is used, and at a very much lower price than wire-wound types.

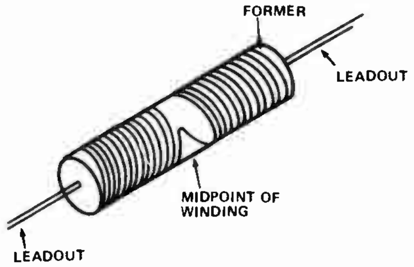


Figure 1. Non-inductive winding for a wire-wound resistor — the wire is put on in the form of two coils wound in opposite directions

Can We Tolerate It?

Carbon resistors bring us sharply up against a fact of mass-production life. When you set out to make a large number of identical products using as near as possible the same material and processes for them all, you still find variations. These are called manufacturing tolerances, and for electronic components these are a lot wider than we are accustomed to in mechanical parts. If you go out and buy a set of pistons for your car, you expect them to fit, not to be half an inch too large or too small: yet this would be the state of affairs if pistons were made to the same tolerance as carbon-composition resistors! The problem with resistors is the mixture of carbon and clay, which can never be entirely identical from one batch to another, and its behaviour when it is baked into the form of a resistor. As a result, we find tolerances of at least 20% in carbon composition resistors, though much closer tolerances (5% or less) can be obtained with carbon-film or metal-film types, and closer still for wire-wound. If you care to wind your own resistors, you can have tolerances as close as you like.

. . . We Might Prefer It

The large tolerances, which are inevitable when carbon-composition resistors are manufactured, are reflected by the scale of preferred values which we use. The preferred values are the 'target values' to which machines for making resistors are set, so that you could expect a correctly adjusted machine to produce most of its output at the target value, but with a fair quantity also scattered around each side of the target value (see **Fig.2**). The curve in **Fig.2**, incidentally, is called a distribution graph, and the bell shape is a very familiar one — it occurs when curves are drawn of examination marks, height of adults, lengths of blades of grass — almost every natural distribution you can think of, provided that large numbers are being considered.

If the spread of resistor values around the largest value is about 20% of the largest value, so that a machine which is set

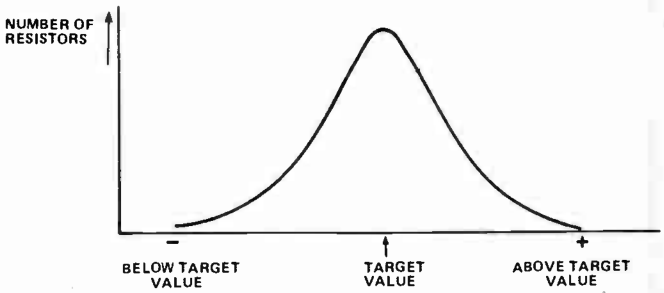


Figure 2. The effect of mass production — a large number of components of close-to-target value are made, but there will also be substantial numbers of components the values of which are well above or well below the target value

to a target value of 100R can produce values ranging from 80R to 120R, then it makes sense to pick target values for which the tolerances overlap. Let me explain that one. Suppose you fix a target value of 10 ohms (10R). A tolerance of 20% up on 10R is 12R, and if we take as our next preferred value 15R, then 20% down on this is 12R again. A 12R resistor could be a 10R, 20% high, or a 15R, 20% low. If we choose target values whose 20% tolerance values overlap like this, there can never be such a thing as a reject — every resistor that is made must come within the 20% tolerance limit of at least one of the preferred values.

There is, of course, a demand for closer tolerances, such as 10% or 5%. What is done is to manufacture huge quantities of resistors with the machines set to the target values for 20% tolerance. The values which come within 5% of target are then picked out, and sold as 5% tolerance, fetching the highest price of all the carbon composition types. Another selection produces the values which fall between 5% and 10%, and these are marked as 10% tolerance and sold at a lower price. What is left must have tolerances of between 10% and 20%, and fetches the lowest prices as an ordinary 20% carbon composition resistor. The moral of this is that you are wasting your time looking over a box of 100R 20% carbon resistors with your ohmmeter, trying to find one which is exactly 100R. This kind of sifting has been done already long before you ever lay your hands on them. **Table 1** shows the preferred values for the 20% and the 10% series of resistors.

20% Series	10% Series
10	10
15	12
22	15
33	18
47	22
68	27
100	33
	39
	47
	56
	68
	82
	100

20% Series	10% Series
10	10
	12
15	15
	18
22	22
	27
33	33
	39
47	47
	56
68	68
	82
100	100

Table 1. Preferred values for fixed resistors of 10% and 20% tolerance

Understanding The Colours

The preferred value system has another cunning aspect to it. Each preferred value has, at most, two digits that indicate what the value is, followed by zeros. For example, we can have 1R2, 12R, 120R, 1k2, 12k, 120k, 1M2, all of which use the digits 12, with the decimal point of the number of zeros indicating the final value. If we write them in the form 1.2, 12, 120, 1200, 12000, 120000, 1200000, you can see this more clearly. This allows us to use the colour code of only three colours to indicate preferred resistor values, with a fourth colour band, if necessary, to indicate tolerance. The standard colour code, just in case you are a complete newcomer to HE, is shown in **Table 2**. Life will be a lot easier for you if you memorise this code thoroughly and practise using it.

Just to give yourself some experience, try measuring some resistor values. Takes a few 100R resistors, for example, and measure them with the HE Multitester (see page 50 for details of our special offer). If you use the RX1 (direct reading) scale, the reading will be well over to the left-hand side of the scale where the scale markings are close together, but if you set the meter to the RX10 (multiply by 10) scale, 100R should come in the middle of the scale. See what actual values you find, and then try a bunch of 1k0 resistors in the same way, using the RX100 (multiply by 100) scale.

First Band — first figure of number value
Second Band — second figure of number value (can be 0)
Third Band — number of zeros following second figure (can be 0)

Colour	Figure
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Table 2. Colour codes for fixed resistors. Examples: Brown, Black, Black — 10 ohms or 10R (no zeros after the second figure), Red, Red, Red — 2200 ohms or 2k2, Yellow, Violet, Orange — 47000 ohms, or 47k

Dividing Your Potential

From resistors as components, the attention naturally turns to the circuits that we use with them. One circuit that keeps cropping up again and again is one called the 'potential divider' — so we'll look at this one first.

A potential divider is made by connecting two resistors in series (**Fig.3**) and then applying a voltage across the pair of them. Having done this, you can measure an output voltage across one of the resistors (usually the one which has a connection to the supply negative), and this voltage will be smaller than the supply voltage.

That may not sound like a big deal, but what makes the circuit useful is that we can calculate what the voltage at the output will be if we know the size of the voltage at the input and the values of the resistors. Let's start with a simple example. Suppose we have a 9 V supply and two 1k0 resistors. Connecting two 1k0 resistors in series gives a total resistance of 2k0, so (Ohm's law again) the current that will flow through each resistor when we connect a 9 V supply across both of them will be 9/2 mA, equal to 4.5 mA. With this amount of current flowing through one of the 1k0 resistors, the voltage across it will be 4.5 mA x 1k0 = 4.5 V, exactly half of the supply voltage. Any potential divider which uses identical resistor values, whatever they are, gives an output voltage which is half of the input voltage.

Now what happens if you use different values for the

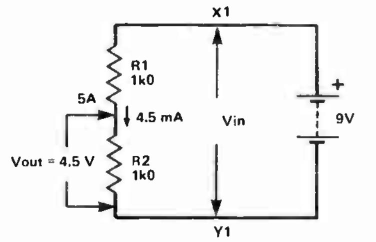


Figure 3. Circuit of a potential divider. The voltage across R2 is a fraction of the supply voltage (VIN), and it depends on the values of R1 and R2

resistors? Suppose we take non-preferred values just to make the arithmetic easier, and imagine that we can have a 1k5 and a 3k0. This gives a total of 4k5, and the current through this with a 9 V supply is 9/4.5 = 2 mA. With 2 mA flowing, the voltage across the 1k5 will be 1.5 x 2 V, which is 3 V, and the voltage across the 3k0 will be 3 x 2, which is 6 V. The voltages add up, as you might expect, to the 9 V which is the supply voltage.

We don't, in fact have to go through this lot of calculations each time we want to know what a potential divider does. There is a time-saving formula for the circuit in Fig.3 which is:

$$V_{OUT} = V_{IN} \times \frac{R2}{R1 + R2},$$

where V_{OUT} is the voltage we measured across R2, V_{IN} is the supply voltage which is across both R1 and R2, and R1 + R2 is the total resistance.

If, for example, and using realistic values now, we had R1 = 4k7 and R2 = 2k2, then for V_{IN} equal to 9 V, V_{OUT} would be

$$9 \times \frac{2.2}{R1 + R2},$$

which is 2.87 V as near as maybe.

Try it out for yourself, using the Eurobreadboard to mount the resistors and to make the connections. Remember, however, that each resistor can have 20% tolerance, so that the actual values that you find can be quite a way out, particularly if the two resistors have their tolerances in opposite directions.

For example, if R1 is 20% high and R2 is 20% low, then the actual resistance values would be: R1 = 5k6, R2 = 1k76, and V_{OUT} will be

$$9 \times \frac{1.76}{5.64 + 1.76},$$

which is 2.14 V. This value is more than 20% different from the previously calculated value of 2.87 V.

That's one item that can upset the calculation. Another one which can upset things even more is if any current is taken from the output of the circuit. Connecting a meter, for example, to measure the output voltage will take some current from the circuit (as mentioned in Part 2 last month), and unless the meter has a high resistance (so taking very little current), the measured readings will not be anywhere near the calculated ones — because the measured readings are incorrect.

What if some other circuit takes current from the potential divider? Easy — we can amend the formula to read:

$$V_{OUT} = V_{IN} \times \frac{R2}{R1 + R2} - R1 \times I_{OUT},$$

where I_{OUT} is the amount of current taken by the circuit that is connected to the potential divider.

For example, if we use the potential divider in the previous example, with 4k7 and 2k2, and 0.2 mA is taken from it, then the voltage at the output, V_{OUT}, is:

$$9 \times \frac{2.2}{6.9} - 0.2 \times 4.7,$$

$$= 2.87 - 0.94 = 1.93\,V.$$

A circuit taking a current of 0.2 mA could be one including the base of a transistor, for example.

I've shown each of these calculations with two decimal places (two figures after the decimal point), but when we're dealing with 20% tolerance components it's daft to pretend that we can get anything to this sort of accuracy — so it makes more sense to round every answer to one decimal place. To do this, look at the second figure after the decimal point. If this figure is less than 5, then just chop off this figure and all the ones that follow it. If the second figure after the decimal point is 5 or more, then chop it off and all the ones which follow it, but increase the remaining figure by one. For example, 1.632 rounds off to 1.6, but 1.664 rounds to 1.7. It's a common mistake to show far more figures after a decimal point than can be justified when we use 20% (or even 1%) components, so from now on, all answers will be rounded off. So don't dash off a letter to the Editor complaining that I've written 2.4 when your MASHIO calculator gives 2.398456785614!

Varying Your Resistance

With all this 20% tolerance caper and with meters drawing currents from potential dividers to mess up our calculations, it's not surprising that most circuits need some sort of adjustment somewhere. One type of component which provides you with a means of adjustment is called a variable resistor or potentiometer, names that cause a lot of confusion. In fact, the names really refer to the way in which we use these components rather than to the components themselves. The usual form of construction of a potentiometer is shown in **Fig.4**, and if you have an old potentiometer (for example, an old volume control), you can take it apart and have a look. There's a section of track which is in the shape of a circle with a chunk out of it. A connection is made to each end of this piece of material, which can be carbon composition, a wire winding, or a metal or carbon film. So far, that just makes it an inconveniently-shaped fixed resistor, and the point that distinguishes it from other resistors is the fact that there is a movable contact which can be swung around the circular track by turning a shaft. This contact also rubs against a metal collar, and that in turn is connected to a third terminal, which is always the centre terminal in a group of three. The symbol (**Fig.5**) shows the principle of the thing, with the fixed connections and the variable one indicated.

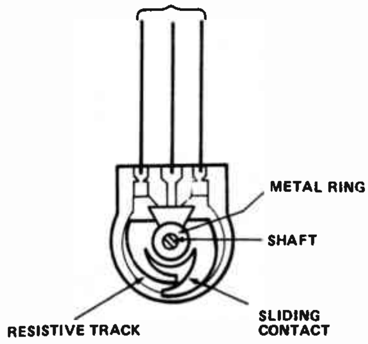


Figure 4. Construction of a potentiometer

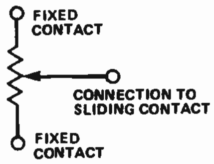


Figure 5. Symbol for a potentiometer in a circuit diagram

This three-terminal resistor can be used in two ways. If we use one end-terminal and the centre one, turning the shaft will cause the resistance between the contacts to vary from zero (when the movable contact is touching the fixed one) to the maximum that the size of the track permits. Try connecting your HE Meter to one end terminal (either one) and the centre terminal of a 1k0 potentiometer. Use the RX10 ohms scale of the HE Meter, and see what reading you get as you slowly turn the shaft of the 'pot'. You'll find this a whole lot easier if you fasten the HE Meter leads with crocodile (croc) clips, incidentally. One way is to make up a set of leads, one red, one black, with a 4 mm plug at each end. One plug of each can then fit into the HE Meter sockets, and the other will push into the socket end of the croc clip. The other way is to compress the socket ends of the croc clips, using pliers, until the HE Meter probe leads are a tight push-fit.

When we use two of the terminals like this, we're using the device as a variable resistor (two common circuit symbols are shown in **Fig.6**). A much more common use is as a variable potential divider, with all three terminals used, as in **Fig.7**. This way, it's not resistance change we're interested in but the change in the *ratio* of resistance.

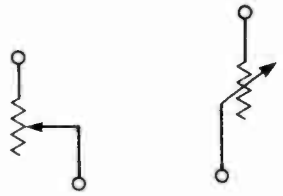


Figure 6. Circuit symbols for a potentiometer when used as a variable resistor, where only one end-connection and the movable connection are used

If we think of the potentiometer as consisting of two resistors in series, the resistance of terminal A (**Fig.7**) to the tap, and the resistance from the tap to terminal B, then it's clearly a potential divider and we should be able to measure a voltage between the tap and the end of the potentiometer which is connected to the supply negative. Try it, using the connections shown in **Fig.7**, and with the HE Meter set to the 10 VDC range, using a 9 V battery as a supply. Slowly turn the shaft of the potentiometer from one extreme to the other and watch how the voltage measured on the meter changes as the shaft is turned.

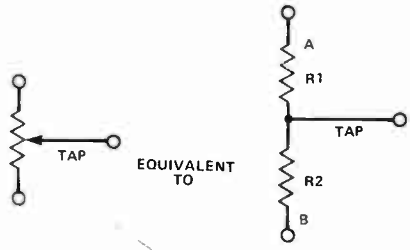


Figure 7. Using the potentiometer as a variable potential divider

We usually arrange potentiometers so that the voltage at the tap increases as we turn the shaft clockwise, looking from the shaft end of the potentiometer. To make sure of this, connect the potentiometer up in the way shown in **Fig.8**.

A lot of electronic circuits use potentiometers for adjustments which have to be made by the user — the volume control and brightness of the telly are good examples. Inside a lot of circuits, though, there are small potentiometers which can be adjusted by using a screwdriver and which are referred to as presets. As the name suggests, these are adjusted when the circuit is first tested, and are set to values which allow the circuit to act correctly, so compensating for all the uncertainty caused by the 20% tolerance. Presets should need their settings altered only very rarely, and only when the effect of the alterations is known and can be checked. In other words, don't open up the telly and start twiddling. Even if you don't electrocute yourself, you'll probably put so many settings out of their correct positions that it'll take months to get them all back again.

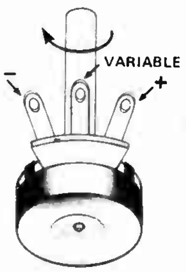


Figure 8. Conventional way of connecting a potentiometer so that its output voltage (from the movable connection) increases as the shaft is turned clockwise

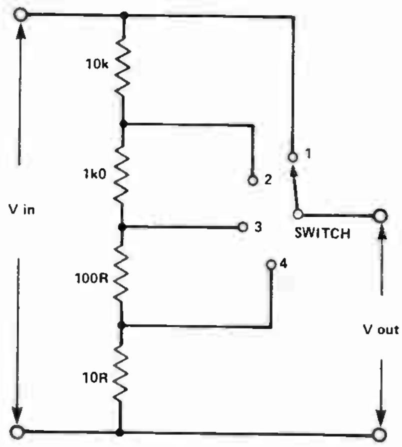


Figure 9. Switched attenuator. This circuit is used a lot in multimeters, oscilloscopes and other electronic instruments.

Thinning Out Your Potential

Another name we sometimes use for the potential divider circuit is 'attenuator'. Attenuation literally means 'thinning out', and the action of a potential divider on a signal is just that — it reduces the AC signal voltage just as it reduces a DC voltage. When we make use of a volume control on a radio, we are in fact attenuating the audio signal, and the potentiometer is being used as a variable attenuator.

A single potential divider is not a particularly useful attenuator, however, because it permits only one amount of attenuation. A much more useful arrangement is the switched attenuator which is shown in **Fig.9**. This consists of a lot of resistors in series, with connections to a switch, and the action is of a potential divider in which we can change the resistance of the two sections by switching in different values of resistors.

For example, looking at the attenuator circuit in **Fig.9**, with the switch in position 1, there is no attenuation: the signal at the output is the same as the signal at the input. With the switch in position 2, however, the upper resistance is 10k and the lower resistance is 1k0 in series with 100R and 10R, a total of 1110R or 1k11. The division ratio (that is, the fraction of the input voltage which is at the output) is

$$\frac{1.11}{11.11},$$

which is about 0,1, so that the output voltage is about one tenth of the input voltage. If we now switch to position 3, the resistor values are 11k and 110R, so that the division ratio is

$$\frac{0.11}{11},$$

which is 0.01, making the output voltage one hundredth of the input voltage. At switch position 4, the resistance values are 11.1k and 10R, so that the division ratio is

$$\frac{0.010}{11.1},$$

which is about 0.001, making the output voltage about one thousandth of the input voltage.

It's a useful circuit, particularly where you want to be able to switch between very different voltage values, and it's used a lot in multimeters, oscilloscopes and signal generators.

Next month we'll look at how to store electricity in capacitors (and how to extract it when stored). HE

Multitester Offer

Special Offer To HE Readers Only

Invaluable Aid To The Hobbyist

THIS Multitester offers much more than a standard multimeter, as the specification shows. Apart from DC and AC voltage, DC current, resistance and decibel ranges, the HE Multitester has a range doubler for voltage and current measurements. Thus sensitivity on DC voltage ranges extends to 50k/V.

The meter dial is large (111 mm by 89 mm) and easy to read. It has a mirror strip to improve accuracy of readings.

The new series Into Electronic Components has been written around this Multitester. Although other instruments can be used in conjunction with the series, the HE Multitester is undoubtedly the best choice.

So take advantage of this special offer: the Multitester is supplied complete with test leads with probes attached, batteries and instructions for only £19 plus 95p post and packing.

Specification

- Overloed protected by two silicon diodes
- Uses double-jewelled ± 2% meter with mirror and ± 1% temperature stabilised resistor

Measurement	Ranges	Accuracy	Remarks
DC Voltage	0-125-250 mV 0-1.25-2.5-5-10 -25-50-125-250 -500-1000 V	±4% 125 mV to 2.5 V 500 to 1000 V ±3% except as noted	Sensitivity 50k/V range doubled 25k/V normal
AC Voltage	0-5-10-25-50- -125-250-500 -1000 V	±4% of full scale	Sensitivity 10k/V range doubled 5k/V normal
DC Current	0-25-50 uA 0-2.5-5-25-50 -250-500 mA 0-5-10 A	Same as for DC voltage	
Resistance	0-2k -20k -200 k 0-2M-20M (centre scale 10)	±3% of scale length	Batteries: one penlight 1.5 V one rectangular 9 V
Decibels	– 20 to + 62 dB		8-ranges
Size	H170 x W124 x D50 mm		
Weight	590g (battery and test leads included)		

To: HE Multitester Offer, Modmags Limited, 145 Charing Cross Road, LONDON WC2H 0EE

Please send me . . . . . . Multitester(s) at £19.95 including post and packing.
I enclose a cheque/PO made payable to Modmags Limited for £ . . . . . .

OR

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

BARCLAYCARD VISA . . . . Access

Signature . . . .

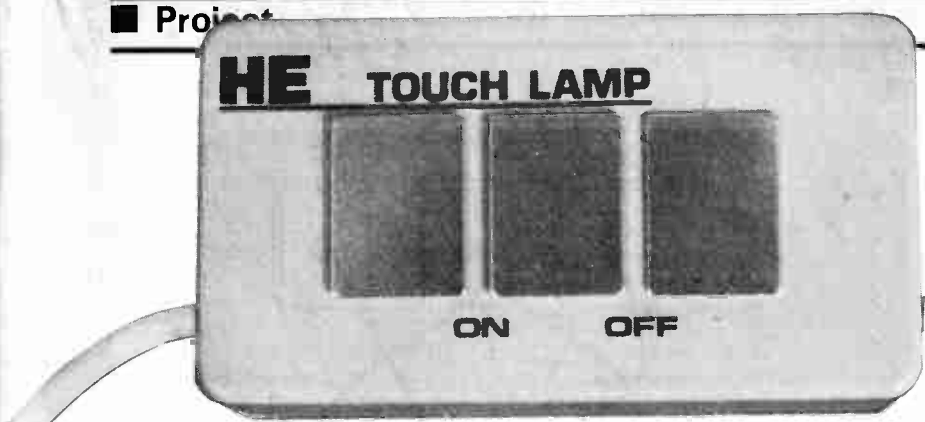
Name . . . .
(BLOCK CAPITALS)

Address . . . .
(BLOCK CAPITALS)

. . . .

Please note that the offer applies to UK mainland only: allow 28 days for delivery

Multitester-Only £19



Touch Lamp

Left in the dark? This project gives simple on/off touch control of your battery or mains powered bedside light

IF YOU'RE TIRED of fumbling around in the dark in search of the bedside lamp switch, and then fumbling around trying to actually *operate* the switch, our touch-operated bedside lamp is just what you need. It is a very simple and economic battery operated design which has a neglible stand-by current. The use of a touch switch makes the lamp extremely easy to operate even in the dark, since once you have found the touch contacts the unit virtually operates itself!

You can use this project to either turn a small 6 V bulb on and off or alternatively to operate a relay (which can be used to switch a mains-powered bulb on and off). The amount of light available from a 6 V bulb, such as a torch bulb, is not very much of course, but is adequate for its purpose and has the advantage of making a completely self-contained project with no trailing wires. If you choose to build in a relay to the project (as in our prototype) then mains input and output leads will be necessary.

A point worthy of note is that, wired for mains control purposes, the project will not only turn a lamp on and off, but in fact most mains equipment. The project may find other uses, therefore, *particularly as an aid for handicapped persons.*

Construction

Build up the project using one of our standard sized (24 hole by 10 strip) pieces of Veroboard, carefully following the overlay details in **Fig. 2** (see also Building Site this month, page 41). Make sure the transistors are inserted correctly.

Drill the case lid to fit the three touch contacts, which can be specially bought contacts, or simply three M4 (or similar) pan head bolts. Mount the contacts using soldertags (to provide connection points) and nuts.

You must now decide whether you want the project to operate a small bulb or a relay. If you choose the small bulb, then mount it in a holder fitted to the top of the case. Drill a hole near the holder to enable the two leads from the lamp to pass through to the interior of the case.

Some sort of shade can be placed over the lamp to give a neater finish and a more diffuse light. Some food containers and aerosol caps are made of a suitable thin white plastic material, and a little ingenuity must be used here.

Fit the battery and circuit board inside the case and wire up the project as in **Fig. 3**.

If you choose to operate a relay and thus control a separate mains powered lamp (such as a bedside or overhead lamp) then drill the sides of the case to fit rubber grommets. Push the two grommets into position — they will protect the mains cable from being damaged.

Fasten the relay to the bottom of the case (double-sided, self-adhesive pads are ideal for this purpose) and connect the project as shown in **Fig. 4**.

Use cable ties on mains input and output leads to prevent them from being accidentally pulled out.

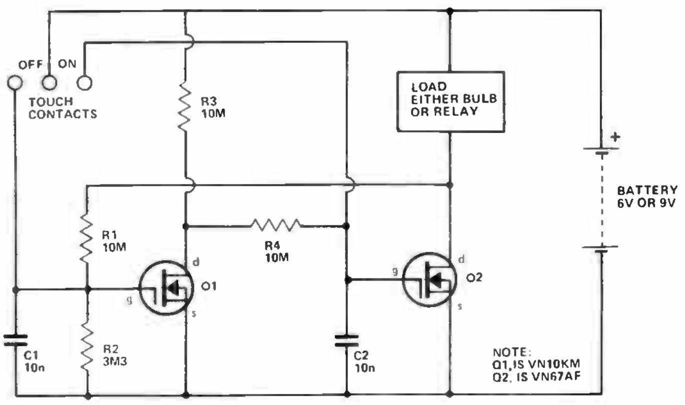


Figure 1. Circuit of the HE Touch Lamp

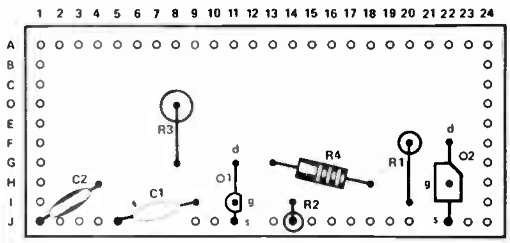


Figure 2. Veroboard layout of the project. Note that there are no track breaks to make underneath the circuit board

Parts List

RESISTORS (All ¼ W, 5 or 10%)
R1 10M
R2 3M3

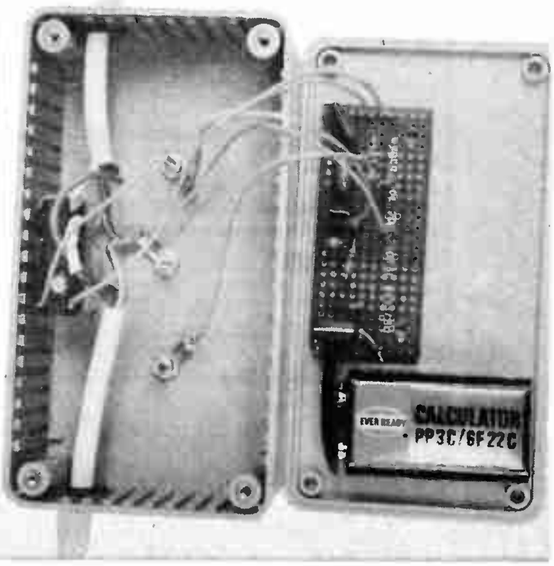
CAPACITORS
C1,2 10n polyester

SEMICONDUCTORS
Q1 VN10KM VMOS transistor
Q2 VN67AF or VN66AF VMOS power transistor

MISCELLANEOUS
Suitable plastic case
Veroboard, 24 hole x 10 strip
Touch contacts (see Buylines)
PP3-sized battery clip

Either: MES bulb holder + 6 V MES 100 mA bulb for AA-sized cells + plastic holder

Or: 6-12 V operated relay (100R coil, or greater)
PP3-sized battery



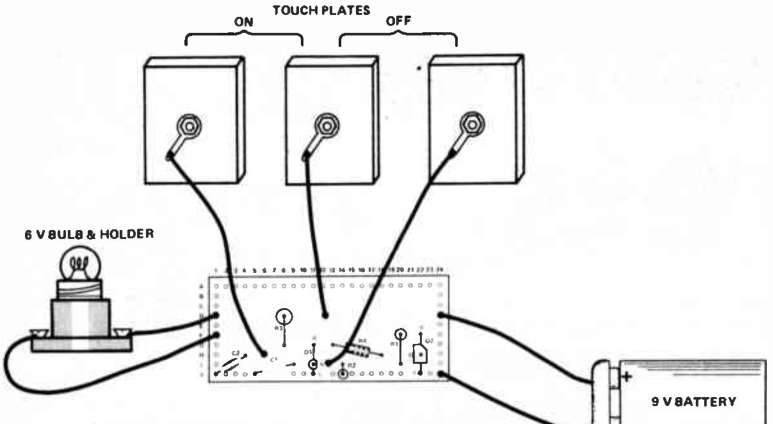


Figure 3. Connection details of the project if you choose to operate a low-voltage bulb

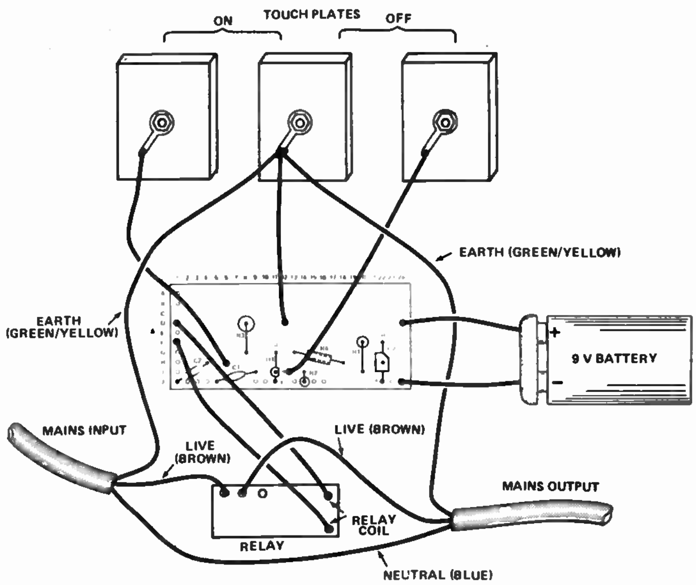


Figure 4. Project connection details to control mains powered equipment

Buylines

Many of the mail order companies advertising within HE's pages stock the VMOS transistors for this project.

Suitable touch contacts are available from:

Watford Electronics
33/35 Cardiff Road
Watford.

All other components are easily obtainable. The total cost of parts for the project, exlcuding case, will be about £5.

The How It Works section for the Touch Lamp project will be given in next month's issue of HE

HE

Synthesiser Secrets

Synthesisers are becoming established as keyboard instruments in many pop groups, alongside the long-accepted guitars and drumkits. Ron Keeley describes how synthesisers produce such an amazing variety of sounds

A SYNTHESISER is an electronic musical instrument that can be used to imitate any other known instrument (this is called imitative synthesis) or to create sounds that have never been heard before. Such is the flexibility of the synthesiser that it can produce unique sounds, created in the mind of the musician. To understand how a synthesiser produces these sounds, it helps first to understand how musical sounds and musical notes (there *is* a difference) are formed.

Musical notes have three essential qualities: pitch, tone and loudness. A sound is a musical note if it is 'pitched' at one of the frequencies of a musical scale (see **Table 1**). The note middle C on a piano has a fundamental frequency of 261.626 Hz: the fundamental of B, one note down, is 246.942 Hz but any frequency in between is not a musical note in this scale.

	C		261.626
C#		D♭	277.183
	D		293.665
D#		E♭	311.127
	E		329.628
	F		349.228
F#		G♭	369.994
	G		391.995
G#		A♭	415.305
	A		440
A#		B♭	466.164
	B		493.883

Table 1. Scale of notes and frequencies for one octave from middle C

So, the pitch of a note depends mainly on the fundamental frequency of the sound, such as the vibration frequency of a guitar or a piano string. But if all instruments produced only the one frequency, though, they would all sound the same. The reason we can tell the difference between, for example, a flute and an oboe is that they have different *tonal* qualities. Tone, in a musical sense, is not 'bass' or 'treble' but the distinctive quality of a musical sound or note.

As well as the fundamental frequency, or 'first harmonic' as it is also called, every note produced by an instrument contains a large number of higher frequencies or harmonics (see **Fig.1**). These are related to the first harmonic in a specific way that is different for each instrument, and all the harmonics add up to form a tonal quality that is different for each instrument.

Loudness, as you would expect, is the volume of a note or sound. However, many instruments will have a different tone, depending on whether they are played hard or soft, so loudness also affects musical tone.

On the other hand, any sound can be a musical sound as long as it is part of a musical performance! Musical sounds may be pure (for example, a sinewave) or they may even be random noises. Frequently they are complex but un-pitched sounds such as those made by 'indefinite pitch' instruments like drums, cymbals, castanets and so on.

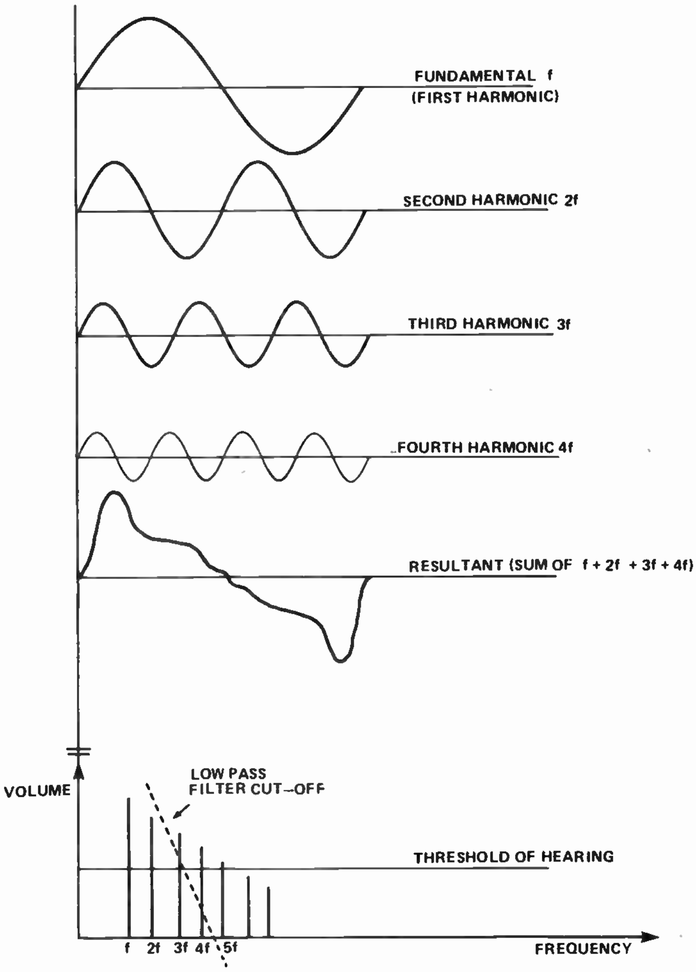


Figure 1. A complex waveform or sound is the result of the combination of two or more simple sinewaves. If the sound is a musical note, these sinewaves are harmonics of the fundamental frequency of the note. A low-pass filter can be used to 'subtract' some of the higher harmonics to give a less complex waveform (producing a more pure sound)

The three qualities of a musical note (or, for that matter, of musical sounds) are not static but dynamic; that is, they are not constant for the duration of a note. A note from a musical instrument is often loudest when it is first made — when a trumpet player first puffs into the mouthpiece, for example — and then gradually dies away. A piano note is loudest just after the note is struck, then fades to nothing. As loudness changes, so does the tone because the higher harmonics fade quickest, so that the sound becomes less complex.

Pitch, too, can vary with time. Some instruments (organ, particularly) have built-in vibrato but pitch variations are mostly controlled by the musician. Tone and loudness may also be manipulated with playing technique. If a synthesiser is to be able to imitate both musical notes and sounds, then, it must not only generate the three essential musical qualities, but it must also permit very fine control over them.

In generating musical notes and sounds, synthesisers work in a decidedly back-to-front fashion.

Musical instruments can be said to 'synthesise' sounds in the sense that they produce a number of pure sounds — harmonics — which then 'add up' to give the complex tone characteristic of the instrument. A few electronic synthesisers were made which operated on this principle, which is called additive synthesis, but they require very large numbers of oscillators and are difficult to use.

All modern synthesisers operate on the principle of subtractive synthesis. This method starts with a very complex waveform such as a squarewave or sawtooth waveform and works backwards by subtracting harmonics to form a less complex waveform.

Virtually any 'natural' waveform can be duplicated by selective filtering of harmonics, and of course an almost infinite variety of 'unnatural' waveforms or sounds can be created.

An oscillator and a filter are sufficient to determine the musical qualities of pitch (oscillator frequency) and tone (filter frequency), and an amplifier stage takes care of loudness but how are these to be controlled? A row of knobs cannot be 'played' like a proper musical instrument!

Electronic music synthesisers were invented, as almost everyone knows, by Robert Moog (pronounced 'Mogue', as in vogue) and the key to his invention was a system of voltage controlled circuit elements, shown in simplified form in Fig.2. The frequency of a voltage controlled oscillator (VCO) is determined not by a variable resistor or capacitor, but by a variable control voltage. Similarly the cut-off frequency and 'Q' (peakiness) of a voltage controlled filter (VCF) are set by two voltages, and the gain of a voltage controlled amplifier (VCA) is set by another voltage.

The advantage of voltage control is that any available electronic method can be used to vary a voltage, and in turn the frequency, tone or loudness.

The real beauty of the system, though, is that it permits fine dynamic control over all three musical qualities, which is just what is needed. For example, the output of a second oscillator can be used to control the frequency of a VCO, the 'Q' of a VCF or the gain of a VCA. In fact all synthesisers have several special voltage control generators that allow a synthesiser player to modify the three parameters over times as short as ten milliseconds (10 ms).

It is this capability for dynamic control that makes a synthesiser such a flexible and versatile instrument, capable of imitating not only the natural dynamics of notes and sounds but also the style and technique used with traditional instruments.

However, just how this is accomplished will have to wait for another day, another page.

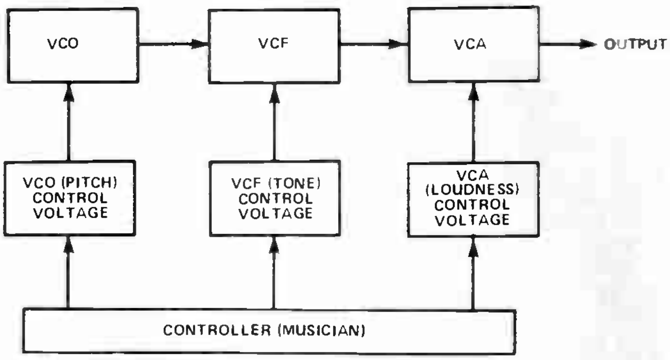


Figure 2. An elementary synthesiser consists of a VCO, VCF and a VCA, together with controllable voltage generators. A practical synthesiser is somewhat more complicated!

HE

Your Letters

The Editor replies to a selection of your letters

SEVERAL PROJECTS published in HE over the last year have inspired readers to adapt them for different or extended uses. The first letter from a reader living in the West Midlands serves as a typical example, and could be of interest to photography enthusiasts — particularly those who have built the Sound Operated Flash Trigger (HE July '80, pp 11 to 13).

Dear Sir,
I have just built the Flash Trigger project you featured in your July 1980 edition. I have also found a second function for it.

I have a Chinon CE4 camera with autoflash (dedicated) and PW540 power winder. The power winder has a socket (this takes a 2.5 mm jack plug) for connecting to a remote control unit. With one slight modification to your Project, which is to add a plug and socket connection to the output leads from the thyristor, I now have the option of firing the flash only, the camera only or both together. This last facility eliminates totally any problems of exposure, as with the dedicated flash, fully automatic exposures can be made, with the power winder advancing the film and resetting the shutter automatically.

I think this (modification) would also be possible with other automatic camera systems having similar connections but I would check with the instruction manual first.

Finally, one more tip; don't insert the plug with the winder switched on. If you do you'll waste a shot, as inserting the plug triggers the shutter automatically.
M. L. Peake
Bilston, West Midlands

PS With a 2.5 mm plug on the trigger lead this will also fit the remote control socket of most portable cassette players (and is compatible with) the player sync sockets on some Aiwa stereo cassette decks. A most versatile project.

The next letter contains a suggestion that we will implement from this issue onwards; that is, the addition of voltages to be expected at various points in some of the circuits for our projects. These values can be useful in fault finding, and will usually be relative to the ground line. There will be little need to add the voltages (apart from the supply voltage) to most digital circuits, because inputs and outputs will be either 'high' (close to the supply voltage) or 'low' (0 V).

Dear Editor,
I have taken your magazine from the first issue and have gained a fair amount of elementary knowledge by building various projects.

To date only two have worked first time — mainly through electronic atrocities perpetrated by myself, though the odd one or two were built in to your diagrams.

There must be thousands of novices like me who find terrible difficulty in fault location and would suggest that you add to your circuit diagrams the voltage that would normally occur at various points.

Without this information even professional service engineers would often hesitate to carry out a repair.
K. W. Hawkins
Southport, Merseyside

PS. Could you suggest the name of a book which lists the majority of transistor and semiconductors, which gives equivalents and pin layouts?

PPS. Can you assure me that the 40 kHz ultrasonic burglar alarm will not be within the hearing range of my dog?

In answer to your first postscript, a book containing details of thousands of transistor types is *Towers' International Transistor Selector* by T. D. Towers and published by W. Foulsham & Company Limited, Yeovil Road, Slough, Berks.

As to your second query, we think it is more likely that your dog will hear the sound of the *alarm* triggered by a burglar rather than the 40 kHz tone radiated from the HE Ultrasound Burglar Alarm.

Dear Sirs,
I have been reading the latest issue of 'Hobby Electronics' magazine and note that you include the PCB foil patterns for each project in the issue.

I would be grateful if you could advise me whether you publish a book of PCB foil patterns for all your projects to date, or intend to do so at a later date.

I am a beginner in electronics and find the PCB diagrams with component locations of great assistance when constructing projects (me being one of those people who can't make heads or tails of the circuit diagrams using physics symbols).

'Hobby Electronics' is an excellent magazine for beginners and, no doubt, experienced electronics enthusiasts.

Anyway keep up the good work and well done!
Michael B. Ough
Weston Mill, Plymouth

No, we don't publish a book of foil patterns but we do publish *Electronics Digest*, a quarterly magazine containing a selection of popular projects from HE.

As you may have noticed in the September '81 issue, we now run a PCB service (see page 61 of this issue for the latest details). As a result of the introduction of the new service *we no longer operate our Hobbyprint transfer service.*

Dear Sir,
Having had the pleasure of making up your Digital Speedometer, December edition of Hobby Electronics, could you please consider the digital indication of Petrol & Temp, as this would give a complete instrumentation.
L. A. M. Hughes
Cambridge

Glad to hear of your pleasure in building the Digital Speedometer project. Your letter triggered a 'feasibility' discussion in the HE office and as a result we are now seriously considering your suggestion for future projects.

Dear Sir,
I read with interest your article in HE (July) on the Ultrasound Burglar Alarm.

In my opinion the quality of the text is sub-standard and I can see why the author's name was not printed. I would make the following comments:
1) The circuit diagram quotes Q3 as BFY50 yet the parts list gives Q3 as BFY51.
2) There are no pin numbers given for the gates of IC3. The pins which connect to the supply are not given any mention. Not everybody is familiar with this type of chip.
3) On the diagram, mention is made of a separate battery — 'See text'. Yet I can find nothing in the text.

I must say that I have been let down frequently by errors in the circuit diagrams both from magazines and the many constructional books available. I would appreciate your comments.
A. Casson
Arundel, West Sussex

Your comments 1 to 3 are all valid. We did quote two type numbers for Q3 but, at the operating voltages of the HE Ultrasound Burglar Alarm, the BFY50 or the 51 derivative will work satisfactorily. And yes, we did forget to include pin numbers for IC3 in the circuit shown in **Fig.1** on page 12 of the July '81 issue. Final 'sin' was that we did not say anything about a 'separate battery' in the text. As you will see from **Fig.1**, the separate battery or power source will depend on the type of alarm used with the project. Thanks for pointing out these omissions.

It is a sad fact of life that, even with rigorous checking, errors manage to escape notice in most technical publications, whether they be for hobbyists or professional engineers.

Finally a letter from Malta.

Dear Sir,
I am writing you this letter to ask you if you have any books which would help me build a high wattage amplifier, which I could fix to my music set.

Sir, if you have any books which would help me could you please send me details of how much each would cost me.
L. Bruno
St. Julians, Malta G.C.

If you are thinking in terms of several hundred watts of power, then I cannot think of a suitable constructional book to help you. For the design of lower-power amplifiers (that is, up to 100 W) you could try *Audio Amplifiers For Home Construction* by I. R. Sinclair (see Books from the HE Book Service on page 64 of the September '81 issue of HE).

And that's the lot for this month. **HE**

Telephone Bell Repeater

The HE telephone bell repeater doesn't cost the earth, is fun-to-build and use, and features long battery life

IF YOU'RE WORKING outside in the garden, or perhaps underneath the car in the garage, and the telephone rings — chances are you won't hear it and an all-important conversation could be missed. Of course, British Telecom can fit an outside bell to your home which rings whenever your telephone does, but it costs money. A much cheaper alternative, and one which allows you the pleasure of building it yourself, is our battery-powered telephone bell repeater.

The **HE** Telephone Bell Repeater consists of two main parts: a pickup placed close to the telephone which detects when the telephone bell is ringing; and the alarm-generating circuitry which turns the signal received from the pickup into a loud, piercing alarm. The alarm-generating circuitry is placed somewhere within earshot of the 'long-distance worker' and the two parts of the project are joined by a suitable length of thin screened cable.

Sensitivity of the circuit is such that other things may be detected and generate the alarm. For instance, if the pickup unit is positioned on the rear of your front door, it will detect the sound of a personal caller knocking. Likewise, the pickup will detect the sound of a doorbell if it is placed close to it, and this would generate the alarm. For this reason the project is designed to accept inputs from two pickups simultaneously, so the user can monitor, say, the telephone and the doorbell as required.

Although the circuit is designed to be self-contained (with its own alarm and loudspeaker), we have included the facility of a relay so that separate alarms or lamps, for example, can be triggered by the repeater.

Construction

Build up the Veroboard as the layout in **Fig.2** shows. If you have never used Veroboard before, or you are a bit hazy as to its use, make sure you read this month's Building Site on page 41.

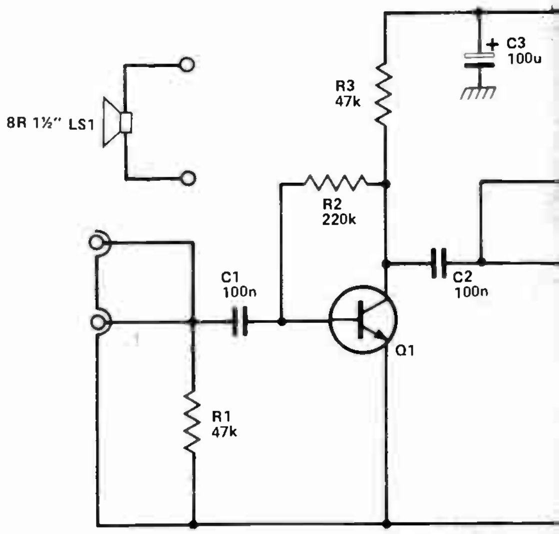
Insert all low level components (eg, resistors), into the board first and work through to the higher ones. Make sure that all polarised components (eg, transistors, ICs, electrolytic capacitors and diodes) are inserted the right way round before soldering them in. Insert and solder circuit board pins where all off-board connections are to be made.

Next mark and drill the case for the two 4 mm sockets (which connect to the switched terminals of the relay), the two input jack sockets, the on/off switch, and a matrix of holes to act as a loudspeaker grille.

Fasten all sockets and the switch in their positions to the case. Glue the loudspeaker to the inside of the case lid making sure that no glue gets onto the loudspeaker cone.

Now, wire up your project as shown in **Fig.2**.

Mark and drill the pickup case for a jack socket and a matrix of holes for the loudspeaker. Glue the loudspeaker to the inside of the case. Finally wire up the jack socket to the loudspeaker.

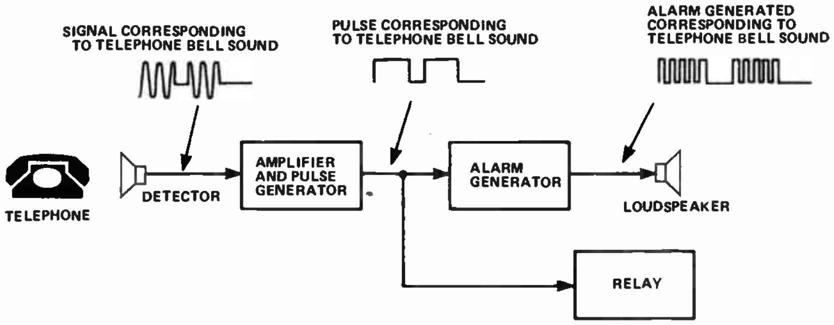


How It Works

A miniature loudspeaker is used to detect the ringing of the telephone bell, and the signal obtained is amplified and rectified to give pulses corresponding to the *shape* of the telephone bell signal, not its sound.

These pulses control the alarm generator, the output of which is fed to a loudspeaker.

Alternatively the pulses switch a relay on and off.



The output of the miniature 8R loudspeaker LS1 is fed via a screened cable to the input stage of the amplifier circuitry. Transistors Q1 and 2 form a two-stage amplifier with high gain and low current drain.

The output signal from the amplifier is rectified by D1 and stored across capacitor C4. Thus, if a sound of some sort is detected by the miniature loudspeaker, the voltage across the capacitor rapidly increases, turning on transistor Q3. When the input sound ceases, the voltage across C4 decreases and Q3 turns off.

Gates IC1a&b are connected as a buffer so that the output of Q3 is amplified and fed to:

- the base of transistor Q4
- the gated multivibrator oscillator IC1c&d

As the output of IC1b changes, because of the detected sound, transistor Q4 thus turns on, operating relay RLA.

Similarly, the changing output of IC1b operates the gated astable multivibrator, so that a tone is given from IC1d which is amplified by Q5 and fed to the loudspeaker LS2.

Overall quiescent current drain of the whole circuit is less than 200 uA.

Parts List

RESISTORS (ALL ¼ W, 5%)

R1	47R
R2,6,8	220k
R3,13	47k
R4	10k
R5,12	1M0
R7,10	2M2
R9	22k
R11	6k8

CAPACITORS

C1,2	100n polyester
C3	100u, 10 V electrolytic
C4	470n polyester
C5	10n polyester
C6	220u, 10 V electrolytic

SEMICONDUCTORS

IC1	4001, quad NAND gate
Q1,2,3	BC184 NPN transistor
Q4,5	BC213 PNP transistor
D1	1N4148 diode
D2	1N4001 diode

MISCELLANEOUS

SW1 single-pole, single-throw toggle switch
LS1 8R, 1½" loudspeaker
LS2 75R loudspeaker
Cases to suit
Veroboard, 24 strip x 37 hole
2 x miniature jack sockets + plugs
2 x 4 mm sockets
RLA 12 V relay (coil 100R or greater)
Length of screened cable
6 x AA-sized cells + holder + battery clip

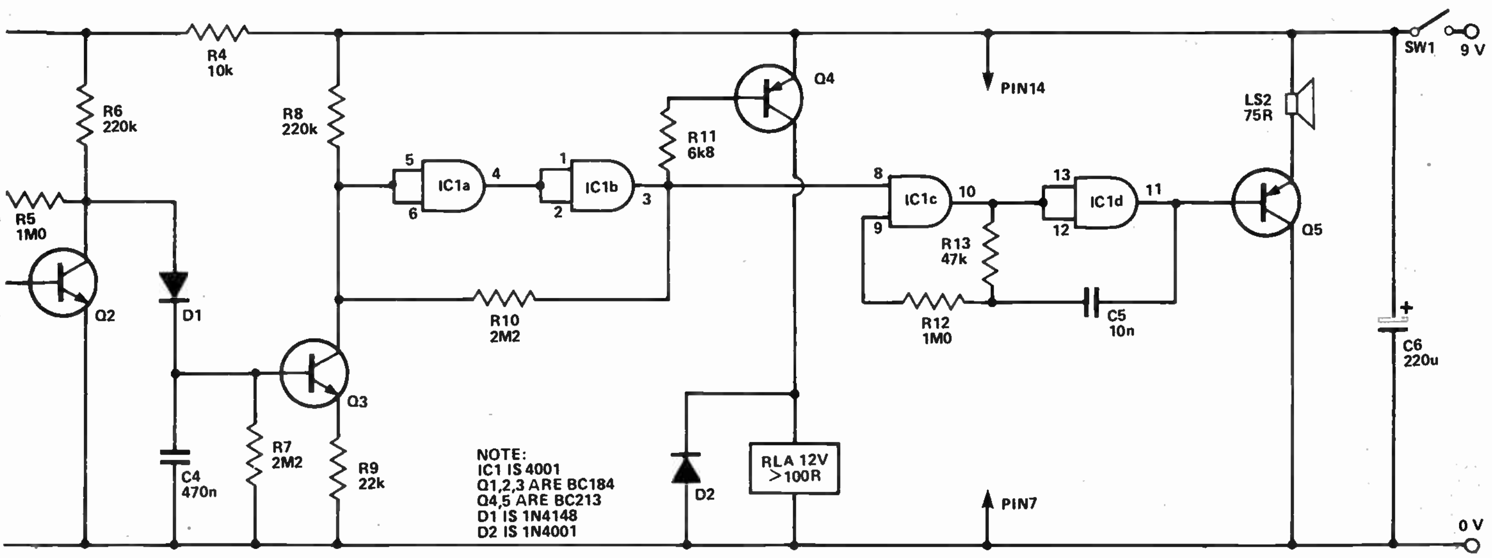
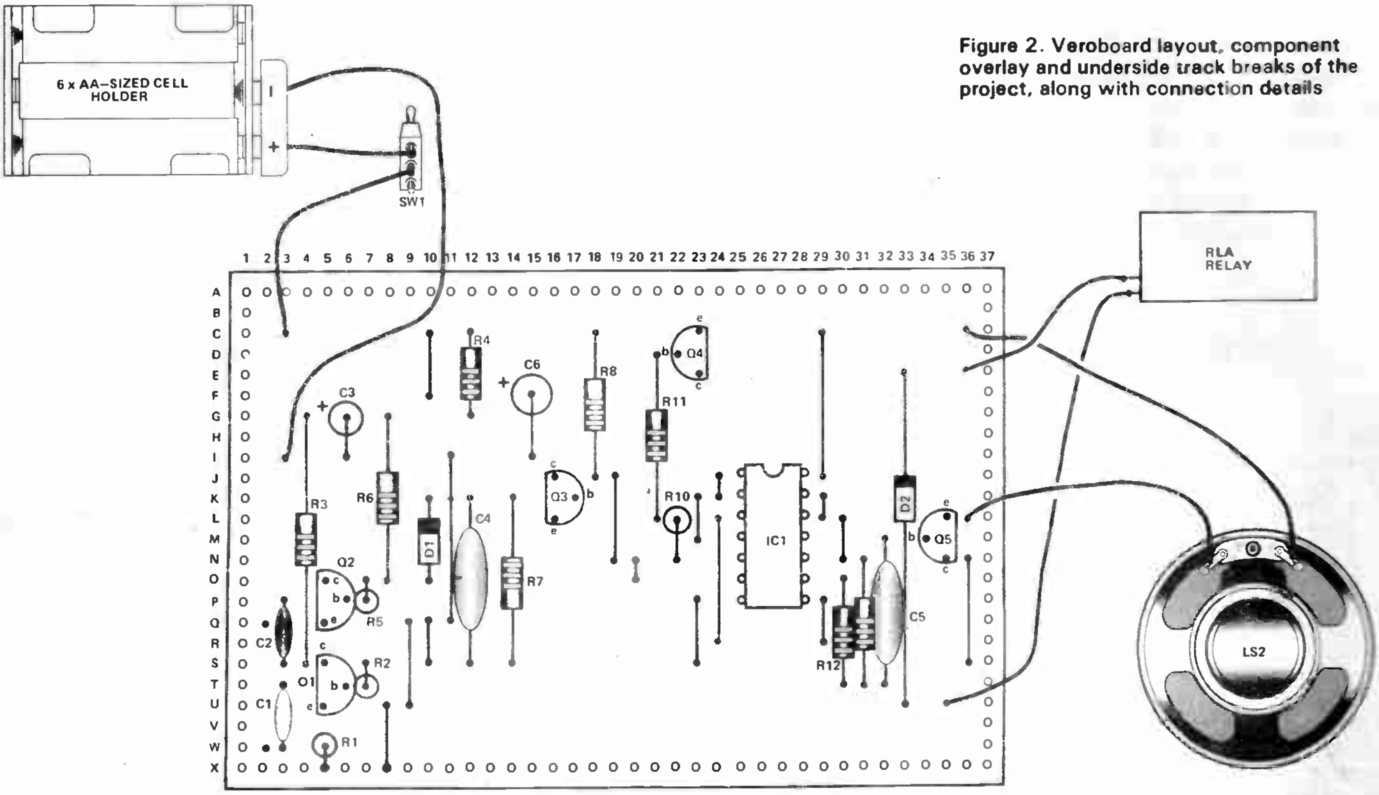
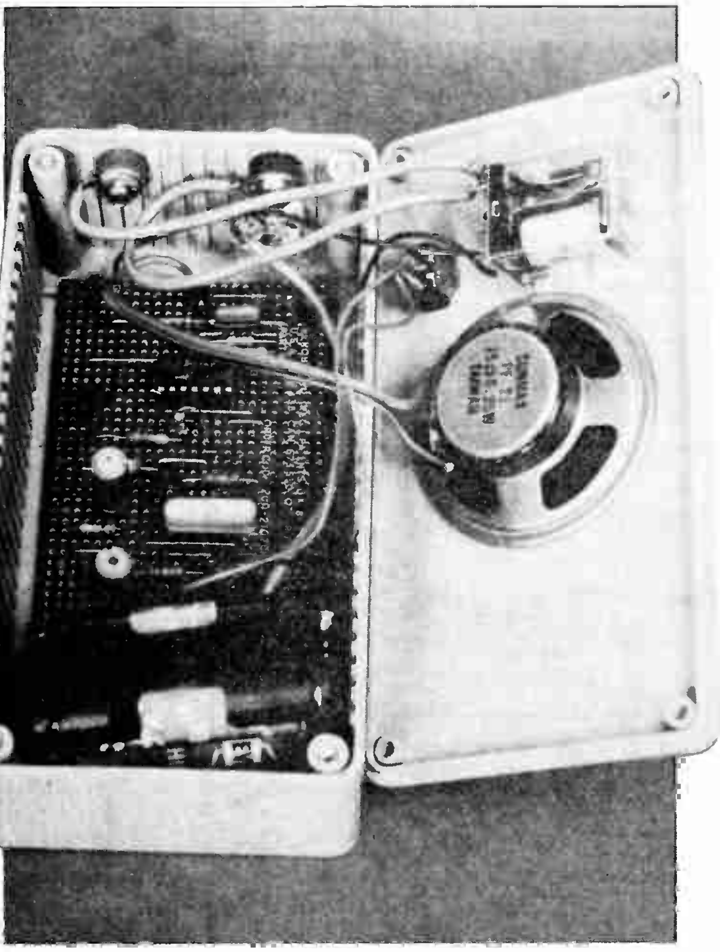


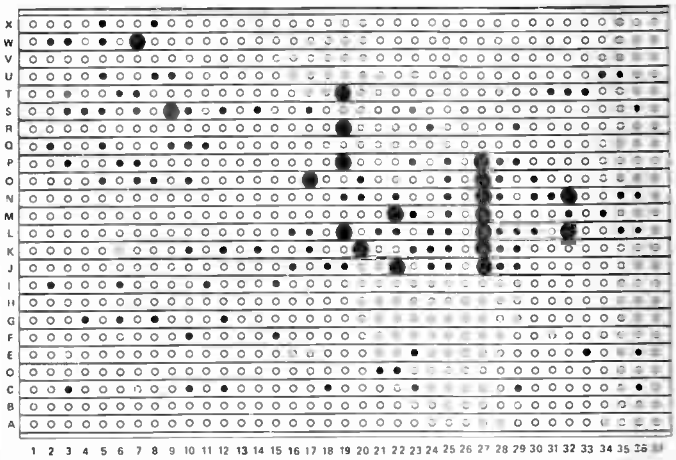
Figure 1. Circuit of HE Telephone Bell Repeater

Figure 2. Veroboard layout, component overlay and underside track breaks of the project, along with connection details





Left. Internal view of our prototype telephone bell repeater

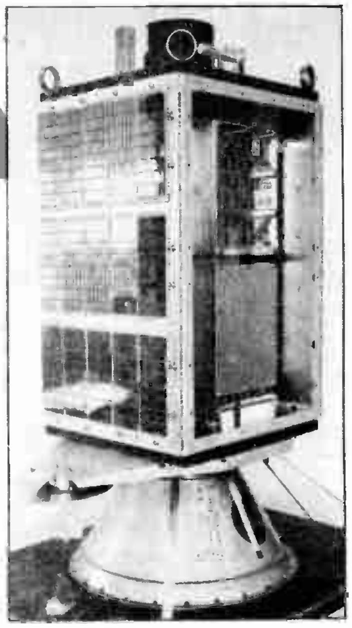


Buylines

Magenta Electronics, who advertise in HE, have produced a kit of parts for this project. The kit price is £12.78, but please add 40p to cover p&p. Connecting cable is also available from Magenta at 14p per metre.

HE

UOSAT Launch Imminent



View of UOSAT's structure. One of the solar cell panels has been removed to show four of the sixteen boxes machined from solid aluminium. Each box contains two printed circuit boards: about 400 PCBs are used in the spacecraft

With the University of Surrey's satellite due for launch in September, we give a progress report

DETAILS OF UOSAT (University Of Surrey SATellite) were given in Bill Mitchell's article *UOSAT — Britain's first educational & hobbyist satellite* in the August '81 issue of HE (pages 56 and 57).

Briefly, the satellite was built at Surrey University with the intention of increasing the interest in space science among educational establishments and also among radio amateurs and hobbyists in their homes. When in orbit UOSAT will transmit a variety of data, including pictures of the earth's surface in a form which can be easily displayed on a domestic TV receiver. It will also have a voice synthesiser on board which will 'speak' in English, giving information about telemetry, experimental data and spacecraft operations.

The exciting part is that radio amateurs and hobbyists, equipped with standard narrow-band VHF receivers, will be able to listen in to these transmissions and will require only a simple fixed aerial. It is anticipated by Surrey University that receiver kits will become available commercially this year for around £150. We hope to give details of these kits in a later issue.

Launch Date

We contacted the University of Surrey as late as possible (half-way through August) to get its most recent estimate of the launch date. In the space of two weeks this date had been shifted *back* to a 'nominal' date of Tuesday 22nd September. It was due to leave the University on 24th August for a flight the next day to the Goddard Space Flight Center in Washington.

Early in August, the spacecraft had been brought back from British Aerospace in Stevenage, Herts, where it had undergone a series of stringent flight acceptance tests. These included vibration, spinning and alternate freezing and heating while under vacuum. It had to undergo further tests at the University before being shipped to the United States.

Pre-launch Preparations

When UOSAT arrives at Goddard Space Flight Center, its magnetometer will be calibrated. This instrument, identical to that used in the Voyager spacecraft on its missions to Jupiter and Saturn, will be used to study the earth's magnetic field.

Next stop after Goddard will be the Western Test Range at Vandenberg, California. Here it will undergo a week of final testing before being 'mated' to the Delta 2310 launch vehicle. (A trial 'mating' of UOSAT with the launch vehicle took place last December at the McDonnell-Douglas works in California.)

Once Launched. . .

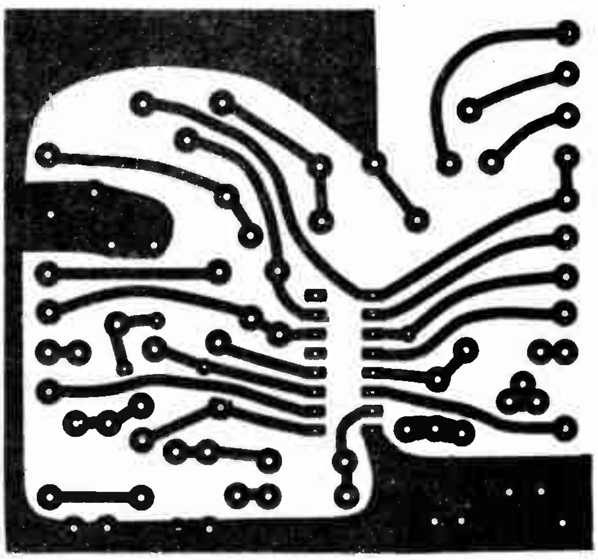
Full control of UOSAT should take place about an hour after its launch. Shortly after the separation from its launch vehicle, the Surrey University Satellite Command Station will activate UOSAT as it comes within radio sight in its orbit. (The University's Command Station controls all spacecraft in the international amateur space programme while they are orbiting over Europe.)

The first two weeks after the launch will be spent in deploying UOSAT's aerials and its 50 ft stabiliser boom. Checks will also be made of its computer and other operational systems, experiments and data beacons to see whether they have been affected during the launch. It may also be necessary, using the on-board magnetorquer, to turn the spacecraft the right way up.

We'll try to keep you informed about UOSAT's progress.

HE

PCB Foil Patterns



PCB pattern for Combination Lock (see page 21)

HE

COMPUTERS ● AUDIO ● RADIO ● MUSIC ● LOGIC ● TEST GEAR ● CB ● GAMES ● KITS

BREAD BOARD 81

Wednesday	11th November	10 a.m.-6 p.m.
Thursday	12th November	10 a.m.-8 p.m.
Friday	13th November	10 a.m.-6 p.m.
Saturday	14th November	10 a.m.-6 p.m.
Sunday	15th November	10 a.m.-4 p.m.

COMPONENTS ● DEMONSTRATIONS ● SPECIAL OFFERS ● MAGAZINES ● BOOKS

**ROYAL HORTICULTURAL SOCIETY'S
NEW HALL, GREYCOAT STREET,
WESTMINSTER, LONDON S.W.1.**

17,000 PEOPLE CAN'T BE WRONG

For 5 days last year they packed the RHS halls for Breadboard '80. All the leading companies were there.....

.....and they're back again this year for BREADBOARD '81.....with larger stands and wider gangways.

Whether you're buying or just browsing, BREADBOARD '81 has something to offer you. The top electronics magazines will be there.

If you're interested in kits, components or computing, BREADBOARD '81 covers it all..... books, bargains and demonstrations. It's all happening at BREADBOARD '81.

Cost of entry will be £2.00 for adults, and £1.00 for children under 14 yrs and O.A.P.s.

To avoid queueing. Advance tickets will be available from:
Advance Tickets BB '81.
Modmags Ltd. 145 Charing Cross Road.
London WC2H 0EE.

Special Advance Booking Price
Adults £1.75. Children under 14 yrs and O.A.P s 80p

Please send .... tickets @ £1.75 .... tickets @ 80p

To ....

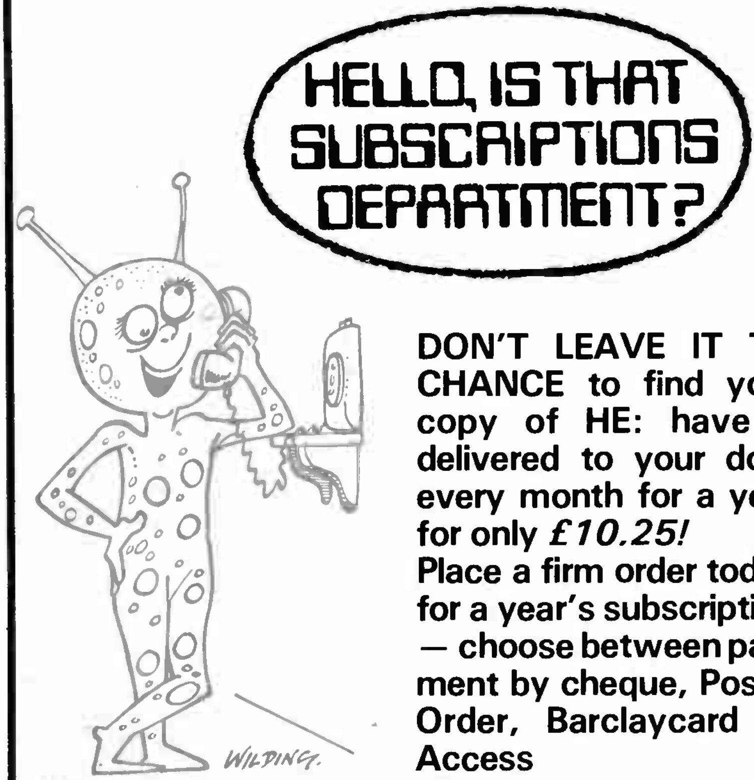
....

....

I enclose PO/cheque for £ ....

Advance tickets MUST be ordered BEFORE 20th October 1981.

SUBSCRIBE TO HE



DON'T LEAVE IT TO CHANCE to find your copy of HE: have it delivered to your door every month for a year for only *£10.25!* Place a firm order today for a year's subscription — choose between payment by cheque, Postal Order, Barclaycard or Access

Send to HE Subscriptions Department, 513 London Road, Thornton Heath, Surrey CR4 6AR

I would like to subscribe to 12 issues of Hobby Electronics

I enclose a Cheque/Postal Order* made payable to Modmags Limited for £10.25

OR

I wish to pay by Barclaycard. Please charge to my account number BARCLAYCARD VISA

....

OR

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

....

SIGNATURE ....

NAME ....
(BLOCK CAPITALS)

ADDRESS ....
(BLOCK CAPITALS)

....

Delete as appropriate

HE PCB SERVICE

Ready made PCB's For Readers!

PRINTED CIRCUIT BOARDS (PCBs) for HE projects have often represented an obstacle for our readers. Some of you, no doubt, make your own but our PCB Service saves you the trouble.

NOW you can buy your PCBs direct from HE. All (non-copyright) PCBs will be available automatically from the HE PCB Service. Each board is produced from the same master as that used for the published design and so each will be a true copy, finished to a high standard.

Apart from the PCBs for this month's projects, we are making available some of the popular designs from earlier issues. See below for details. *Please note that only boards for projects listed below are available*: if it isn't listed we can't supply it.

January 80	
Digi Dice	£2.20
February 80	
Win Indicator	£1.98
March 80	
5080 25 W Amplifier Module	£1.95
5080 PSU Module	£1.98
April 80	
Speed Controller For R/C	£1.60
Digital Frequency Meter	£2.95
Hobbycom: Two-wire Intercom (set of two)	£3.98
Electronic Ignition (CD)	£2.98
May 80	
5080 Pre-amplifier	£3.50
June 80	
Fog Horn	£1.40
Egg Timer	£1.58
July 80	
18 W + 18 W Car Stereo Booster (two required for stereo) each	£1.20
August 80	
Equitone Car Equaliser	£1.79
Gaztec Gas Detector	£2.98
Pass The Loop Game	£1.98
September 80	
Auto Probe	£1.25
Guitar Phaser	£1.48
Development Timer	£1.35
Bench PSU	£2.20
October 80	
Nobell Doorbell	£1.98
Intruder Alarm	£1.88
Tug O' War	£1.99
November 80	
Memory Bank Synth:	
Mainboard PCB	£2.48
Keyboard PCB	£2.70
Party Grenade (set of three)	£2.60
Double Dice	£2.20
December 80	
Stereo Power Meter	£2.12
Digital Speedo (set of two)	£3.50
January 81	
Car Rev Counter	£2.24
February 81	
Heartbeat Monitor	£1.90
Audio Signal Generator	£1.85
March 81	
Steam Loco Whistle	£1.99
April 81	
Super Siren	£1.48
Russian Roulette Game	£1.20
May 81	
Voice Operated Switch	£1.25
Organ 1	£3.48
June 81	
Envelope Generator	£1.40
Organ 2	£1.90
July 81	
Organ 3	£4.50
Organ 4	£4.50
Ultrasound Burglar Alarm	£1.90
August 81	
RPM Meter	£1.33
Thermometer	£1.25
September 81	
Power Pack	£1.27
Reaction Tester Game	£1.28
'Diana' Metal Detector	£2.48
October 81	
Combination Lock	£1.99

PLACE an order for your PCBs using the form below (or a piece of plain paper if you prefer not to cut the magazine), then simply wait for your PCBs to drop through your letterbox, protected by a Jiffy bag.

HE PCB Service, Modmags Limited, 145 Charing Cross Road, London WC2H 0EE

I enclose a cheque/Postal Order made payable to Modmags Limited for the amount shown below

OR

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

. . . . BARCLAYCARD VISA

OR

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

. . . .

SIGNATURE . . . .

NAME . . . .
(BLOCK CAPITALS)

ADDRESS . . . .
(BLOCK CAPITALS)

. . . .

. . . .

Boards Required	Price
Add 40p p & p	0.40
Total Enclosed £	

Please allow 14 days for delivery

A STAR IS BORN

THE AX-210 IS OUT OF THIS WORLD

THE WORLDS MOST VERSATILE WATCH

CASIO AX-210
Multiple Display LCD Analogue/Digital

ANALOGUE display of time plus:
*Digital time display, 12 or 24 hour system.
*Digital date, month and year, plus day flag.
*Full month calendar display, current month.
*Full month calendar display, next month. Auto-calendar pre-programmed to the year 2029.

Dual time modes
*ANALOGUE display of local time plus digital second time zone, 12 or 24 hour system.

Alarm mode
*ANALOGUE time with digital "Alarm Set Time", 24 hour system, AM/PM and "alarm on" indicators.
*Buzzer for 20 seconds or select "Dixie Land", "Green Sleeves" or "My Darling Clementine".

Hourly time signal
*Chimes at noon. Easily switched on or off.

RRP (34.95)
ONLY £29.95

Countdown alarm timer mode
*Amazing ANALOGUE display, plus digital countdown. Normal and net times from 1 to 60 minutes with automatic retrieval of pre-entered time.

Stop watch mode
*ANALOGUE countup, with digital timing of net, lap and first and second place times from 1/100 second to 1 hour. Confirmation signal.

Easy setting of times and alarm with forward and backward stepping, and rapid run facility. Dims: 9.25 x 35 x 36mm approx. Mineral glass. Long life lithium battery. +/-15secs/month.

NEW LOWER PRICES

100 METRE WATER RESISTANT WATCHES WITH C/D ALARM AND STOPWATCH

W150	W150C	W100
£24.95*	£21.95*	£19.95

Time and auto calendar, alarm, hourly chimes, countdown alarm timer with repeat memory function, stopwatch. Time is always on display, regardless of mode. Stainless steel.

THESE SPACE INVADERS WILL ALARM YOU

CA90 (LEFT)
£19.95*

CA901 (RIGHT)
£29.95*

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

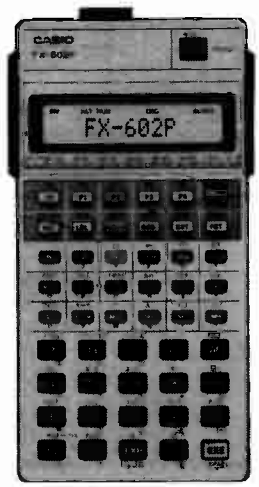
CASIO's MOST AMAZING WATCHES EVER

PROGRAMMABLE CALCULATORS

POWERFUL HIGH SPEED FX702P COMPUTER USING BASIC LANGUAGE

CASIO
FX702P
(RRP £134.95)
ONLY **£119.95**

LCD scrolling display of alpha/numeric (dot matrix) characters. Input can be varied from 1680 programme steps with 26 independent memories, to 80 programme steps with 226 memories. (All retained when switched off). Up to 10 programmes can be stored (PO to P9). Subroutine. Nested up to 10 levels. FOR NEXT looping. Nested up to 8 levels. Straightforward programme debugging by tracing. Editing by moving cursor. 55 built-in scientific and statistical functions, including regression analysis and correlation coefficient, can be incorporated in programmes. Programme/data storage on cassette tape via optional FA-2 (available soon). Optional FP-10 mini printer. PLUG-IN ROM MODULES, available soon. Two lithium batteries give approx. 200 hours continuous operation, with battery saving Auto Power Off after approx. 6 minutes non-use. Dimensions: 17 x 165 x 82mm (5/8ths x 6½ x 3¼"). Weight: 180g (6.3oz).



CASIO FX602P
(RRP £84.95)
ONLY **£74.95**

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

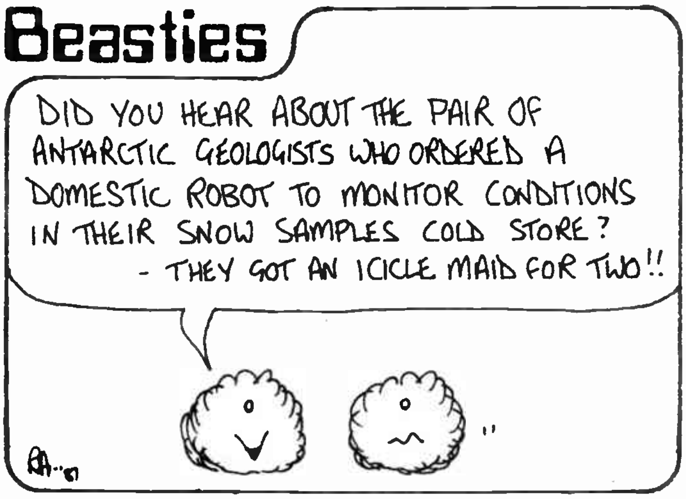
PRICE includes VAT and P&P. Send your company order, cheque, PO or phone your Access or Barclaycard number to

TEMPUS

LEADING CASIO DISTRIBUTOR

Dept. HE/10
164/167 East Road, Cambridge CB1 1DB
Telephone: 0223 312866

Beasties


DID YOU HEAR ABOUT THE PAIR OF ANTARCTIC GEOLOGISTS WHO ORDERED A DOMESTIC ROBOT TO MONITOR CONDITIONS IN THEIR SNOW SAMPLES COLD STORE?
- THEY GOT AN ICICLE MAID FOR TWO!!

D.I.L. MINIATURE ON-OFF SWITCHES
Gold-plated contacts. Sealed base. Ideal for programming. 8-position at less than half manufacturer's price.
ONLY 75p
Will fit into 14-pin dil socket. Ten at 65p ea.; per 100 55p ea.

HONEYWELL PROXIMITY DETECTOR integral amplifier, 8v. D.C., £3.50 ea.
PHOTO CONDUCTIVE CELL, £1.25. High-power Cds cell, 600MW, for control circuits. Resistance 800 ohm to 4K Max. volts 240. Size 1½ × ½in.
RIBBON MICROPHONE with pre-amp. on chassis, £1.75.

MULLARD MODULES
LP1171 / LP1179 IF Strip / AM, FM Front end — Pair £5.75. Complete with Data
LP1186 varicap — £5.00; LP1157 Med. & Long Tuner — £2.50

ULTRA SONIC TRANSDUCERS 40KC/S. Complete on 18in. Screened cable, £1.75 each; pairs £2.95.
ULTRA SONIC TRANSMITTER. Complete unit (uncased requires 1.5V), £3.25.
FOSTER DYNAMIC MICROPHONES. 200 ohm impedance. Moving coil. Complete on chassis £1.75 pair.

U.H.F. MODULATORS
Latest type, adjustable, ideal for computers.
Size 3×2½×1 inch
Only £2.95
In screened case

LM380 Amplifier 75p
LM318N Hi-Slew Op. Amp. £1.50
LM323K, 5v. 3-amp. reg. £3.80
LM310N Volt. Follower Amp. £1.20
LM311H High Perf. Volt. Comparator £1.00
LM384N, 5-watt Amp £1.20
LM393N, Dual Comparator 60p

CRYSTALS COLOUR TV
4.433619 mc/s £1.25
Miniature type sealed

7905 Voltage Regulator 1 amp TD220 Negative - Motorola
80p

CHIPS
2102 450 n/s £1.00
2114 300 n/s £1.75
4116 200 n/s £1.50
2732 450 n/s £7.50

MONSANTO
Half-inch + 1 Display
High Intensity
£1 each
set of 4 £3.50
Common anode
14 Pin Dil Package

BRIDGE RECTIFIER
800 PIV 35 amps
1½×1½×½in. £3.50

STEREO CASSETTE TAPE HEADS. Quality replacement for most recorders with mounting plate. Record/Replay £2.80
MARRIOTT TAPE HEADS Quarter track.
Type
XRPS18 Record/Replay (each) £2.00
XRPS36 Record/Replay (each) £3.00
XES11 Erase (each) £1.00

HEWLETT-PACKARD DISPLAYS
HIGH EFFICIENCY AND VERY BRIGHT
Only £1.00 each
Set of 6 for £5
Half-inch red common cathode will replace OL707, 14-pin Dil.

EX-MOTOROLA 5 + 5-WATT CAR STEREO AMPLIFIERS
WATT CAR STEREO AMPLIFIERS
Complete and tested units. Medium and Long Wave. Supplied as two built units (5 × 2 × 2in.) with circuit and data. Only £5 pair. Includes pre-amp.

RELAY (General-purpose Type). 4½-6v. single-pole changeover. 200 ohms (open type). 1 × 1 × 1 inch, 60p.
MINIATURE MP.C. POTENTIOMETERS. Model M2. High-quality, 5% tolerance, 2-watt, with 1in. spindles. All values, 47 ohms-47k only 60p each per 10; 50p each per 100; 40p each.

RECHARGEABLE BATTERIES
VARTA 3.6 volts DEAC, M/AH 225 .... £1.50
DRYFIT 6-volt, 4.5 amp. £7.50

XJAL FILTER 10.7mc/s, 12.5DB separation, 1½×1¼×1 inch £7.00
100KC/S + 1 meg. 3-pin £2.00

"CHERRY" ADD-ON KEYPAD

A compact 12-button keypad suitable for use with Cherry Keyboard to extend its functions plus four extra keys.
Supplied brand new with data.
A 3 × 4 non-encoded single mode keyboard in sloped format.

QUANTITY DISCOUNTS on *ALL* items (unless stated), 15% per 10, 20% per 50, 25% per 100. All items *BRAND NEW* (unless otherwise stated).
DELIVERY from stock – All post paid. Please add VAT. **EXPORT enquiries invited.**
TELEX 262284 Transonics Mono 1400

HENRY'S 01-723 1008/9
404 EDGWARE ROAD, LONDON W2 1ED

RECHARGEABLE BATTERIES
AND CHARGERS

PRIVATE OR TRADE ENQUIRIES WELCOME

FULL RANGE AVAILABLE SEND SAE FOR LISTS. **£1.45** for Booklet "Nickel Cadmium Power" plus Catalogue. Write or call:

* NEW SEALED LEAD RANGE AVAILABLE *

SANDWELL PLANT LTD.
2 Union Drive, Boldmere
Sutton Coldfield, West Midlands
021-354 9764

TO PLAY

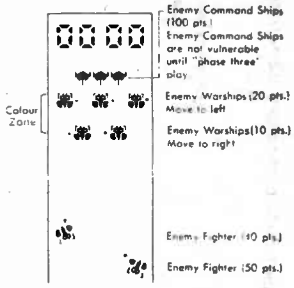
1. Set game to desired level of difficulty – skill level "1", "2", "3", or "4" – by pressing Skill Level Select Button. Check number at top of Game Display to be sure game is set at desired level. Skill level can not be changed until new game is started.
2. Press Start Button to begin "phase one" combat action. You will see a "5" on the Game Display. This means you have 5 earth ships.
3. The aliens now begin their attack. You fight back by manoeuvering your earth ship to right or left with the Joy Stick and by pressing the Fire Button.
4. When your earth ship has been hit by an alien, you will hear an electronic sound. You have lost an earth ship. The number of earth ships you have left is shown at the top of the Game Display.
5. You may continue to play – through "phase one," "phase two", "phase three", the "phase four" docking manoeuvre and even play again – until your last earth ship has been lost.
6. When you have lost all 5 of your earth ships, you have no more chances to counterattack and the game is over. If you are a beginning player, this may happen in "phase one" or "phase two".
7. When the game is over, your total score is shown at the top of the Game Display. If you are very skilful, you can score up to 10,000 points and hear a special electronic victory tune.

Ultra-modern arcade excitement is now yours, as you defend your earth ships against a fierce invasion. You must dodge the enemy missiles and fire back at the squadrons of attacking fighters, warships and enemy command ships. If you survive, you can attempt the exciting DOCKING MANOEUVRE and earn extra points.

A table-top Space Game with many unique features – Multi-coloured Invaders – Magnified display – Unique, exciting sound effects – Built-in automatic bonus game – Five Lanes of action – Five lives per game – Four Levels of play – Uses 4 × HP 11/MN 1400.

MOVEMENT OF THE ALIENS

Phase One

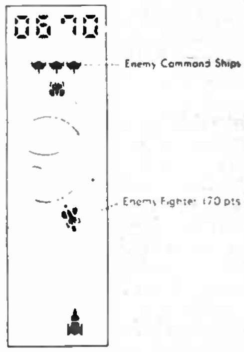


At the top of the Game Display are three enemy command ships and directly below in the colour zone are two rows of enemy warships which are worth 10 and 20 points when hit. Now, a squadron of enemy fighters begins an attack in two different patterns – a zigzag pattern (50 pts.), a horizontal and vertical pattern (40 pts.). If you destroy 10 of these fighters, worth 40 or 50 points when hit, you will hear an electronic sound and "phase two" action will begin.

Skill Level "1" – Alien fighters attack one at a time.
Skill Level "2" – Alien fighters attack one at a time but combat speed is faster.
Skill Level "3" – Alien fighters attack two at a time.
Skill Level "4" – Alien fighters attack two at a time but combat speed is faster.

C.W.O. £29.95

Phase Two



In "phase two" another squadron of enemy fighters attacks, this time in a circular pattern. Each attacking enemy fighter you hit is worth 70 points. If you destroy 10 of these fighters, you will hear an electronic sound and "phase three" action will begin.

Mini Sensory Chess Challenger

SMALL IN SIZE, BIG ON PLAYABILITY AND IT'S SENSORY, OF COURSE!

A computerised chess opponent that's always ready, willing, and very able to play whenever you're in the mood – any time, any place. Battery operated, it's ideal for use on that car or plane trip, at the beach or picnic, in a hotel room, or anywhere you have the time and the inclination.

Price: £56.95 inc. VAT plus **£2** post, packing and insurance.
Supplied complete with dust cover, chess pieces, main adaptor and full two-year guarantee.

Advanced sensory playboard automatically recognises and records your every move. Brightly lit LEDs and beep tone graphically and audibly inform you of the computer's response. Simply press down on the piece you are moving, and LEDs light to show your "from" location. Press the piece down on your "to" location, and the computer instantly knows which piece was moved to where it was moved to. No keys to press – you devote all your attention to the game.

Plays excellent chess, and provides these outstanding additional features:

- Infinite levels of play
- Levels changeable during game: change from Level 1 to any level at any time, on any move
- Random computer responses make every game different
- Select offence or defence; play white or black. Change sides at any time during a game
- Position verification by computer memory recall at any time during a game
- Problem Mode lets you set up piece positions to work out problems. Add or subtract a piece during a game
- Replaceable plug-in modules will be available that greatly expand Mini Chess Challenger's capability almost without limit as present technology advances

Optional plug-in modules will include: Advanced chess programme, popular chess book openings, Greatest Chess Master Games, Checkers, Reversi, and Mini Go-moku.

Includes compact, impact-resistant plastic housing. 100% solid state. Works on 6 AA 1.5-volt alkaline batteries. 8½in. long, 4½in. wide, 1⅞in. high (batteries not included).

C.W.O. to KRAMER & CO., 9 October Place, London, N.W.4. Telephone 01-203 2473. Telex 888941, Attention K7. Visa, Access, Barclaycard & Company Orders accepted. Orders by telephone/telex. Open Monday to Friday (Sunday by appointment only).

ALSO AVAILABLE: Electronic Chess **£39**, as recommended by Hobby Electronics. Chess Challenger 7 **£73**. Sensory 8 **£113**. Chess Partner 2000. Morphy Encore. Great Game Machine. Supersystem. Voice Champion Sensory Chess Challenger. Computer Bridge. Mattel TV Games. Atari 400, 800. Consols, Thandar Multimeters, Oscilloscopes, Teletext, Commodore Vic available. Galaxy 1000, Earth Invader. S.A.E. for full details of the above and details of cartridge for the Atari TV Game.

PRICE: £56.95 incl. V.A.T. plus **£2** post, packing and insurance. Supplied complete with Dust Cover, Chess Pieces, Mains Adaptor and Full 2-year Guarantee.

CLASSIFIEDS

ETI RATES
1-4 Insertions £9.00 per scc
5-11 Insertions £8.00 per scc
12+ Insertions £7.00 per scc
30p per word (min 12 words)
Box No. £2.00
Closing date 1st Friday in month preceding publication.

HE RATES
1-3 Insertions £5.00 per scc
4-11 Insertions £4.50 per scc
12+ Insertions £4.00 per scc
18p per word (min 15 words)
Box No. £1.50
Closing date 2nd Friday in month preceding publication.

Classified Advertisements must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

SEND TO:- ETI/HE CLASSIFIED, 145, CHARING CROSS ROAD. LONDON WC2H 0EE. TEL: 01-437 1002 Ext. 50.

3 INCH 30 OHMS 1.5 Watt loudspeakers, square frame, suitable metronome project, etc. 70p each, 50p p&p per order. Cheques, PO to – AFDEC Electronics Ltd, 17c London St, Basingstoke, Hants.

CONVERT ANY TV into large screen oscilloscope. External unit plus into aerial socket. Circuit and plans £3 (SAE details). – J. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

BARGAIN COMPONENT PACKS: 100 mixed resistors £1; 1,000 for £7.50, post free. – JKS Electronics, 2 Poundfield Rd., Debden, Loughton, Essex.

DIGITAL WATCH SPARES. Standard parts for all LCD Watches. Send s.a.e. for full list. – Profords, Copners Drive, Holmer Green, Bucks.

CLOSE ENCOUNTERS GROUP. Personal introductions/dances, parties, talks, social events. Meet interesting, attractive people. All areas. – Tel. (Liverpool) 051-931 2844 (24 hours).

ZX80/ZX81 PROGRAMMABLE CHARACTER GENERATOR. Just plugs in. Built and cased, £34.50. Kit £29.95. Colour to follow. Edge connector, £2.50. Memory, sound, keyboard. UK101/superboard p.c.g., p.o.a. Resistors ¾p. S.a.e. for details. – Haven Hardware, 4 Asby Road, Asby, Workington, Cumbria.

AMAZING OFFER

MEN'S 5-FUNCTION LCD DIGITAL WATCHES
£4.99
Price includes postage, packing and V.A.T. Guaranteed one year. Money back if unsatisfied and watch returned within 14 days. Limited stocks. First come first served.
Cheque/P.O. to: **Zedelec, 45 Kerry Close, Barwell, Leics., LE9 8HT.**

GUITAR/PA MUSIC AMPLIFIERS

100 watt superb treble/bass overdrive, 12 months' guarantee. Unbeatable at £50; 60 watt £44; 200 watt £68; 100 watt twin channel sep. treble/bass per channel £65; 60 watt £52; 200 watt £78; 100 watt four-channel sep. treble/bass per channel £75; 200 watt £98; slaves 100 watt £34; 200 watt £60, 250 watt £70; 500 watt £140; fuzz boxes, great sound, £12; bass fuzz £12.90; overdriver fuzz with treble and bass boosters, £22; 100 watt combo, superb sound, overdrive, sturdy construction, castors, unbeatable, £98; twin channel, £115; bass combo £118; speakers 15in. 100 watt £36; 12in. 100 watt £24; 60 watt £16; microphone shure unidyn B £25; 3-channel sound/light £26.
Send cheque P.O. to: **WILLIAMSON AMPLIFICATION**
62 Thorncliffe Avenue, Oukinfield, Cheshire. Tel. 061-308 2064

HAVE YOU SEEN THE GREEN CAT?
1000s of components (C.B., Radio & Electronic). Aerials, Plugs, SWR Meters & Accessories, Audio, Hi-Fi, Experimental devices. In fact anything electronic at unbelievably low prices. Something for everyone. Send 30p for list and receive FREE RECORD SPEED INDICATOR. MAIL ORDER ONLY. MYERS (Dept. HE), 12 Harper Street, Leeds, LS2 7PE.

AMAZING ELECTRONICS PLANS. Lasers; Super-powered Cutting Rifle, Pistol, Light Show, Ultrasonic Force Fields, Pocket Defence Weaponry, Giant Tesla, Satellite TV Pyrotechnics, 150 more projects. Catalogue 75p. – From Plancentre, 16 Mill Grove, Bilbrook, Codsall, Wolverhampton.

CENTURION BURGLAR ALARM EQUIPMENT. Send s.a.e. for free list or a cheque/p.o. for £5.95 for our special offer of a full-sized decoy bell cover. To: Centurion, Dept. ETI, 265 Wakefield Road, Huddersfield, West Yorkshire. Access and Barclaycard. Telephone orders 0484 35527.

ZX81 FLICKER-FREE GAMES, 6 on cassette, £3 (or SAE details). – Kerr, Dept HE, 29 Chadderton Drive, Unsworth, Bury, Lancs.

PRINTED CIRCUITS. Make your own simply, cheaply and quickly! Golden Fotolac light-sensitive lacquer – now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric Chloride 55p. Clear acetate sheet for master 14p. Copper-clad fibreglass board, approx. 1mm thick £1.75 sq. ft. Post/packing 75p. White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall.

WANTED. Electronic components and test equipment. Good prices given. Q Services, 29 Lawford Crescent, Yately (0252) 871048, Camberley, Surrey.

MAIL ORDER PROTECTION SCHEME
If you order goods from mail order advertisers in this magazine and pay by post in advance of delivery, this publication *Hobby Electronics* will consider your for compensation if the advertiser should become insolvent or bankrupt, provided:

1. You have not received the goods or had your money returned; and
2. You write to the publisher of this publication *Hobby Electronics* explaining the position not earlier than 28 days from the day you sent your order and not later than 2 months from that day.

Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required.
We guarantee to meet claims from readers made in accordance with the above procedure as soon as possible after the advertiser has been declared bankrupt or insolvent to a limit of £1,800 per annum for any one advertiser so affected and up to £5,400 p.a. in respect of all insolvent advertisers. Claims may be paid for higher amounts, or when the above procedures has not been complied with, at the discretion of this publication *Hobby Electronics*, but we do not guarantee to do so in view of the need to set some limit to this commitment and to learn quickly of readers' difficulties.
This guarantee covers only advance payment sent in *direct* response to an advertisement in this magazine (not, for example, payments made in response to catalogues, etc, received as a result of answering such advertisements). Classified advertisements are excluded.

ELECTRIFY YOUR SALES! • CLASSIFIED ADVERTISEMENT

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15

Please place my advert in: Electronics Today International
(Delete as applicable) Hobby Electronics

Advertise nationally in Electronics Today International/Hobby Electronics. Simply print your advertisement in the coupon here (left), indicating which magazine you require.
Or telephone for more information.

Name ....

Address ....

....

....

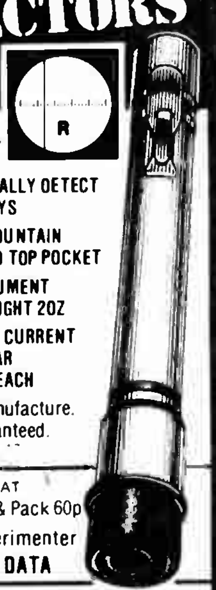
Tel. No. (Day) ....

Send, together with your cheque to:
Jenny Naraine, ETI/HE,
145 Charing Cross Rd., London WC2H 0EE.
Tel: 01-437 1002 Ext. 50.

RADIATION DETECTORS

BE PREPARED

VIEW THRU LENS ▶



- THIS DOSIMETER WILL AUTOMATICALLY DETECT GAMMA AND X-RAYS
- UNIT IS SIZE OF FOUNTAIN PEN & CLIPS ONTO TOP POCKET
- PRECISION INSTRUMENT METAL CASED WEIGHT 2OZ
- MANUFACTURERS CURRENT PRICE OF A SIMILAR MODEL OVER £25 EACH

British design & manufacture.
Tested & fully guaranteed.
Ex-stock delivery.

£6·95 inc. VAT Post & Pack 60p

Ideal for the experimenter
COMPLETE WITH DATA

HENRY'S

404 EDGWARE ROAD, LONDON W2 1ED

ELECTRONIC KIT BUILDERS. You supply the kit – we build it for 60% of kit price. Powertran approved. – for quotation telephone 0604 56248 or 0908 564542.

PRE-PACKED SCREWS, nuts, washers, solder tags, studding. Send for price list. – A1 Sales (HE), P.O. Box 402, London, SW6 6LU.

ADVERTISEMENT INDEX

NEW!

OFFICIAL POWERTRAN KIT REPAIR AND ASSEMBLY SERVICE

Circolec (EGS) are delighted to announce their new OFFICIAL Powertran repair and assembly service for electronic kits, we can supply you any kit ready built and tested (see Powertran advert in this issue). Either buy direct from us or through Powertran. Full details on request.

All Powertran kits are now served and repaired efficiently by our experienced engineers. Simply send your faulty unit to us carefully packed together with details of problems and we will do the rest.

ASSEMBLY PRICES EXAMPLES:
1024 Composer **£50** + VAT; Vocoder **£120** + VAT.
Prices include postage but Securicor delivery available at extra cost.

ALL GAMES STILL AVAILABLE AT THE BEST PRICES!

CIRCOLEC
1 FRANCISCAN ROAD, TOOTING, LONDON SW17
Tel: 01-767 1233

P.C.B.s THE FOTO WAY

WHY wait weeks for manufacturers?
WHEN you can make professional printed circuit-boards yourself!

IT'S SO SIMPLE WITH: THE PATH P.C.B. FOTOSYSTEM METHOD.

i) Make master pattern of P.C.B. layout on clear drafting film
ii) Take FOTO sensitised board (pre-coated or make your own using FOTOspray) Place master pattern upon board
iii) Expose to UV or daylight
iv) Place exposed board into developer.
v) Wash.
vi) Etch in ferric chloride.
vii) Remove resist with wire wool or use FOTO stripper

You now have your perfect P.C.B. ready for use.

Your master pattern may be used again and again for extra copies

Materials from stock you can rely on:
Pack of Drafting Transfers (5 sheets asstd.) £1.98
Drafting sheet for master pattern £0.20
Developer crystals or: £0.35
Developer Liquid concentrate £2.20
Ferric Chloride 250g. (½lb.) £0.80
Ferric Chloride ½kg (1lb.) pack £1.50
FOTOstripper Concentrate £3.41
FOTOspray light sensitive lacquer in aerosol form enough to cover 1 to 1½ sq. metres £2.30
Polypropylene Dishes for etchants and developers £1.30

FOTOboard
1.6mm 1oz. copper Fibreglass Pre-sensitised board.

	Single sided	Double Sided
100mm × 160mm (Euro Card)	£1.55	£1.70
203mm × 114m (8in × 4½in.)	£1.72	£2.12
203mm + 228m (8in. × 9in.)	£3.60	
467mm × 305mm (18in × 12in.)	£9.00	

Plain Copper Laminate Top-quality 1oz. Copper. Fibreglass Laminate.

	1mm SS	1mm DS	1.6mm SS	1.6mm OS	2.4mm SS	2.4mm DS
152mm × 152mm (6in. × 6in.)	£0.80	£0.85	£0.85	£0.90	£1.27	£1.35
152mm × 305mm (6in. × 12in.)	£1.40	£1.50	£1.49	£1.51	£2.27	£2.43
305mm × 305mm (12in. × 12in.)	£2.50	£2.72	£2.70	£2.75	£4.27	£4.58

POST & PACKING. Please add 80p per order. Plus V.A.T. at 15% to total. Prompt despatch assured

UV Boxes, Tubes and P.C.B. associated products available – ask for details

PATH ELECTRONIC SERVICES 369 Alum Rock Road, Birmingham, B8 3DR - Tel: 021-327 2339

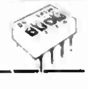
PARNDON ELECTRONICS LTD.

Dept. No. 22, 44 Paddock Mead, Harlow, Essex CM18 7RR. Tel. 0279 32700

RESISTORS: ¼ Watt Carbon Film E24 range ± 5% tolerance. High quality resistors made under strictly controlled conditions by automatic machines. Bandoliered and colour coded
£1·00 per hundred mixed (Min 10 per value)
£8·50 per thousand mixed (Min 50 per value)
Special stock pack 60 values 10 off each **£5·50**

DIODES: **IN4148** 3p each Min order quantity 15 items
£1·60 per hundred

DIL SWITCHES: Gold plated contact in fully sealed base – solve those programming problems
4 Way **86p** each 6 Way **£1·00** each 8 Way **£1·20** each



DIL SOCKETS: High quality, low profile sockets
8 pin – **10p.** 14 pin – **11p.** 16 pin – **12p.** 18 pin – **19p.** 20 pin – **21p.**
22 pin – **23p.** 24 pin – **25p.** 28 pin – **27p.** 40 pin – **42p.**

ALL PRICES INCLUDE V.A.T. & POST & PACKING — NO EXTRAS
MIN ORDER - U.K. £1.00 OVERSEAS £5 CASH WITH ORDER PLEASE

Electronic Kits for the Thrifty!

Build 50 Interesting Projects on a P.C. Chassis with surplus components from your "Spares-Box."

EXPERIMENTER'S PRINTED CIRCUIT KIT

Contents: 4 small boards to suit the enclosed designs, Etching Powder, Resist Paint, Solvent, Degreaser and Etching Instructions, also 50 Circuit Diagrams, Chassis Plans and Layouts for simple Crystal Sets, Transistor Radios, Transmitters, Amplifiers, Intercoms., Radio Control, Metal Detector, Photoelectric and Ultrasonic Alarms, "Perpetual Motions", Light-Beam Telephone Instruments, Testers, Gadgets, etc. You can build at negligible cost with "Surplus" or reclaimed parts and transistors you already have.

Price. £1.70. Postage and Packing 30p

PHOTOELECTRIC KIT

A kit of basic parts to build a simple I.R.-sensitive Photoelectric Switch. Contents: Phototransistor, Transistors, Diode, Resistors, Connector, Latching Relay, Chassis Board, Case, Screws and full instructions.

Price. £4.50. Postage and Packing 50p

OPTICAL KIT

A kit of parts to build an I.R. folded-beam Projector and Receiver to suit the above kit. Contents: 2 Lenses, 2 Mirrors, 2 45-deg. blocks, Infra-Red Filter, Lampholder, Building Plans. Price £3.70. Postage and Packing 30p. Both kits together make an Invisible-Beam Alarm.

EXPERIMENTAL ELECTRONICS
335 Battersea Park Road, London, SW11 4SL
Send s.a.e. for full details of all kits and circuits

STOP PRESS

MAPLIN ROAD SHOWS

Friday 25th September
Grainger Room
Newcastle Centre Hotel
New Bridge Street,
Newcastle-upon-Tyne

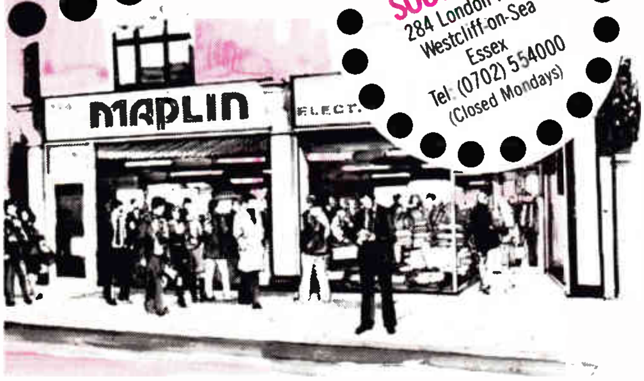
Saturday 26th September
Rosebery Room
Grosvenor Centre Hotel
Grosvenor Street
Edinburgh

Sunday 27th September
Ullswater Room
Portland Hotel
3 Portland Street
Piccadilly Gardens
Manchester

Monday 28th September
The Malvern Suite
Birmingham Centre Hotel
New Street
Birmingham

Tuesday 29th September
The Riverside Suite
Hotel Nelson
Prince of Wales Road
Norwich

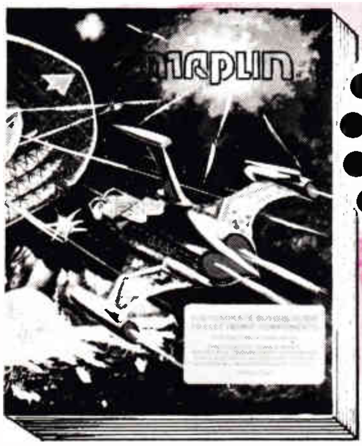
For further details phone 0702 554155



in SOUTHEND
284 London Road
Westcliff-on-Sea
Essex
Tel: (0702) 554000
(Closed Mondays)

in HAMMERSMITH
159-161 King Street
Hammersmith
London W6
Tel: 01-748 0926
(Closed Mondays)

For personal service visit one of our stores.
Our new store at Hammersmith is conveniently situated near the end of the M4 and the North and South Circular Roads.
There is excellent street parking on meters a few steps away and Hammersmith Underground Station is nearby. Call in and see us soon.



in our CATALOGUE
320 big pages packed with data and pictures of over 5,500 items

Over 100,000 copies sold already!
Don't miss out on your copy.
On sale now in all branches WH Smith price £1.
In case of difficulty check the coupon below.

by MAIL ORDER
A fast service
You can rely on

- Same day service on in-stock lines
- Very large percentage of our stock lines in stock
- All prices include VAT
- Large range of all the most useful components
- First class reply paid envelope with every order
- Quality components—no rejects—no re-marks
- Competitive prices
- Your money is safe with a reputable company

On price, service, stock, quality and security it makes sense now more than ever to make MAPLIN your first choice for components every time!

make it easy... with MAPLIN

The Maplin Matinée
Amazing value for only £299.95 plus £99.50 for cabinet if required (carriage extra)

Easy to build, superb specification. Comparable with organs selling for up to £1,000. For full construction details refer to Electronics & Music Maker.

Post this coupon now.
Please send me a copy of your 320 page catalogue. I enclose £1.25 (incl. 25p p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the U.K. send £1.68 or 12 International Reply Coupons.

Name ______________________
Address ______________________

HE1081

MAPLIN ELECTRONIC SUPPLIES LTD.
All mail to: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) 554155 Sales: (0702) 552911