Australia $1.60 New Zealand $1.75 Malaysia $4.95

PRACTICAL ELECTRONICS

MAY 1984

90p

TEST GEAR SPECIAL

TEST GEAR SPECIAL

FREE! LOGIC DESIGN CARD-Nº3

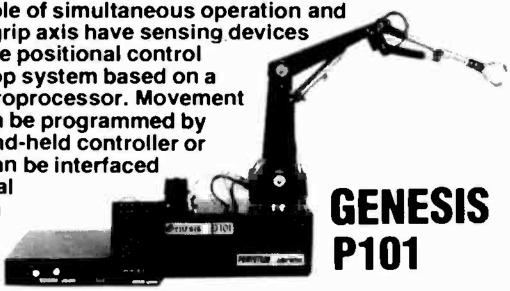
Low-price robots from POWERTRAN

– hydraulically powered
– microprocessor controlled

The UK-designed and manufactured range of Genesis general purpose robots provides a first-rate introduction to robotics for both education and industry. With prices from as low as £470, even the home enthusiast can aspire to his or her own robot.

GENESIS S101

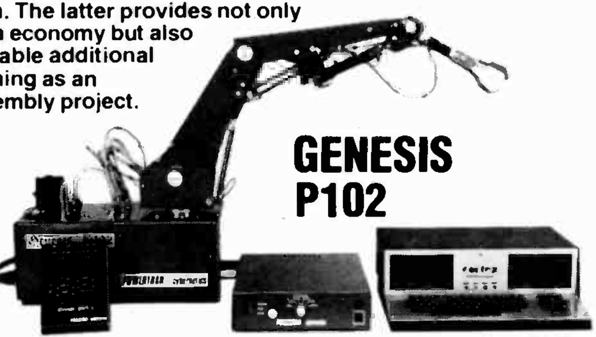
Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed loop system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link.



GENESIS P101

The top-of-the-range P102 has dual speed control, enhanced memory and double acting cylinders for increased torque on the wrist and arm joints. There is position interrogation via the RS232C interface, increasing the versatility of computer control and inputs are provided for machine tool interfacing.

All Genesis robots are available either ready-built or in kit form. The latter provides not only extra economy but also valuable additional training as an assembly project.



GENESIS P102

Cortex 16 bit microcomputer

HEBOT II Turtle-type robot

For a little over £100, Herbot II takes programming off the VDU and into the real world. Each wheel is independently controlled by a computer, enabling the robot to perform an almost infinite number of moves. It has blinking eyes, a two-tone bleep and a solenoid-operated pen to chart its moves. Touch sensors, coupled to its shell return data about its environment to the computer enabling evasive or exploratory action to be calculated.

The robot connects directly to an I/O port or, via the interface board, to the expansion bus of a ZX81 or other microcomputer.

HEBOT II

Weight 1.8kg	
complete kit with assembly instructions	£95
Interface board kit	£11

MICROGRASP

A real programmable robot for under £300! Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about its base and there is a motor driven gripper. All five axes are motor driven and four of these are servo controlled giving positive positioning. The robot can be controlled by any microcomputer with an expansion bus – the Sinclair ZX81 being particularly suitable.

MICROGRASP

Weight 8.7kg, max. lifting capacity 100g	
Robot kit with power supply	£215.00
Universal computer interface board kit	£57.00
23 way edge connector	£3.00
ZX81 peripheral/RAM pack splitter board	£3.50

GENESIS S101

Weight 29kg, max. lifting capacity 1.5kg	
4-axis model (kit form)	£470
5-axis model (kit form)	£525
5-axis complete system (kit form)	£817

GENESIS P101

Weight 34kg, max lifting capacity 1.8kg	
6-axis model (kit form)	£750
6-axis complete system (kit form)	£1050

GENESIS P102

Weight 36kg, max lifting capacity 2kg	
6-axis system (kit form)	£1476
Powertran Cortex microcomputer self-assembly kit	£295.00

POWERTRAN
cybernetics ltd.

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PRACTICAL ELECTRONICS

VOLUME 20 No. 5 MAY 1984

OUR JUNE ISSUE WILL BE ON SALE FRIDAY, MAY 4th, 1984
(for details of contents see page 15/4 of Micro-file)

*The instruments featured on the front cover were kindly loaned to us by the House of Instruments, Global Specialties Corporation and Maplin Electronic Supplies

WATFORD ELECTRONICS

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POLYESTER RADIAL LEAD CAPACITORS: 250V; 10n, 20n, 15n, 22n, 27n **6p;** 33n, 47n, 68n, 100n **8p;** 150n, 220n **10p;** 330n, 470n **15p;** 680n **19p;** 1μ **23p;** 1μ5 **40p;** 2μ2 **46p.**

ELECTROLYTIC CAPACITORS (Values in μF). **500V:** 10μF **52p;** 47 **78p;** **63V:** 0·47, 1·0, 1·5, 2·2, 3·3, **8p;** 4·7 **9p;** 10 **10p;** 15, 22 **12p;** 33 **15p;** 47 **12p;** 68 **16p;** 100 **19p;** 220 **26p;** 1000 **70p;** 2200 **99p;** **50V:** 68 **20p;** 100 **17p;** 220 **24p;** **40V:** 6·8 **15p;** 22 **9p;** 33 **12p;** 330, 470 **32p;** 1000 **46p;** 2200 **90p;** **25V:** 4·7, 10, 22, 47 **8p;** 100 **11p;** 150 **12p;** 220 **15p;** 330 **22p;** 470 **25p;** 680, 1000 **34p;** 1500 **42p;** 2200 **50p;** 3300 **76p;** 4700 **92p;** **16V:** 2·5, 40 **8p;** 47, 68, 100 **9p;** 125 **12p;** 220 **13p;** 330 **16p;** 470 **20p;** 680 **34p;** 1000 **27p;** 1500 **31p;** 2200 **36p;** 4700 **79p.**

TAG-END TYPE: 64V: 4700 **245p;** 3300 **198p;** 2200 **139p;** **50V:** 3300 **154p;** 2200 **110p;** **40V:** 4700 **160p;** **25V:** 4700 **98p;** 10,000 **320p;** 15,000 **345p.**

TANTALUM BEAD CAPACITORS:
35V: 0·1μ, 0·22, 0·33 **15p** 0·47, 0·68, 1·0, 1·5 **16p** 2·2, 3·3 **18p** 4·7, 6·8 **22p** 10 **28p** **16V:** 2·2, 3·3, **16p** 4·7, 6·8, 10 **18p** 15 **36p** 22 **36p** 33, 47 **50p** 100 **95p** 220 **100p** **10V:** 15, 22 **26p** 33, 47 **50p** 100 **75p.**

SILVER MICA (pf)
2, 3·3, 4·7, 6·8, 8·2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 **15p.**
220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF **21p.**
1000, 1200, 1800 **30p each**
3300, 4700 **60p each**

SIEMENS multilayer miniature capacitors
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n, 15n, 22n **7p;** 18n, 27n, 33n, 47n **8p;** 39n, 56n, 68n **9p,** 100nF **11p.**
100V: 100n, 120n, **10p;** 150n **11p;** 220n **13p;** 330n **18p;** 470n **23p;**680n**30p;**1μF**34p;**2μ**250p.**

CERAMIC Capacitors: 50V
Range 1pF to 6800pF **4p;** 10nF, 15n, 33n, 47nF **5p;** 100nF/30V **7p.**

POLYSTYRENE Caps:
10pF to 1nF **8p**
1n5 to 12nF **10p**

POTENTIOMETERS: Carbon Track, 0·25W Log & Linear Values.
500Ω, 1K & 2K (LIN ONLY) Single **34p**
5KΩ-2MΩ single gang **34p**
5KΩ-2MΩ single gang D/P switch **80p**
5KΩ-2MΩ dual gang stereo **90p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track
5KΩ-500KΩ Single gang **70p**

PRESET POTENTIOMETERS
0·1W 50Ω-2·2M Mini Vert. & Horiz. **8p**
0·25W 220Ω-4M7 Vert. & Horiz. **12p**

RESISTORS Hi-stab, Miniature, 5% Carbon.

	RANGE	Val.	1-99	100+
0·25W	2Ω2-4 M7	E24	**3p**	**1p**
0·5W	2Ω2-4M7	E12	**3p**	**1p**
1W	2Ω2-10M	E12	**6p**	**4p**
1% Metal Film 51Ω-1M		E24	**8p**	**6p**

RESISTORS S.I.L. Package: 7 Commoned, 100Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K **24p.**
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 6K8, 10K, 22K, 47K, 100K **26p**

TRANSISTORS

AC127/8	35
AC141/2	35
AC176	35
AC187/8	35
AC188	35
AD142	120
AD149	79
AD161/2	42
AF118	95
AF139	40
AF239	65
BC107/8	12
BC107B	14
BC108B	14
BC108C	14
BC109	12
BC109B	14
BC109C	14
BC114/5	30
BC117/8	25
BC140	38
BC142/3	38
BC147/8	12
BC147B	15
BC148C	10
BC149	12
BC149C	15
BC153/4	30
BC157/8	14
BC159	11
BC167A	14
BC168C	12
BC169C	12
BC171/2	12
BC173	15
BC177/8	16
BC179/81	20
BC181	30
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	28
BC212/3	12
BC212L	10
BC213L	12
BC214	10
BC214L	12
BC237/8	15
BC307B	15
BC308B	16
BC327/8	15
BC337/8	15
BC441	34
BC461	34
BC477/8	40
BC516/7	40
BC547/8	12
BC549C	15
BC556/7	15
BC558/9	15
BCY41/42	30
BCY70	18
BCY71/2	20
BCY72	25
BCY78	30
BD131/2	65
BD133	60
BD135	45
BD136/7	40
BD138/9	40
BD140	40
BD158	68
BD245	65
BD434	70
BD695A	150
BD696A	150
BF115	45
BF154/8	30
BF167	35
BF173	35
BF177	35
BF178	35
BF179	40
BF194/5	12
BF198/9	18
BF200	30
BF224	40
BF244A	28
BF244B	29
BF245	50
BF256B	50
BF257/8	32
BF259	40
BF394	40
BF451	40
BF494/5	40
BF594/5	30
BFR39/40	25
BFR41/79	25
BFR80/81	25
BFR98	105
BFX29/84	35
BFX84	35
BFX85/86	35
BFX87/88	28
BFY50/51	30
BFY52	30
BFY53	35
BFY55	35
BFY56	35
BFY64	40
BFY90	80
BRY39	50
BSX20	30
BSX29	45
BSY26	35
BSY95	35
BU105	180
BU205	190
BU206	200
BU208	200
MJ2955	90
MJE340	54
MJE371	100
MJE2955	99
MJE3055	70
MPF102	40
MPF103/4	30
MPF105	30
MPSA05	30
MPSA06	25
MPSA08	30
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	40
MPSU02	58
MPSU05	60
MPSU06	60
MPSU52	65
MPSU55	60
MPSU56	60
OC23	170
OC28/36	220
OC41/42	75
OC70	40
OC72	50
OC75/76	55
OC76	50
OC81/82	50
OC83/84	70
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	75
TIP34A	85
TIP34C	105
TIP35A	120
TIP35C	130
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121	73
TIP141	120
TIP142	120
TIP147	120
TIP2955	70
TIP3055	70
TIS43	50
TIS44	45
TIS88A	50
TIS90	30
TIS91/93	32
VK1010	99
VN10KM	70
VN46AF	95
VN66AF	110
VN88AF	120
VN89AF	120
ZTX107/8	12
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301/2	16
ZTX303	25
ZTX304	17
ZTX320/26	30
ZTX500/1	14
ZTX502/3	18
ZTX504	25
ZTX531	25
ZTX550	25
2N696	30
2N697	23
2N698	40
2N699	48
2N706A	25
2N708	25
2N914/5	32
2N918	40
2N930	20
2N1131/2	30
2N1303/4/5	
2N1307/8	65
2N1613	30
2N1671B	160
2N2160	325
2N2219A/20A/21A/22A	28
2N2369A	18
2N2646	45
2N2846	80
2N2904A/05A/06A/07A	26
2N2926G	10
2N3053	25
2N3054	55
2N3055	50
2N3442	140
2N3615	199
2N3663	20
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710	10
2N3771	179
2N3772	195
2N3773	210
2N3819	30
2N3820	50
2N3822/3	45
2N3866	90
2N3903/4	15
2N3906/5	15
2N4037	60
2N4058	15
2N4061/2	15
2N4264	30
2N4286	25
2N4289	25
2N4400	25
2N4427	80
2N4859	78
2N5135	30
2N5138	28
2N5172	25
2N5180	45
2N5191	75
2N5194	80
2N5305	24
2N5457	30
2N5458/9	30
2N5485	36
2N5777	45
2N6027	32
2N6109	60
2N6290	70
2SA636	250
2SA671	250
2SA715	75
2SC495/6	85
2SC1061	250
2SC1096	85
2SC1162	45
2SC1172/3	125
2SC1306	100
2SC1307	150
2SC1449	95
2SC1679	190
2SC1678	140
2SC1923	65
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	200
2SC2078	170
2SC2091	85
2SC2166	165
2SC2314	85
2SC2335	200
2SC2465	125
2SC2547	40
2SC2612	200
2SD234	75
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	115
3N140	115
40251	150
40311	60
40313	130
40361/62	70
40408	76
40412	90
40467	130
40468	85
40594	105
40595	110
40603	110
40673	70
40871/2	90

LINEAR IC's

555 CMOS	95
702	75
709C 8 pin	35
710	48
741	16
747C 14 pin	70
748C 8 pin	30
753 8 pin	185
810	159
9400CJ	375
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-8910	400
AY-3-8912	500
AY-5-1317A	630
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	110
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	325
CA3075	213
CA3080E	70
CA3081	190
CA3085	00
CA3086	60
CA3089E	200
CA3090AQ	375
CA3123	165
CA3130	90
CA3140	45
CA3160	95
CA3161E	160
CA3162	620
CA3189	275
CA3240	110
HA1366	175
HA1388	255
ICL7106	690
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038CC	300
ICL8211	350
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	95
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7120	300
LC7130	320
LC7137	350
LF347	150
LF351	48
LF353	90
LF355	95
LF356	99
LF357	110
LF398	495
LM10	350
LM301A	25
LM307	45
LM308	95
LM311	65
LM318	150
LM319	160
LM324	50
LM334Z	90
LM335	135
LM337	00
LM339	40
LM348	60
LM349	125
LM358	60
LM377	215
LM379	495
LM380	90
LM381N	175
LM382	115
LM384	190
LM386	90
LM387	120
LM389	95
LM393	85
LM394CH	395
LM558	170
LM725CN	300
LM733	60
LM1871	300
LM1889	350
LM2907	00
LM2917	200
LM3900	50
LM3909	85
LM3911	150
LM3914	250
LM3915	200
LM3916	250
LS7220	280
M51513L	230
M51515L	320
M51516L	475
M70681	150
MB3712	200
MB3756	440
MC1204	250
MC1301	90
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC1455	50
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC3302	75
MC3340	145
MC3360	145
MC3401	50
MC3403	65
MC3404	85
MC3405	150
MC3442	00
MC3423P	80
MC3487	00
MC4016	00
MF10	350
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	140
NE543	225
NE544	200
NE555	20
NE556DB	45
NE558	170
NE560	350
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567	140
NE570	410
NE571	400
NE5532	175
NE5534	105
OM335	750
RC4136D	60
RC4558	60
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SL924	00
SL6270	150
SN76013N	350
SN76023N	350
SN76033	350
SN76488	480
SP8629	00
SP0256AL	850
TA7120	140
TA7130	125
TA7204	150
TA7205	175
TA7222	150
TA7310	00
TAA900	395
TAA621	296
TAA661	190
TAA700	275
TAD100	159
TBA120S	70
TBA540	275
TBA550Q	330
TBA641	290
TBA651	190
TBA800	80
TBA810S	95
TBA820	80
TBA920Q	200
TBA990	350
TCA270	350
TCA280A	220
TCA940	175
TCA950	00
TCA965	125
TDA1004	350
TDA1008	310
TDA1010	235
TDA1022	499
TDA1024	115
TDA1034	350
TDA1054	00
TDA1490	350
TDA2002	325
TDA2003	250
TDA2004	400
TDA2006	330
TDA2020	320
TDA2030	190
TDB0791	420
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	30
TL072CP	54
TL074CN	100
TL081CP	24
TL082CP	45
TL083CP	75
TL084CP	90
TL091CP	55
TL170	50
TL430C	90
TL507	110
TL509	110
UA2240	120
UA78540	230
UAA170	180
UAA180	180
ULN2003	75
ULN2004	75
ULN2283	100
UPC556	00
UPC575	275
UPC1025H	375
UPC1156H	295
UPC1181	00
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	360
ZN414	90
ZN419CE	180
ZN423E	130
ZN424E	130
ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	435
ZN429E-8	210
ZN459	290
ZN1034E	200
ZN1040E	665
ZNA234E	925

COMPUTER IC's

2102L	100
2114L-4	150
2147-3	425
2516	350
2532-4	300
25L32	350
2564	700
27L08	450
2716-5V	350
2732	450
2764-250	850
26501	75
27128/250n	£22
3242	590
4027	95
4164-150	495
4416-2	475
4532-3	250
4816-100ns	300
5101	300
5514	250
6116-150	550
6116L-120ns	650
6117-100n	490
6167-6	795
6264L-15	£32
6402	350
6502 CPU	325
6502A	490
6503	650
6504	600
6505	650
6520	175
6522 VIA	325
6530 RRIOT	£11
6532 RIOT	650
6545 CRTC	899
6551 ACIA	650
6592	00
6800	220
6802	275
6803	850
6805	670
6808	520
6809	950
6810	125
68B21	220
6821	175
6840	375
6843	00
6845	750
6846	625
6847	650
6850	175
6852	250
6854	650
68B54	780
6875	500
68000	£50
8035	600
8080A	250
8085A	425
8088	£18
81LS95/96	140
81LS97/98	140
8123	125
8131	275
8154	£9
8155	495
8156	350
8202	£25
8212	150
8214	425
8216	130
8224	220
8226	250
8228	220
8236	00
8243	270
8250	950
8251A	440
8253	400
8255	275
8256A	£35
8257A	400
8259	395
8271	£60
8272	£17
8279	385
8282	450
8283	450
8284	350
8288	00
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33	150
AY-3-1015	300
AY-5-1013	300
AY-5-1350	388
AY-5-2376	600
AY-5-3600	750
COM8017	275
COM8116	700
DM8131	275
DP8303	00
DP8304BN	250
DS3647	00
DS3691N	00
DS8820	110
DS8830	110
DS8831	125
DS8832	250
DS88LS120	00
E9364	800
E9365	£35
FD1691	£15
FD1771	£16
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
HD26501	75
HM6845	755
IM6402	350
INS8060N	1050
MC1488	55
MC1489	55
MC14411	675
MC14412	725
MC3242	590
MC3446	250
MC3447P	315
MC3486	175
MC3487	175
MK3886-2M	£7
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	700
RO-3-2513L	550
RO-3-2513U	650
SFF96364E	800
SP0256AL2	850
TMS2716-3	725
TMS4047	100
TMS4164-15	395
TMS4416-2	475
TMS4500	£14
TMS4532-3	350
TMS5100	600
TMS6011	500
TMS9927	£14
TMS9928	£20
TMS9929	£16
TMS9980	£20
TMS9995	£12
ULN2003	75
UPD7002	425
WD1691	£14
Z80CPU 2·5	299
Z80ACPU4M	375
Z80ACTC	335
Z80B	875
Z80DART	495
Z80ADART	820
Z80ADMA	925
Z80DMA	795
Z80P10	295
Z80AP10	325
Z80S10-1	850
Z80AS10	900
Z80AS10-2	£9
Z8002CPU	00

74S

74S00	30
74S02	30
74S03	35
74S04	40
74S05	60
74S08	60
74S09	00
74S10	40
74S11	50
74S15	00
74S20	40
74S22	50
74S30	40
74S32	70
74S37	60
74S38	00
74S40	00
74S51	00
74S64	00
74S65	00
74S74	75
74S85	295
74S86	70
74S112	90
74S113	90
74S114	80
74S124	300
74S132	110
74S133	60
74S134	00
74S135	00
74S138	100
74S139	115
74S140	60
74S151	180
74S153	182
74S157	250
74S158	195
74S162	00
74S163	300
74S168	00
74S169	00
74S174	250
74S175	320
74S181	00
74S182	00
74S188	140
74S189	140
74S194	295
74S195	275
74S196	00
74S197	400
74S201	350
74S225	500
74S226	00
74S240	300
74S241	300
74S244	290
74S251	225
745257	225
745258	250
74S260	70
74S262	850
74S274	00
74S275	00
74S280	00
74S281	00
74S283	00
74S287	225
74S288	210
74S289	200
74S299	540
74S301	350
74S365	250
74S373	400
74S374	365
74S412	380
74S470	325
74S471	620
74S472	1150
74S473	00
74S474	400
74S475	800
74S571	620
74S573	950

75

75107/8/9	95
75110	90
75114	00
75121	00
75122	00
75150	125
75151	00
75154	195
75158	150
75159	125
75182/3	99
75188/9	55
75322	140
75324	00
75325	00
75353	00
75361	00
75365	00
75376	00
75450	86
75451/2	52
75454	70
75491/2	65

TTL 74

7400	20
7401	20
7402	20
7403	22
7404	22
74L04	00
7405	25
7406	125
7407	125
7408	25
7409	25
7410	25
7411	25
7412	25
7413	35
7414	50
7416	35
7417	35
7420	22
7421	22
7422	30
7423	30
7425	30
7426	45
7427	30
7428	30
7430	25
7432	25
7433	25
7437	30
7438	95
7440	25
7441	65
7442	55
7443	70
7444	65
7445	80
7446	78
7447	70
7448	75
7450	25
7451	25
7453	25
7454	25
7460	25
7470	35
7472	35
7473	35
7474	35
7475	60
7476	40
7480	55
7481	120
7482	100
7483	65
7484	90
7485	110
7486	40
7489	175
7490	40
7491	55
7492	45
7493	40
7494	80
7495	50
7496	60
7497	120
74100	100
74104	55
74105	55
74107	40
74109	50
74110	50
74111	60
74112	170
74116	100
74118	100
74119	105
74120	90
74121	40
74122	50
74123	80
74125	50
74126	50
74128	60
74132	60
74136	40
74141	75
74142	195
74143	200
74144	200
74145	80
74147	105
74148	105
74150	125
74151	50
74153	50
74154	100
74155	50
74156	50
74157	50
74159	130
74160	50
74161	50
74162	55
74163	65
74164	65
74165	65
74166	80
74167	200
74170	175
74172	280
74173	60
74174	100
74175	70
74176	50
74177	50
74178	80
74179	80
74180	50
74181	140
74182	55
74184	110
74185	110
74186	70
74188	75
74190	70
74191	75
74192	75
74193	60
74194	50
74195	50
74196	60
74197	50
74198	110
74199	110
74221	90
74246	120
74247	120
74248	175
74249	120
74251	55
74259	150
74265	50
74273	170
74276	120
74278	120
74279	45
74283	65
74284	220
74285	180
74290	120
74293	75
74297	900
74298	100
74351	120
74365	60
74366	60
74367	60
74368	50
74376	90
74390	80
74393	120
74490	110

74C

C244	195
C245	195
C373	240
C374	245
C922	570
C923	500
C925	698

74LS

LS00	30
LS01	18
LS02	18
LS03	18
LS04	30
LS05	18
LS08	18
LS09	18
LS10	20
LS11	18
LS12	20
LS13	30
LS14	45
LS15	20
LS19	00
LS20	25
LS21	20
LS22	18
LS24	50
LS26	25
LS27	30
LS28	20
LS30	25
LS32	50
LS33	20
LS37	20
LS38	60
LS40	25
LS42	40
LS47	50
LS48	50
LS49	60
LS51	20
LS52	20
LS54	20
LS55	20
LS63	55
LS73	50
LS74	60
LS75	40
LS76	30
LS78	40
LS83	45
LS85	70
LS86	34
LS90	30
LS91	60
LS92	35
LS93	35
LS95	40
LS96	80
LS107	40
LS109	40
LS112	40
LS113	35
LS114	35
LS122	60
LS123	120
LS124	150
LS125	45
LS126	45
LS132	40
LS133	32
LS135	28
LS136	30
LS138	60
LS139	60
LS145	80
LS147	120
LS148	100
LS151	50
LS153	50
LS154	150
LS155	35
LS156	35
LS157	35
LS158	35
LS160	50
LS161	50
LS162	50
LS163	85
LS164	55
LS165	65
LS166	120
LS168	140
LS169	90
LS170	100
LS173	100
LS174	50
LS175	90
LS181	110
LS183	110
LS190	55
LS191	50
LS192	55
LS193	55
LS194	45
LS195	45
LS196	55
LS197	55
LS221	90
LS240	120
LS241	100
LS242	75
LS243	75
LS244	250
LS245	250
LS247	65
LS248	65
LS249	65
LS251	40
LS253	40
LS256	175
LS257	40
LS258	40
LS259	120
LS260	30
LS261	150
LS266	30
LS273	120
LS275	165
LS279	45
LS280	175
LS283	45
LS290	45
LS292	900
LS293	45
LS294	999
LS295	70
LS298	70
LS299	160
LS320	180
LS323	185
LS324	150
LS325	150
LS326	290
LS327	290
LS347	65
LS348	125
LS352	65
LS353	65
LS356	180
LS363	175
LS365	45
LS366	45
LS367	45
LS368	45
LS373	100
LS374	100
LS375	50
LS377	95
LS378	85
LS379	106
LS384	475
LS385	180
LS386	50
LS390	60
LS393	100
LS395	85
LS396	300
LS398	120
LS399	100
LS445	125
LS447	50
LS465	140
LS467	120
LS490	110
LS540	100
LS541	120
LS624	150
LS629	150
LS640	200
LS641	200
LS645	200
LS668	60
LS669	60
LS670	120
LS673	950
LS674	800
LS682	250

CMOS

4000	20
4001	20
4002	22
4006	65
4007	22
4008	48
4009	33
4010	33
4011	22
4012	25
4013	48
4014	46
4015	55
4016	40
4017	60
4018	60
4019	58
4020	90
4021	58
4022	67
4023	30
4024	45
4025	22
4026	90
4027	48
4028	45
4029	60
4030	35
4031	130
4032	70
4033	130
4034	140
4035	70
4036	275
4037	115
4038	110
4039	280
4040	42
4041	67
4042	50
4043	42
4044	60
4045	110
4046	60
4047	60
4048	55
4049	38
4050	35
4051	45
4052	60
4053	60
4054	85
4055	85
4056	85
4057	£10
4059	435
4060	58
4061	£5
4062	995
4063	85
4066	45
4067	245
4068	22
4069	22
4070	22
4071	22
4072	22
4073	26
4075	22
4076	68
4077	22
4078	20
4081	22
4082	22
4085	60
4086	60
4089	125
4093	37
4094	70
4095	95
4096	100
4097	275
4098	80
4099	75
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	850
4409	850
4410	725
4411	750
4412	805
4415	590
4419	280
4422	770
4433	770
4435	850
4440	999
4450	350
4490	450
4500	395
4501	38
4502	60
4503	40
4504	99
4505	385
4506	100
4507	32
4508	130
4510	46
4511	46
4512	45
4513	199
4514	115
4515	125
4516	65
4517	275
4518	53
4519	32
4520	53
4521	115
4522	125
4526	60
4527	65
4528	50
4529	150
4530	90
4531	130
4532	65
4534	400
4536	275
4538	80
4539	90
4541	95
4543	70
4544	150
4549	400
4553	245
4554	180
4555	35
4556	55
4557	250
4558	120
4559	395
4560	160
4561	104
4562	350
4566	165
4568	250
4569	175
4572	45
4580	255
4581	125
4582	99
4583	100
4584	48
4585	70
4599	155
40097	45
40098	42
40100	215
40101	130
40102	140
40103	412
40104	120
40105	220
40106	38
40107	38
40108	198
40109	100
40110	175
40114	240
40161	194
40163	50
40174	45
40175	50
40181	220
40192	75
40193	95
40194	90
40195	80
40244	195
40245	195
40257	198
40373	240
40374	245

JUST PHONE YOUR ORDER THROUGH, WE DO THE REST.
0923 50234

SPEAKERS

8Ω, 0 3W, 2"; 2·25", 2 5", 3" **80p**

0 3W, 2·5" 40Ω; 64Ω or 80Ω **80p**

DIODES	
AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	14
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

SCR's Thyristors	
0 8A-100V	32
5A/300V	38
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
2N5064	38
2N4444	130

DIAC
ST2 **25**

BRIDGE RECTIFIERS (plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**

Range: 3V3 to 33V 1 3W **15p each**

VARICAPS	
MVAM2	165
BA102	30
BB105B	40
BB106	40

TRIACS	
3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	125

SOLDERCON PINS	
100	75p
500	370p

OPTO

LEDS price includes Clips

TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 ·2" Red	12
0·2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	45
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0·2" Flashing LED Red	56
0·2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0·2" Tri colour LEDs Red/Green/Yellow	85
0·2" Red High Bright	59
High Bright Green or Yellow	65
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	55
TIL38	50
TIL81 **82**; TIL100	90

7 Segment Displays	
TIL321 ·5" C.An	140
TIL322 ·5" C.th	140
DL704 ·3" C.Cth	125
DL707 ·3" C.Anod	125
FND357 or 500	130
·3" Green C.A.	140
±1 ·3" Red or Green	150
Bargraph 10 seg. Red	275
Bargraph NSM3914	500

FERRIC CHLORIDE

Crystals 1lb

195p + 50p p&p

DALO ETCH RESIST

Pen plus spare tip **100p**

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9·5"×8·5"
6"×6"	100p	125p	110p
6"×12"	175p	225p	

VEROBOARDS 0·1"

	Clad	Plain
2½×3¾"	95	—
2½×5"	110	—
3¾×3¾"	110	—
3¾×5"	125	95p
3¾×17"	420	275p
4¾×18"	590	—
Pkt. of 100 pins		55p
Spot Face Cutter		150p
Pin Insertion Tool		185p

'VQ' Board	180
'DIP' Board	395
Vero Strip	144

PROTO-DECs	
Veroblock	480
S-Dec	395
Eurobreadboard	590
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool **350p**
Spare Wire (Spool) **75p**; Combs **6p** ea.
Wire Wrapping Stakes 100 **250p**

0·5" LCD DISPLAYS	
3½ digit	495
4 digit	530
6 digit	625
BPX25	250
BPW21	320
BPX65	320
IL74	65
ILD74	115
ILQ74	220
ILCT6 Darlington Isolator	135
TIL111	70
OCP71	120
ORP12	78
2N5777	50
4N33	135
Pin diode	720
Schmitt Receiver	715

OPTO SWITCH

Reflective TIL139	225
Slotted similar to RS	186

ALUM.BOXES	
4×2½×2"	100
4×2¾×2½"	103
4×4×2½"	120
5×4×2"	105
5×2¾×1½"	90
5×2¾×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

VOLTAGE REGULATORS

1A	T0220 Plastic Casing			
	+ve		−ve	
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		
100mA	T092 Plastic Casing			
5V	78L05	30p	79L05	50p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	50p

ICL7660	248	LM317K	250
78H05 5V/5A	550	LM317P	99
78H12 12V/5A	640	LM323K	500
78HG +5 to +24V 5A	599	LM337T	175
		LM723	30
79HG −2.25V to −24V 5A	685	TBA625B	75
		RC4194	375
LM309K	120	RC4195	160

SWITCHES

SLIDE 250V	
1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40

TOGGLE 2A 250V	
SPST	35
DPDT	48
4 pole on off	54

PUSH BUTTON
Spring loaded
Latching or Momentary 6A

SPDT c/over	150
DPDT c/over	200

MINIATURE
Non Locking

Push to make	15p
Push break	25p

SUB-MIN TOGGLE 2 amp

SP changeover	64
SPST on off	58
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	80
DPDT C/OFF	88
DPDT on/on/on	185
DPDT Biased	145
4-pole 2 way	220

ROTARY: (Adjustable Stop Type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **46p**

ROTARY: Mains 250V AC, 4 Amp **64p**

DIP SWITCHES: (SPST) 4 way **65p**; 6 way **80p**; 8 way **87p**; 10 way **100p**; (SPDT) 4 way **190p.**

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	475p	470p
36 way Centronix	450p	475p
24 way Female	525p	490p

ASTEC UHF MODULATORS

6MHz Standard	325p
8MHz Wideband	450p

DIL SOCKETS	Low profile	Wire wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

ZIF DIL SOCKET	
24 way	565p
28 way	750p
40 way	799p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
28	185p	290p
40	195p	218p

RIBBON CABLE (price per foot)

Ways	Grey	Colour
10	15p	28p
16	25p	40p
20	30p	50p
26	40p	65p
34	60p	85p
40	70p	90p
64	100p	135p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	80p	75p	75p	90p

IDC 25 way Plg. 385p, Skt 450p

SIL Sockets 0.1"
20 way **65p**
32 way **95p**

EDGE CONNECTORS

	1"
2×18 way	210p
2×22 way	215p
2×23 way	175p
2×25 way	285p
2×28 way	190p
2×30 way	310p
2×36 way	330p
2×40 way	380p
2×43 way	450p
2×75 way	650p

BEEBFONT ROM

This is a character FONT ROM that gives you 5 16×16 predefined FONT. The ROM is ideal for high quality demonstration on screen and when used in conjunction with EPSON printer, allows printing of letters etc. in mixed type faces. The package is complete, including an Editor to design your own Fonts and several spare Fonts which could not be fitted in the ROM can still be run from RAM. Supplied complete with ROM, software on DISC/tape and Manual. **Price £45**

IDC CONNECTORS (Speed block type)

2 rows	PCB Male with latch Strt Pins	Angle Pins	Female Header Socket	Female Card-Edge Connector
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	195p
20 way	145p	166p	125p	240p
26 way	175p	200p	150p	320p
34 way	205p	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS Gold flashed contacts	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2×32 way	275p	320p	220p	285p
DIN 41612 2·3×32 way	295p	340p	240p	300p
DIN 41612 3×32 way	360p	385p	260p	395p

TRANSFORMERS (mains Prim. 220-240V)
3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA **98p**
6VA: 2x6V·5A; 2x9V–4A; 2x12V·0 3A; 2x15V·25A **250p**
12VA: 2x4V5-1·3A; 2x6V-1·2A; 2x12V–5A; 2x15V·4A **345p** (35p p&p)
24VA: 6V-1 5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15·8A 15·8A; 20V–6A 20V–6A **385p** (60p p&p)
50VA: 2×6V-4A; 2×9V-2 5A; 2×12V-2A; 2×15V-1 5A; 2×20V-1·2A; 2×25V-2A; 2×30V-0 8A **520p** (60p p&p)
100VA: 2×12V-4A; 2×15V-3A; 2×20V-2 5A; 2×30V-1·5A; 2×40V-1·25A; 2×50V-1A **965p** (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	325p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

IDC FEMALE RECEPTACLE Jumper Leads 36"

	20pin	26pin	34pin	40pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

COMPUTER CORNER

- **SEIKOSHA GP100A** – Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. **FREE 500 Sheets** **£155**
- **SEIKOSHA GP 250X** Printer **£199**
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  Connecting lead for KAGA monitors **£5**
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- **C12 COMPUTER Grade BASF Cassettes** in Library Cases **40p**
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MANY MORE PRINTERS, MONITORS, INTERFACES, AVAILABLE. CALL IN AT OUR SHOP FOR DEMONSTRATION OR WRITE IN FOR OUR DESCRIPTIVE LEAFLET.

(P&P on some of the above items is extra)
Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

BROTHER HR-15 'DAISEY-WHEEL PRINTER/

An exceptionally high quality Daisy Wheel printer at the price of a Dot matrix printer. 18CPS; Bi-directional, has 3K of Buffer; has clear buffer facility, Carriage skip movement. Proportional spacing; underlining; Bold print and Shadow print. Prints in two colours; Super and subscript facility. Impact control facility to vary pressure on paper for making carbon copies. Has Centronics parallel or RS-232 interface. Connects directly to BBC Micro. A ribbon cassette plus a separate red ribbon. Optional extras: Single Sheet Feeder takes up to 150 A4 sheets; & Keyboard that transforms HR15 into a sophisticated electronics typewriter. Attractively finished in Beige. Special Introductory Offer:
Only £375 (Carr. £7)

NEW LAUNCH

Z80A 2nd PROCESSOR BOARD for BBC

With CP/M and Double Density Disc Interface for BBC MICRO

Yes it's here. Z80A 4 MHz 2nd processor Board with 64K memory, 4K Monitor EPROM, Parallel printer interface, CP/M handling, double density board will handle, 3½", 5¼" & 8" Floppy Disk Drives and many more facilities. All neatly housed in a twin slimline disc drive case.
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C15W	510	Spare bits	85
G517W	510	Elements	230
G18W	525	Iron stand	175
XS25W	530	Heat Shunt	30

CRYSTALS	
32·768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1 008M	275
1·28MHz	392
1·5MHz	420
1 6MHz	395
1 8MHz	395
1 8432M	200
2 0MHz	225
2 4576M	200
2·5MHz	225
2·56250M	220
3·2768M	150
3·57954M	98
3 6864M	300
4 0MHz	150
4 032MHz	290
4·194304M	200
4 433619M	100
4 608MHz	200
4 80MHz	200
5 0MHz	160
5·185MHz	300
5 24288M	390
6·0MHz	140
6·144MHz	150
6·5536MHz	200
7 0MHz	150
7 168MHz	250
7 68MHz	200
8 0MHz	150
8 08333M	395
8 867237M	175
9·00MHz	200
9 375MHz	350
10·0MHz	175
10·5MHz	250
10·7MHz	150
10·24MHz	200
12 0MHz	175
12·528MHz	300
14·31818M	170
14 7456M	175
14 765MHz	250
15 0MHz	200
16 0MHz	200
18 0MHz	180
18·432M	150
19 968MHz	150
20 0MHz	200
24 0MHz	170
24 930MHz	325
29 695MHz	150
26 670MHz	325
27·125MHz	295
27·145M	190
27 648MHz	300
38 66667M	175
48 0MHz	175
55·5MHz	400
100MHz	295
116 0MHz	300
145 8MHz	225

BBC MICROCOMPUTER

Model A **£299**; Model B **£399** (incl. VAT). We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, Printer Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM, The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEBCALC, Software (Educational Application & Games), BOOKS, etc. etc. Please send SAE for our descriptive leaflet.

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T.V. SOUND TUNER

SERIES II BUILT AND TESTED Complete with case. **£26.50** + £2.00 p&p.

Also available with built-in headphone amp. ONLY **£32.50 + £2.00 p&p.**

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. The unit is mains-operated.

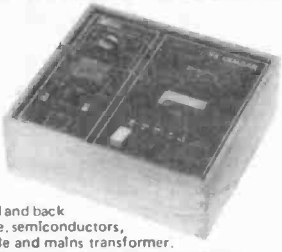
This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 10½"x7½"x2½".

E.T.I. kit version of above without chassis, case and hardware. £16.20 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

COMPLETE WITH CASE

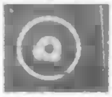
ONLY **£34.50** plus £2.75 p&p.



• NOISE REDUCTION SYSTEM. • AUTO STOP. • TAPE COUNTER. • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS. • TWIN V.U. METER. • WOW & FLUTTER 0.1%. • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING. • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TYPES.

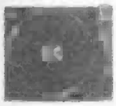
Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire. Featured in April P.E. reprint 50p. Free with kit.

BSR RECORD DECKS



Auto-Changer model - takes up to 6 records with manual override. Supplied with stereo ceramic cartridge.

£12.95 plus £1.75 p&p.



3 speed, auto, set-down; with auto return. Fitted with viscous damped cue, tubular aluminium counter-weighted arm, fitted with ADC magnetic head. Ideally suited for home or disco use.

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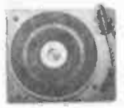


Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco. 13"x11" approx.

£14.95 plus £1.75 p&p.

SPECIAL OFFER! Replacement st. cassette tape heads. £1.80 ea. Add 50p p&p to order. Philips st. mag. cartridge. £3.95 + 60p p&p.

PLINTH to suit BSR Record Player Deck (with cover). Size 16½"x 14¾"x 2¾". Cover size: £14½"x 13½"x 3½". Due to fragile nature, Buyer collect only. Price: £8.95.

STEREO TUNER KIT

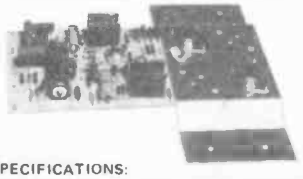
SPECIAL OFFER!

£13.95

+ £2.50 p&p.

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with P.E. (July '81). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System. Front scale size 10½"x2½" approx. Complete with diagram and instructions.

125W HIGH POWER AMP MODULES



The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

Accessories: Stereo mains power supply kit with trans. £10.50 + £2p&p. Mono: £7.50 + £2p&p.

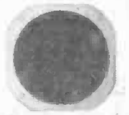
SPECIFICATIONS:
Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4 - 16 ohm. Frequency response measured @ 100 watts: 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%. Dimensions: 205x90 and 190x36mm.

KIT **£12.00** +£1.15 p&p.

BUILT **£17.50** +£1.15 p&p.

HI-FI SPEAKER BARGAINS

AUDAX 8" SPEAKER £5.95 + £2.20 p&p.



High quality 40 watts RMS bass/mid. Ideal for either HIFI or Disco use this speaker features an aluminium voice coil and a heavy 70mm dia. magnet. Freq. Res.: 20Hz to 7kHz. Imp.: 8 ohms.

AUDAX 40W FERRO-FLUID HI-FI TWEETER Freq. res.: 5KHz - 22KHz. Imp.: 8 ohms. 60mm sq. **£5.50** + 60p p&p.

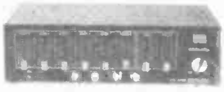
GOODMANS TWEETERS 8 ohm soft dome radiator tweeter (3¾"sq) for use in systems up to 40W. £3.95 ea + £1 p&p. £6.95 pr + £1.50.

MONO MIXER AMP

Ideal for halls and clubs.

£45.00

+ £2 p&p.



50 Watt, six individually mixed inputs for 2 pickups (Cer. or mag), 2 moving coil microphones and 2 auxillary for tape tuner, organs etc. Eight slider controls – 6 for level and 2 for master bass and treble, 4 extra treble controls for mic. and aux. inputs. Size: 13¼"x6½"x 3¾" app. Power output 50 W RMS (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

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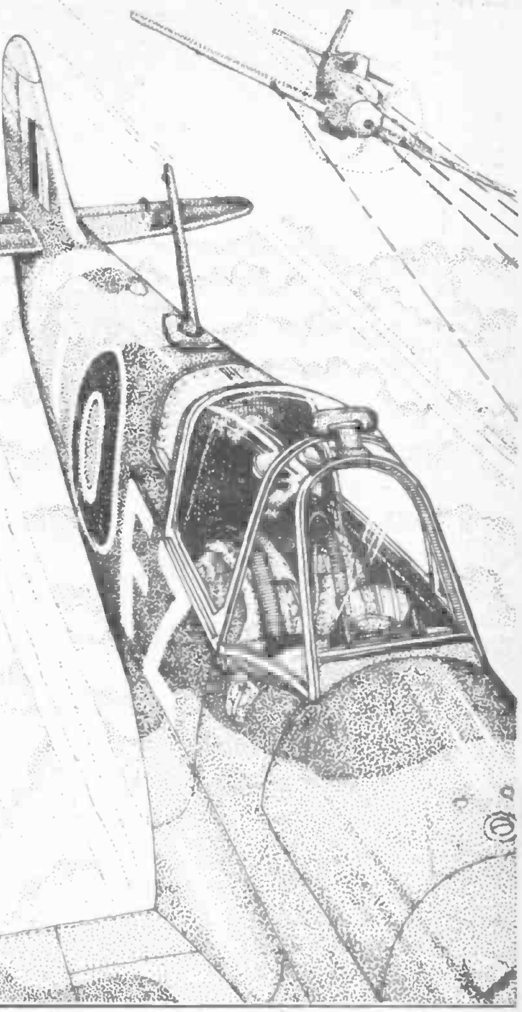
WOULD YOU HAVE MADE A FIGHTER PILOT? NOW YOU CAN FIND OUT WITH THE **NEW**

REACTION TESTER

A **FREE** PROJECT FROM GSC



Split second timing is essential for this, the latest and fastest game from GSC. Find out how long you could have stayed "upstairs" before you "bought it". Press start switch, after a random time period, a moving light appears. The quicker you press the button, the longer you "stay alive". You can't fool this game though — a "cheat" light will tell everyone that you guessed when the lights would come on.

Speed and concentration are the names of this game — build our kit and "beat the bullet".

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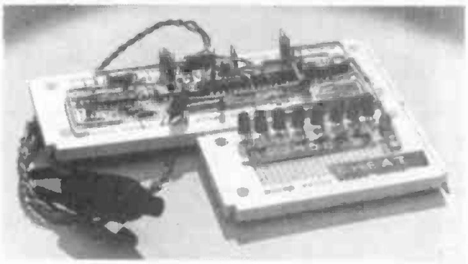
Our **FREE** project sheet gives you a large, clear diagram of the components layed out on an **EXP 300** breadboard. Each component is labelled, and the values are given in a component listing. Even the 'row and column' lettering of our **EXP 300** is shown to make the location of the correct holes, in which to push the components, easy to find. There's no soldering involved; it couldn't **be easier!** As an extra bonus, there's a full circuit description, and the details of a regulated power supply on the other side of the sheet.

"Clip the coupon" and get your FREE project sheet with each EXP 300 bought. AND a free catalogue! Just ask about our other free projects too.



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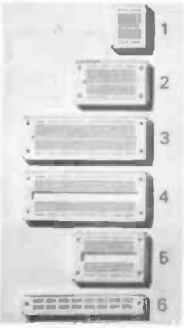
The largest range of breadboards from GSC. Each hole is identified by a letter/number system. EACH NICKEL SILVER CONTACT CARRIES A LIFE TIME GUARANTEE. Any Experimentor breadboard can be 'snap-locked' with others to build a breadboard of any size.



1. **EXP 325 £2.00** The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars.
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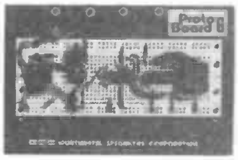

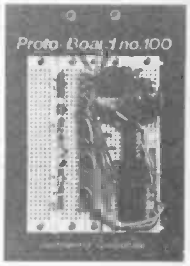

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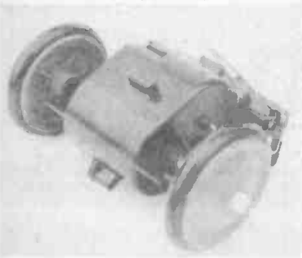

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Z901 Can you follow the flashing light/pulsating tone sequence of this famous game? Supplied as a fully working PCB with speaker (no case) plus full instructions. **Only £4.95**

Z902 Probably the most popular electronic game on the market – based on the old fashioned pencil and paper battleship game, this computerized version has brought it bang up to date! We supply a ready built PCB containing 76477 sound effect chip, TMS1000 micro-processor chip, R's, C's etc. Offered for its component value only (board may be cracked or chipped, it's only **£1.95**. Instructions and circuit, **30p**.

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Send for our latest wholesale list – IC's from **5p**, R's **£2/1000**, transistors **2½p**, C's **0.8p** etc. Bargains galore!!

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K522 Copper clad board. All pieces too small for our etching kits. Mostly double sided fibreglass. 250g (approx 110 sq ins) for **100p**

STORE CLEARANCE!!

We've bought so much surplus recently our stores are bulging at the seams! In order to clear some space, we're once again offering "Bargain Parcels" which have proved very popular in the past. They contain resistors, capacitors, switches, panels with transistors and IC's, screws and various hardware + all the odd bits and pieces which have accumulated over the years. Each parcel weighs 10lbs and costs just **£8.00**.

TTL PANELS

Panels with assorted TTL inc. LS types. Big variety. 20 chips **£1.00**; 100 chips **£4.00**; 1000 chips **£30.00**.

RIBBON CABLE

Special purchase of multicoloured 14 way ribbon cable – 40p/metre; 50m **£18.00**; 100m **£32.00**; 250m **£65.00**.

NICAD CHARGERS

Versatile unit for charging AA, C, D and PP3 batteries. Charge/test switch, LED indicators at each of the 5-charging points. Mains powered. 210 × 100 × 55 mm **£7.95**.

Model A124. Unit plugs directly into 13A socket, and will charge up to 4 AA cells at a time. Only **£4.80**.

NI-CAD BATTERIES

AA size 99p each; C size 199p; D size 220p; PP3 size 395p. SPECIAL!! 6 × D size. For only **£11.00**.

PRECISION PCB DRILL

Small size, 35mm dia × 165mm long. 12V operation. Supplied with collett + 1mm bit 6000RPM. Only **£7.50**.

5000 COMPONENTS £25!!

Amazing variety of passive components – carbon, film oxide, wirewound resistors from ¼W to 10W, ceramic, polystyrene, polyester and electrolytic capacitors in an extremely wide range of values and types from a few pF to 1000uF!! All parts are brand new, full spec devices. The best value components parcel offer around!! Cost of parts if bought individually would be well over £200!!

CLOCK CASES

We must clear these to make more room in our store!! This attractive white plastic case with rear panel drilled for switches etc is oval in shape, 130×68×87mm. (no front panel). 4 (yes, four!!) for **£1.00!!**

STABILIZED PSU PANEL

A199 A versatile stabilized power supply with both voltage (2-30V) and current (20mA-2A) fully variable. Many uses inc. bench PSU, Ni-cad charger, gen purposes testing Panel ready built, tested and calibrated. **£7.75**. Suitable transformer and pots, **£6.00**. Full data supplied.

PUSH BUTTON BANKS

W4700 An assortment of latching and independent switches on banks from 2 to 7 way, DPCO to 6DPCO. A total of at least 40 switches for **£2.95**; 100 **£6.50**; 250 **£14.00**; 100 **£45.00**.

SEAT BELT ALARM

Originally for sale at £8.95, these well made units 70 × 50 × 25mm provide both audible and visual alarms. Uses 2 IC's, PB2720 transducer, etc. Available ready built, with circuit and instructions for just **£3.95**. Also available as a kit, PCB + all components, box, wire, etc, together with instructions. Only **£2.95**.

VEROBLOC £1 OFF!!

Our biggest selling breadboard on offer at a special price of £4.10.

FERRIC CHLORIDE

New supplies just arrived — 250g bags of granules, easily disolved in 500ml of water. Only **£1.15**, 10 for **£8**, 100 for **£60**. Also abrasive polishing block **95p**.

1N5400 3A 50V RECTS

Bulk purchase enables us to offer these at special low prices: 25 £1.50; 100 £4.50; 250 £12; 1000 £43; 5000 **£200**.

5mm RED LED SCOOP!!

Full spec brand new devices at a low, low price!! 25 £1.95; 100 £6.

GREENWELD

Our shop has enormous stocks of components and is open from 9-5.30 Mon-Sat. Come & see us!!

443C Millbrook Road
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Tel (0703) 772501
ALL PRICES INCLUDE VAT; JUST ADD 60p P&P

ELECTROVALUE

Your

for **CAPACITORS** of all preferred types

POLYESTER LAYER (Siemens) **B.32509** 5mm PCM 10% tolerance 63V. In 13 values from 0.0047 to 0.47μF
B.32510 7.5mm PCM 10% tolerance 100V min. In 9 values from 0.001 to 0.47μF
B.32512 15mm PCM 10% tolerance 100V 1μF. 2.2μF
B.32560 7.5mm PCM 6 Values 10% tolerance 400V 0.001 to 0.0068μF
5% tolerance from 0.0082 to 0.68μF in 400, 250 or 100V 26 values

CERAMIC PLATE
C.333 100Vdc 1.8-4700pF
B.37448 63Vdc 2.5mm PCM 0.068 and 0.1pF
B.37449 63Vdc 5mm PCM 0.68 and 0.1μF

CERAMIC DISC
1nF-10nF, 300Vac

ELECTROLYTIC
Axial in many from 1 to 10000μF, 10 to 100Vdc
Can in several values from 100 to 22,000μF, 16 to 350V
Reversible from 2 to 100μF
Low Leak, Almnm. 0.1-100μF, 17 values, 6-50Vdc
Radial 15 values up to 63Vdc

TANTALUM BEADS
In 18 values from 0.1-100μF, 3 to 35V

POLYSTYRENE (Siemens)
39 values 5pF to 18nF, 160Vdc.

The above ranges should meet the marjority of current requirements. Mention P.E. when sending for our latest A-Z list showing very many more types.

BRITAINS LEADING QUALITY COMPONENT SUPPLIERS - SEND FOR FREE 36 PAGE A-Z LIST
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EV Computing Shop, 700 Burnage Lane, Manchester (061-431 4866).

ACCESS AND BARCLAYCARD Phoned Orders Welcome

3

ORIC AND SINCLAIR COMPUTERS

Oric 1 computer 48K **£143 (£141) £151**. Oric Colour Printer **£134 (£123) £140**. New Sinclair QL Computer **£495 (£455) £475**. Sinclair Spectrum 48K **£131 (£131) £143**. Spectrum 16K **£101 (£105) £117**. Microdrive **£70 (£65) £75**. RS232 interface **£70 (£65) £75**. Blank microdrive cartridges **£8 (£8) £9**. 32K memory upgrade kit for 16K Spectrum (Issue 2 and 3 only) **£31 (£28) £30**. Fuller Master Unit for the spectrum including speech unit, sound synthesizer, amplifier and joystick port **£56 (£56) £62**. Fuller full sized FDS keyboard for the spectrum with proper space bar **£52 (£52) £62**. Spectrum printer interfaces with cables:- Centronics **£57 (£53) £58**, RS232 **£35 (£33) £38**. ZX printer **£41 (£40) £50**. 5 printer rolls **£13 (£16) £21**. ZX81 computer **£45 (£44) £54**. ZX81 16K ram packs **£28 (£25) £30**.

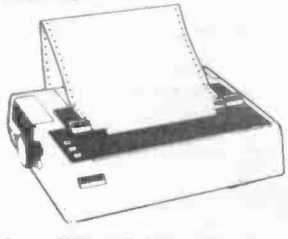
COMMODORE COMPUTERS

Commodore 64 **£204 (£184) £204**. Vic 20 **£104 (£97) £117**. Convertor to allow most ordinary mono cassette recorders to be used with the Vic 20 and Commodore 64: **£10.95 (£11) £13**. Bargain package:- cassette convertor + compatible cassette recorder **£37 (£38) £44**. Commodore cassette recorder **£43 (£44) £50**. Centronics printer interfaces:- for Vic 20 and Commodore 64 **£45 (£44) £50**. 1541 Disc drive **£233 (£209) £234**. 1525 Printer **£235 (£220) £245**. 1526 Printer **£350 (£330) £360**.

ACORN COMPUTERS

Electron **£203 (£209) £229**. BBC Model B **£404 (£378) £408**. 14" Colour monitor **£228 (£299) £319**. Kenda double density disk interface system for beeb **£139 (£125) £135**. We stock the whole range of Cumana disc drives for the beeb e.g. 100K single **£230 (£220) £240**, Double 2 × 400K **£625 (£560) £580**.

PRINTERS



Epson RX80 **£306 (£271) £302**. Epson RX80F/T **£346 (£316) £346**. Shinwa CTI CP80 **£225 (£218) £248**. Epson FX80 **£440 (£408) £438**. Epson MX100/3 **£494 (£465) £495**. Oki Microline 80 **£213 (£197) £238**. Oki Microline 84 **£831**. The Ultra 21 combined daisy wheel and electric typewriter **£438 (£415) £445**. The brother EP22 combined matrix printer and electric typewriter **£173 (£166) £186**. Jukl 6100 proportional daisy wheel printer **£423 (£404) £434**. MCP40 colour printer **£134 (£123) £140**. Star STX80 thermal printer **£158 (£143) £163**. Interfaces to run the above printers Vic and the Commodore 64 **£45 (£44) £50**. We can supply interfaces to run the above printers from Sharp computers **£58 (£52) £55**.

SWANLEY ELECTRONICS

The Computer Export Specialists
Dept PE, 32 Goldsel Rd., Swanley, Kent BR8 8EZ, England.
Please allow 7 days for delivery.

Tel: Swanley (0322) 64851. *Nothing extra to pay. All prices are inclusive. UK prices are shown first and include post and VAT. The second price in brackets is for export customers in Europe and includes insured air mail postage. The third price is for export customers outside Europe (including Australia etc) and includes insured airmail postage. Official orders welcome.*

BI-PAK BARGAINS

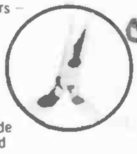
MINIATURE TOOLS FOR HOBBYISTS

Miniature round nose side cutters – insulated handles 4½inch length. Order No: Y043.

Miniature long nose pliers – insulated handles 5½inch length. Order No: Y044.

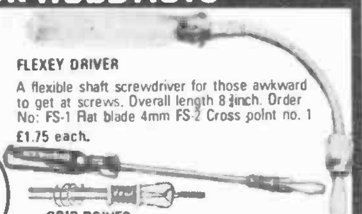
Miniature bend nose pliers – insulated handles 5½inch length. Order No: Y045.

Miniature end nippers – insulated handles 4½inch length. Order No: Y046.



Miniature snipe nose pliers with side cutter and serrated jaws – insulated handles 5inch length. Order No: Y042.

ALL AT £1.25 each



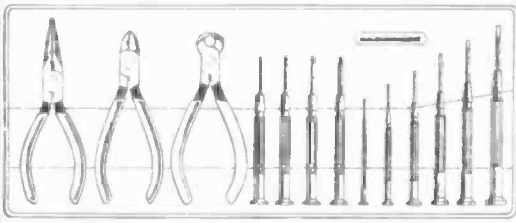
FLEXEY DRIVER

A flexible shaft screwdriver for those awkward to get at screws. Overall length 8¾inch. Order No: FS-1 Flat blade 4mm FS-2 Cross point no. 1 £1.75 each.

GRIP-DRIVER

8inch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places. Order No: SD-1 Flat blade 4mm SD-2 Cross point no.0. £95p each.

13 PIECE TOOL KIT AND CASE



13-piece tool set housed in attractive moulded plastic case with clear sliding cover ● 1 off 5" snipe nose "radio" pliers with side cutters ● 1 off 4½" side cutters ● 1 off 4½" end cutters ● 2 off hex. "Allen" key drivers 2mm and 2.5mm; 2 off cross-point "Phillips" drivers No. 0 and No. 1 (with tommy bar) ● 6 off precision screwdrivers. Sizes from 1mm to 3.5mm ●

ONLY £7.50 ORDER No. VP102

PRECISION JEWELLERS' TOOLS

Rustproof, Tempered Handles and Blades. Chrome Plated Handles. Swivel Heads for use on Precision Work.

5T21 SCREWDRIVER SET

6 precision screwdrivers in hinged plastic case. Sizes – 0.8, 1.4, 2, 2.4, 2.9 and 3.8mm £1.75

5T31 NUT DRIVER SET

5 precision nut drivers in hinged plastic case. With turning rod. Sizes – 3, 3.5, 4, 4.5 and 5mm £1.75

5T41 TOOL SET

5 precision instruments in hinged plastic case. Crosspoint (Philips) screwdrivers – H0 and H1 Hex key wrenches. Sizes – 1.5, 2 and 2.5mm £1.75

5T51 WRENCH SET

5 precision wrenches in hinged plastic case. Sizes – 4, 4.5, 5, 5.5 and 6mm £1.75

MULTITESTER

1,000 opv including test leads & Battery

AC volts - 0-15-150-500-1,000

DC volts - 0-15-150-500-1,000

DC currents - 0 -1ma-150ma

Resistance - 0 -25 K ohms 100 K ohms

Dims - 90 × 61 × 30mm.

O/No. 1322 OUR PRICE £6.50 ONLY

BRAND NEW LCD DISPLAY MULTITESTER

RE 188m

LCD 10 MEGOHM INPUT IMPEDANCE

•3½ digit •16 ranges plus hFE test facility for PNP and NPN transistors •Auto zero, auto polarity •Single-handed, pushbutton operation •Over range indication •12.5mm (½-inch) large LCD readout •Diode check •Fast circuit protection •Test leads, battery and Instructions included.

Max indication	1999 or −1999
Polarity indication	Negative only Positive readings appear without + sign
Input Impedance	10 Megohms
Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	−5°C to 50°C
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155x88x31mm

RANGES

DC Voltage 0-200mV 0-2-20-200-1000V. Acc. 0.8%

AC Voltage 0-200-1000V Acc. 1.2% DC Current 0-200uA 0-2-20-200mA, 0-10A. Acc. 1.2%

Resistance 0-2-20-200K ohms 0-2 Megohms. Acc. 1%

BI-PAK VERY LOWEST PRICE

£45.00 each

Leather Case for 188m £2.50 EACH

SIGNAL INJECTOR

Simple push button operation. Oscillates at 700 – 1k Hz with harmonics to 30MHz. 1.4V p/p output. Impedance 10kΩ. Ideal for trouble shooting with audio equipment. One "AA" penlight battery supplied. O/No VP96 £2.50

LOGIC PROBE

Automatic levelling. White LED indication. Minimum width of measuring pulse 30 millisecs Maximum input frequency 10M Hz.

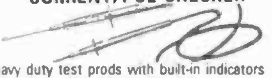
Input impedance: 100kΩ

Power consumption: 40mA maximum

Power supply: 4.5 – 18 V d.c.

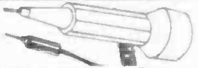
ORDER No. VP97 **£10.50**

CURRENT/POL CHECKER



Heavy duty test prods with built-in indicators for testing polarity: indicates whether a.c. or d.c. 3.5V to 400V. O/No. VP98 £2.50

TESTER

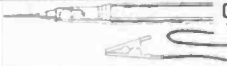


Universal tester with ceramic buzzer. Tests diodes, transistors, resistors, capacitors and continuity. One "AA" penlight battery included.

Test current:	Max 2μA
Test voltage:	1.2V
Response range:	100MΩ
Max voltage:	500V
Internal resistance:	390kΩ
Length:	135mm

£5.00 O/No. VP99

CIRCUIT TESTER



D.C. continuity tester for circuit checking on all low voltage equipment and components. Diode checking also possible. Takes two AA batteries. 90cm lead has crocodile clip. Body length 145mm. O/No. VP100 **75p**

ELECTRONIC SIREN 12v DC

Red plastic case with adjustable fixing bracket. Emits high-pitched wailing note of varying pitch - 100 cycles per minute. Dims - 90mm (dia.) 60mm (depth). Power - 12v DC. O/P 90dBA 1m type.

Our Price: £5.50 O/No. VP79

MINIATURE FM TRANSMITTER

Freq: 95-106MHz. Range: ¼ mile

Size: 45 × 20mm. Add: 9v batt.

Not licenced in U.K.

Ideal for: 007-MI5-FBI-CIA-KGB etc.

O/No. VP128 **ONLY £5.50**

POWER SUPPLY OUR PRICE £4.25

Power supply fits directly into 13 amp socket Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug Input – 240V AC 50HZ, Output – 3, 4, 5, 6, 7-5, 9 & 12V DC Rating – 300 ma VP109.

RATCHET SCREWDRIVER KIT

Comprises 2 standard screwdriver blades 5 & 7mm size. 2 cross point size 4 & 6. 1 Ratchet handle. 5-in-1 Kit. £1.45 each. O/No 329B

VALUE PACKS

Pak No.	Qty	Description	Price
VP1	300	Assorted Resistors Mixed Types	£1
VP2	300	Carbon Resistors ⅛-½ Watt Pre-Formed	£1
VP3	200		£1
VP4	150	¼ Watt Resistors 100 ohm-1M Mixed	£1
VP5	200	Assorted Capacitors All Types	£1
VP6	200	Ceramic Caps Miniature – Mixed	£1
VP7	100	Mixed Ceramics Disc. 1pf – 56pf	£1
VP8	100	Mixed Ceramic Disc. 68pf – .015pf	£1
VP9	100	Assorted Polyester/Polystyrene Caps	£1
VP10	60	C280 Type Caps Metal Foil Mixed	£1
VP11	100	Electrolytics – All Sorts	£1
VP12	60	Bead Type Polystyrene Min Caps	£1
VP13	50	Silver Mica Caps Ass. 5.6pf – 150pf	£1
VP14	50	Silver Mica Caps Ass. 180pf – 4700pf	£1
VP15	50	High Voltage Disc. Ceramic 750v – 8Kv Mixed	£1
VP16	50	Wirewound Res. 9W (avg) Ass. 1 ohm – 12K	£1
VP17	50	Metres PVC Covered Single Strand Wire Mixed Colours	£1
VP18	30	Metres PVC Covered Multi Strand Wire Mixed Colours	£1
VP19	40	Metres PVC Single/Multi Strand Hook-Up Wire Mixed	£1
VP20	6	Rocker Switches 5 Amp 240v	£1
VP21	20	Pcs. 1 – 2 & 4 mm Plugs & Sockets Matching Sizes	£1
VP22	200	Sq. Inches Total Copper Clad Board Mixed Sizes	£1
VP23	20	Assorted Slider Pots. Mixed Values	£1
VP24	10	Slider Pots. 40 mm 22K 5 × Log. 5 × Lin	£1
VP25	10	Slider Pots. 40 mm 47K 5 × Log. 5 × Lin	£1
VP26	20	Small .125" Red LED'S	£1
VP27	20	Large .2" Red LED'S	£1
VP28	10	Rectangular .2" Green LED'S	£1
VP29	30	Ass. Zener Diodes 250mW – 2W Mixed Vlts. Coded	£1
VP30	10	Ass. 10W Zener Diodes Mixed Vlts. Coded	£1
VP31	10	5 Amp SCR's TO-66 50-400v Coded	£1
VP32	20	3 Amp SCR's TO-66 Up To 400v Uncoded	£1
VP33	200	Sil. Diodes Switching Like IN4148 DO-35	£1
VP34	200	Sil. Diodes Gen. Purpose Like OA200/BAX13/16	£1
VP35	50	1 Amp IN4000 Series Sil. Diodes Uncoded All Good	£1
VP36	8	Bridge Rects. 4 × 1 Amp 4 × 2 Amp Mixed Vlts. Coded	£1
VP37	8	Black Instrument Type Knobs With Pointer ¼" Std	£1
VP42	10	Black Heatsinks To Fit TO-3, TO-220 Ready Drilled	£1
VP45	50	BC107/8 Type NPN Transistors Good Gen. Purpose Uncoded	£1
VP46	50	BC177/8 Type PNP Transistors Good Gen. Purpose Uncoded	£1
VP47	10	Silicon Power Trans. Similar 2N3055 Uncoded	£1.50

TRANSISTOR CLEARANCE

All Sorts Transistors. A mixed Bag NPN-PNP Silicon & Germ. Mainly Uncoded You To Sort Pack includes Instructions for Making Simple Transistor Tester. Super Value. Order No. VP60 100 for £1

REGULATED VARIABLE *Stabilised* POWER SUPPLY MODULE + KIT

Variable from 2-30 volts and 0-2 Amps. Kits includes –

1 – VPS30 Module. 1 – 25 volt 2 amp transformer.

1 – 0-50v 2" Panel Meter. 1 – 0-2 amp 2" Panel Meter.

1 – 470 ohm potentiometer. 1 – 4K7 ohm potentiometer. Wiring Diagram.

included Order No. VPS30 KIT £20

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Presented with a Professional Approach and Appeal to ALL who require Quality Electronic Components, Semiconductors and other Accessories ALL at realistic prices. There are no wasted pages of useless information so often included in Catalogues published nowadays. Just solid facts i.e. price, description and individual features of what we have available. But remember, BI-PAK's policy has always been to sell quality components at competitive prices and THAT WE STILL DO.

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This collection of Components & Semiconductors for the hobbyist is probably the most value-packed selection ever offered, it consists of Resistors, carbon and wirewound of various values. Capacitors: All types, sorts and sizes including electrolitics. Potentiometers – single, dual, slider and preset. Switches, Fuses, Heatsinks, Wire, P.C.B. Board, Plugs, Sockets etc., PLUS a selection of Semiconductors for everyday use in popular Hobby Projects. These include: SCR's, Diodes, Rectifiers, Triacs & Bridges as well as a first class mix of Transistors and I.C.'s. In all, we estimate the value of this in current retail catalogues to be over £25! So, help yourself to a great surprise and order a Box TODAY for ONLY at BI-PAK. Remember, stocks are limited so hurry! You can call us on 0920-3182/3412 and order with your Barclaycard or Access Card – 24hr Answerphone Service NOW. Order No. V.P. 85. **just £6.50**

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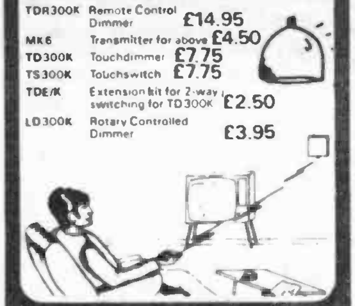
Remember you must add VAT at 15% to your Total order.
Postage add 75p per Total order.

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£14.95
MK6	Transmitter for above	£4.50
TD300K	Touchdimmer	£7.75
TS300K	Touchswitch	£7.75
TDE/K	Extension kit for 2-way switching for TD300K	£2.50
LD300K	Rotary Controlled Dimmer	£3.95



DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL 7126 (a lower power version of the ICL 7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required — details supplied), or a sensitive digital thermometer (−50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week. **Price £15.50**

XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. £5.50

MINI KITS

MK1 ELECTRONIC THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater (1KW). Mains powered. £4.60

MK2 SOLID STATE RELAY
Switches 240V ac motors, lights, heaters from logic/computer circuits. Zero voltage switching, opto isolated. Supplied without triac £2.60

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Max. load 3KW (240V ac). Temp. range up to 90°C. £6.50

MK5 MAINS TIMER
Mains powered timer enabling a load up to 1KW at 240V ac to be switched on (or off) for a variable time from 20 mins. to 35 hrs. Longer or shorter periods possible with minor component changes £6.50

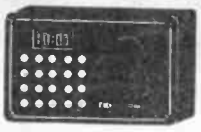
MK15 DUAL LATCHED SOLID STATE RELAY
Comprises two MK2s with latch circuit enabling the MK12 kit to control two mains loads independently. Two output triacs not supplied. (See remote control kits.) £4.50

NEW! **MK19 DC CONTROLLED AUDIO AMPLIFIER**
May be used with virtually any stereo audio amplifier to control bass, volume, treble and balance remotely either using a wire link or the MK11 infra red receiver. A 1 of 10 decoder with LEDS is also included for remote input selection/display. (See remote control kits.) £10.70

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102. £5.50

MICROPROCESSOR CONTROLLED MULTI-PURPOSE TIMER



Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it — the clock will do the rest.

- 7mm LED 12 hour display
- Day of week, am/pm and output status indicators
- 4 open collector outputs for driving relays, triacs, etc.
- 50/60Hz mains operation
- Battery backup saves stored programmes and continues time-keeping during power failures. (Battery not supplied).
- Display blanking during power failure to conserve battery power
- 18 programme time sets
- Powerful "Everyday" function enabling output to switch every day but use only one time set
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- Direct switch control enabling output to be turned on immediately or after a specified time interval
- 20 function keypad for programme entry

NOW ONLY **£39.00**

- Programme verification at the touch of a button
- Plastic box with attractive screen printed front panel 15 × 10 × 5.5cm

(Kit includes all components, PCB, box, assembly and programming instructions.)
Order as CT6000

XK114 OPTIONAL RELAY KIT
Kit includes one relay, PCB to accommodate up to 4 relays, terminal blocks, etc., to fit inside CT6000 box. Provides up to 4 3amp 240V AC changeover contacts £3.90

Additional relays £1.65 each

COMPONENT PACKS

PACK 1	650 Resistors 47 ohm to 10 Mohm — 10 per value £4.00
PACK 2	40 - 16V Electrolytic Capacitors 10μF to 1000μF — 5 per value £3.25
PACK 3	60 Polyester Capacitors 0.01 to 1μF 250V — 5 per value £5.55
PACK 4	45 Sub miniature Presets 100 ohm to 1 Mohm — 5 per value £2.90
PACK 5	30 Low Profile IC Sockets 8, 14 and 16 pin — 10 of each £2.40
PACK 6	25 Red LEDs (5mm dia.) £1.50

DISCO LIGHTING KITS

DL 1000K
This value for money kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers and incorporates a master dimming control. £15.95

DLZ 1000K
A lower cost version of the above featuring unidirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. £8.95

Optional opto input DLA1
Allowing audio ("beat") — light response 60p

DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control and built-in mic. No connections to speaker or amp required. No knobs to adjust — simply connect to mains supply and lamps (1Kw channel) Only £12.95

24 HOUR CLOCK/ APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit	£14.90
CT1000K with white box (56/131 × 71mm)	£17.40
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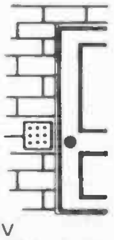
16 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155 × 31mm. Requires PP3 9v battery. Test leads included. ONLY £29.00

ELECTRONIC LOCK KIT



With hundreds of uses in doors, garages, car anti-theft devices, electronic equipment etc. Only the correct easily changed four digit code will open it! Requires a 5 to 15V dc supply. Output 750mA. Fits into standard electrical wall box. Complete kit (excl. front panel) XK101 £11.50

Electronic lock mechanism for use with the above kit. 70 150 £14.95

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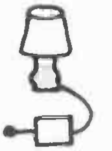
XK103 £25

Extra transmitters XK105 £10.00

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances by means of coded pulses in the mains wiring which may be decoded by special receivers anywhere in the house. The transmitter may be controlled manually or by the computer interface enabling your favourite micro to make your coffee in the morning, switch lights anywhere in the house, or your electric blanket in your bedroom. Just think of the possibilities — and no wiring!



The Kit comprises a transmitter with pre-drilled box and two receivers.

XK112 £42.00
ADDITIONAL RECEIVERS XK111 £10.00

REMOTE CONTROL KITS

These kits have been designed to enable infra red remote control to be incorporated into virtually any application from switching car locks or alarms to controlling Hi-Fi or TV. The exact application will determine the interface circuitry (not supplied) between the receiver and the device to be controlled. In many cases this could by a relay or triac. General instructions and applications are supplied with the kits. The kits are coded and provide a high degree of noise immunity and security.

MK18 Transmitter Kit. For use with MK11/MK12 Receivers and MK9/10/13 keyboards. Requires PP3 battery. Size 8 × 2 × 13 cms. Range approximately 60ft £8.80

MK11 Receiver Kit. Mains powered. Provides 10 latched plus 3 analogue outputs. Ideal for controlling audio amplifiers, TV or lighting circuits where control of lamp brightness is required £13.50

MK13 Transmitter Keyboard £4.35

MK19 DC Controlled Stereo Amplifier Kit. If control of stereo amplifier is required the MK19 may be used providing for remote control of bass, treble and volume (or balance). This kit also includes a one of 10 decoder with LEDs for remote selection of programme or channel. May be connected between the pre-amp and power amp sections of almost any audio amplifier £10.70

MK12 Receiver Kit. Mains powered. Provides up to 16 latched or momentary on/off outputs. The latched version is suitable for applications where only one of the 16 outputs is to be on at any one time, e.g. TV channel selection. The momentary version provides an output only during transmission. Lines may be latched separately if required (circuit supplied). This may be used in conjunction with the MK15 Dual Latched Solid State Relay to switch mains loads, e.g. radio, lights, TV.

MK12 (state latched or momentary)	£13.50
MK9 4-way Transmitter Keyboard	£1.90
MK10 16-way Transmitter Keyboard	£5.40
MK15 Dual Latched Solid State Relay	£4.50

SINGLE CHANNEL UNCODED INFRA RED KITS

MK6 Transmitter — supplied with hand held plastic box. Requires a 9V PP3 battery. Range approximately 20ft £4.50

MK7 Receiver. Mains powered with triac output to switch up to 500W at 240V a.c. On/off or momentary output available £10.50

MK16 Mains Powered Transmitter. For continuous operation such as burglar alarms, automatic door operators etc. Range approximately 6 ft. May also be powered from 9v dc £3.50

MK17 12V d.c. Receiver. For use with MK6 or MK16. Relay output with DP 3A change over contacts. May be used as latched, momentary or "break beam" receiver. Operates from 6-13V dc £10.50

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Features include fuse and surge-absorber protection, banana-type probe jacks and 4" 3-colour mirrored meter with automatic shunt protection (when folded shut). DC Volts: 0 to 1200. AC Volts: 0 to 1200. DC Current: 0-60μA, 3-30-300 mA. Resistance: 0-2-20-200K-2 megohms (centre scale 24). dB: −20 to +63 dB. Requires "AA" battery. **22-211**

Compact 3½-Digit, 16-Range Multimeter

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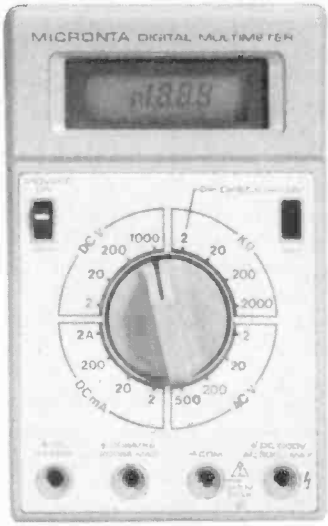

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- Diode Check Function For Testing Semiconductors
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Single-IC design assures extremely low battery drain and high accuracy. Single-knob range switch, full auto-polarity operation. Low-battery and over-range indicators. DC Volts: 2-20-200-2000V (max. 1000V). AC Volts: 2-20-200-2000V mA-2A. Resistance: 2-20-200-2000 kohms. Includes spare fuse, test leads. Requires 9v battery. **22-189**

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The fast way to "peek inside" TTL, LS and CMOS digital circuits. Colour-coded LEDs indicate high, low or pulsed logic states (up to 10 MHz). Simultaneous tone output frees your eyes - really speeds up testing. Minimum detachable pulse width: 50 ns. 36" leads with clips obtain power from circuit under test. Low current drain. With instructions and user's tips. **22-302**

Transistor Checker Tests In Or Out of Circuit

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- Indicates Relative Current Gain
- With Coded Test Leads and Instruction Manuals

Makes Go/No-Go tests on small-signal and power types and allows you to match similar transistors. Indicates relative current gain, "opens" and "shorts". Tests in or out of circuit. Has a front panel socket plus hook-clip leads for in-circuit tests. Requires "AA" battery. **22-025**

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Prior to this advertisement, all quoted regular prices have been charged during the last six months at the Tandy Store, Tameway Tower, Bridge Street, Walsall, West Midlands. WS1 1LA

PE
VOLUME 20 No. 5 MAY 1984

GUIDE

THE multimeter buyer's guide in this issue may be an eye opener to many readers. Obviously a number of meters are regularly advertised in our pages and many component suppliers carry a range in their catalogues. However, the sheer range size may come as something of a shock.

Unfortunately many suppliers do not show a great deal of interest in selling to hobbyists. Even though PE can claim a readership made up from pure hobbyists, students, teachers and professionals in the electronics industry of around 200,000 people, many companies remain unaware of the potential. One large international multimeter manufacturer recently announced its intention to enter the hobbyist field with special products but, apart from a press release sent out months ago, appear to have taken no steps to get this fact across to the buying public.

COMPREHENSIVE

We do not claim that our buyer's guides are comprehensive. What we have attempted to do is take a substantial and representative selection of what is available, in an effort to provide readers with a reasonable choice. Just as one company approached us following our *Monitors For Home Computers* guide in the February issue asking how we missed them, we expect multimeter suppliers to come out of the woodwork following this feature to ask why they have not been included. Our answer is simple: You must make us and our readers aware of your products, not expect someone to find your company.

We have attempted to do their marketing job for them and give readers basic information on the products available. Thankfully these comments do not apply to all companies. You will find some multimeter advertisements in this and other issues of PE and we commend these advertisers to you. They obviously want your business and are prepared to do something about it.

Next month we continue this theme in our pages with a look at oscilloscopes, p.s.u.s, function generators and logic probes. We are sorry to say that by the time you read this it will be too late to get any further material in. If your company has been missed may we suggest that you make sure we are aware of your products and PE readers know where to get them in the future!

SEASONAL

Changing tack slightly may we urge you to make sure you continue to buy the product you are reading. It is normal for us to start getting requests for back numbers just after the summer months, when some readers have been away and missed an issue, only to find that it contained an important feature or project. While we are pleased to supply back numbers, the quantity available is limited and you pay more for them (see foot of this page). So please save yourself all the hassle by placing an order for a regular copy with your newsagent—they will hold them for you while you lie on the beach in some exotic part of the world. Most newsagents also deliver them when you return, and want to catch up on technological innovations.

Of course, if supply of issues is a regular problem, we can offer you a subscription which will ensure your issue is posted to you every month (details at the foot of the page). Just to keep you interested we are planning features or projects relating to the following subjects during the summer months: photography, hi-fi, test gear, fibre optics, radio astronomy, computing, robotics and alarm systems.

Mike Kenward

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We regret that lengthy technical enquiries cannot be answered over the telephone

Queries and letters concerning **advertisements** *to:*
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King's Reach Tower,
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Telex: 915748 MAGDIV-G

Letters and Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to **one published project only**.

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers and Binders

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders for PE are available from the same address as back numbers at £5·50 each to UK or overseas addresses, including postage, packing and VAT where appropriate. State year and volume required.

Subscriptions

Copies of Practical Electronics are available by post, inland for £13, overseas for £14 per 12 issues, from: Practical Electronics, Subscription Department, IPC Magazines Ltd., Room 2816, King's Reach Tower, Stamford Street, London SE1 9LS. Cheques, postal orders and international money orders should be made payable to IPC Magazines Limited. Payment for subscriptions can also be made using any credit card and orders placed via Teledata. Tel. 01-200 0200.

Items mentioned are available through normal retail outlets, unless otherwise specified. Prices correct at time of going to press.

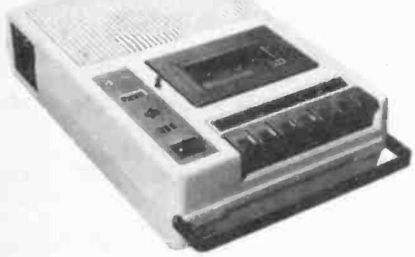
...NEWS &

HEAVY-DUTY CASSETTE

It is estimated that, even at home, a recorder coupled to a computer may go through more cycles of operation in a month than a recorder used only for audio does in a year. Commonsense companionship for a micro with a busy operator comes in the shape of this 'heavy-duty' recorder from Bell and Howell.

Unlike the majority of cassette recorders used for data transferral, the 3179CX is based on a recorder designed specifically for use in schools. The unit is aimed at the BBC machine primarily but is compatible with other personal computers.

The machine incorporates an internal electret microphone and an external microphone socket. Two headphone sockets are provided for private study, as well as a socket for remote control of the drive motor by the computer. In addition to conventional fast-forward and rewind a 'cue and review' mode is incorporated: This allows fast-forward or rewind to be done with the 'play' button depressed so that playback begins immediately the wanted section of the tape has been found.



Other features include auto-stop at both ends of the tape and mains or battery operation. Recording whether computer or audio can be done with either manual or automatic level control. For computers requiring a higher output from the recorder when loading such as the ZX Spectrum, the signal is taken from one of the headphone sockets. From these up to 4V is available from 'volume control' adjustment. The case, mechanism and circuit boards are exceptionally hard wearing and shock resistant.

A full list of micros compatible with the 3179CX is unfortunately not yet available. However, owing to the high output it is expected that most micro users will have little trouble with compatibility. The unit is expected to retail at around £39.95 inc VAT. For further information contact Brian Watkinson, Bell and Howell, Alperton House, Bridgewater Road, Wembley, Middx. HA0 1EG. (01-902 8812).

DOWN TO EARTH AWARD

A coveted Ideal Home Exhibition 'Blue Ribbon' has been awarded by the Daily Mail to B&R Electrical Products Ltd of Harlow for their unique range of 'PowerBreaker' products designed to prevent death or injury from electrical accidents. Invented and manufactured in Britain, the slim plugs and sockets incorporate an electronic residual current circuit breaker (RCCB) which protects in a way that fuses, miniature circuit breakers or double insulation never can.

The unique RCCB constantly monitors the flow of power to an appliance. If an accident occurs and current starts to flow to earth through a human body or other conductive material, 'PowerBreaker' senses the fault instantly and cuts off the current in a split second—well before accepted danger levels are reached.

Less than ½ amp can kill or start a fire, but will not blow a fuse; double-insulation becomes ineffective if the cable is cut or an exposed metal part is made live because of a loose connection. Users of portable electric tools and garden equipment such as electric lawnmowers and hedgecutters are particularly at risk because of the dangers of cut cables, as are users of electrical appliances in kitchens etc.

The 'PowerBreaker' range is available from the usual electrical outlets. The plug has a RRP of £24.15 and the socket £42.97, these prices include VAT. Details from B&R Electrical Products Ltd, Temple Fields, Harlow, Essex CM20 2BG. (0279 34561).

UK Sales Boom

The buoyancy of electronic equipment production in the UK was reflected in substantially increased demand for semiconductors in 1983, says the Electronic Components Industry Federation.

On the basis of ECIF returns and after fair allowances for the imports and production of others, it is calculated that the 1983 UK market for semiconductors attained a size of £600M, which is equivalent to a growth of 41% over 1982. It has now doubled in size in the last 4 years, with continuous growth throughout the recent recession.

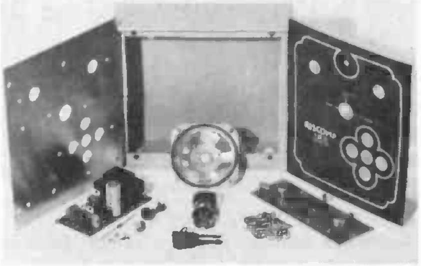
The Federation predicts that 1984 will see a growth of 38% in integrated circuits and 12% in discrete devices.

Beyond this the expectation is for 1985 to see further growth and the UK semiconductor market reaching a size of £1 billion for the first time.

SONIC-ALARM

New from Riscomp, and complementing their existing range of modular alarm systems, is the 'stand alone' ultrasonic intruder detector kit, the CK 5063.

This unit generates an ear-piercing alarm signal in excess of 110dB when triggered. Although designed as a 'stand alone' unit, an external bell or siren can be connected. Simple soldering and assembly is all that is required along with a mains supply on completion.



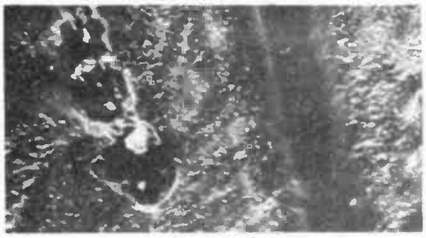
The system incorporates digital circuit techniques and provides for three levels of discrimination against false alarms. A built-in exit-delay and fixed alarm time are incorporated as well as a selectable entrance-delay. A 'hold' position on the key-switch allows for 'walk-testing' the area to be protected.

Normally retailing at £42.55 inc VAT this kit is available on special offer in this issue of PE priced £37.95 inc VAT (see page 34).

MARKET PLACE

ABLATIVE ETCHING

Laser etching, with all its promise in medical and photolithographic applications, suffers from the disadvantage of heating side effects, or charring. The photograph shows this (cut on the left) where a conventional visible infrared laser was used.



The cut on the right was made using a new technique called ablative photodecomposition, and developed by IBM at its Thomas J. Watson research centre. It is seen how a laser can be made to cut biological or polymeric substances *without* heating up the surrounding material. The breakthrough takes advantage of a phenomenon of far-ultraviolet laser, which features an intensity threshold that, if exceeded, will eject molecules from the area, taking with them excess energy that would otherwise have been absorbed by the surrounding material (hence the term 'ablative').

In biological and dental applications, unprecedented accuracy can be achieved because the geometry of the cut is controlled entirely by the shape of the light beam.

The lower photograph shows a scanning electron micrograph of commercial plastic film etched to a line width of five microns, demonstrating the technique's potential in the photolithographic fabrication of integrated circuits.

• • • •

In recent weeks the PE office has received several suppliers' catalogues which may be of interest to readers:

Greenweld's *Components and Equipment Catalogue (84 pages), the post-paid price of £1 is redeemable with a discount voucher against subsequent purchases, 70p to callers at: 443 Millbrook Road, Southampton SO1 0HX (0703 772501).*

Marshalls *Component and Equipment Catalogue (56 pages), costs 75p to callers or £1 post-paid (UK) £1.50 (Rest of World) from: 85 West Regent Street, Glasgow G2 2QD (041-332 4133).*

Marco Trading's *Components and Equipment Catalogue (109 pages), costs 65p post-paid and 65p to callers. A 30p discount voucher (included) is redeemable against subsequent purchases from: The Maltings, High Street, Wem, Shropshire SY4 5EN (0939-32763).*

Jee Distributions' *Components and Equipment Catalogue (48 pages) is free and can be obtained by sending a large s.a.e. to, or calling at: 43 Strathville Road, London SW18 4QX (01-870 0075). A counter-service is also available from: 267 Hanworth Road, Hounslow, Middx.*

Semiconductor Supplies International *Components Catalogue (178 pages) is free and can be obtained by sending a large s.a.e. to, or calling at: Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS (01-643 1126).*

Supercat Electronics' *Test and Measuring Equipment Catalogue (36 pages) is free and can be obtained by sending a large s.a.e. to: PO Box 201, St Albans, Herts AL1 4EN (0727-62171).*

Silicon News Corner

Motorola ◗ Introduces dual-chip, ultrafast rectifiers in TO-220 package to replace two axial lead 3A devices which normally require hand soldering to a heatsink. These switchmode rectifiers are MUR605CT, MUR610CT, MUR615CT & MUR620CT.

◗ 100MHz infrared fibre-optic emitters MFOE1201 & MFOE1202.

◗ Four new r.f. power TMOS f.e.t. transistors for low band linear applications, are MRF148, MRF150 @ 30W & 150W respectively, and MRF138, MRF140 @ 30W & 150W respectively, the former being 50V, the latter, 28V.

◗ Optocoupler/7500V isolator requiring only 1mA input, is MOC8100.

◗ New series of high speed, single supply, quad op amps known as the MC34074 series run from 3 to 44V (±1·5 to ±22V). Bipolar. 4·5MHz gain bandwidth product.

◗ New dual port memory unit (8-bit HCMOS) is MC68HC34.

◗ 3A voltage regulator series in voltages from 5V–24V, with up to 2% o/p voltage tolerance (A suffix) is MC78T00 series.

Motorola European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes.

Countdown . . .

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Life (Fire protection) April 9–13. Olympia. S
Laboratory April 11–12. New Century Hall, Manchester. E
Tectronica April 16–18. Earls Court, London. T
Fibre Optics May 1–3. Porter Tun Room, Whitbread Brewery. E
All Electronics/ECIF May 1–3. Barbican, London. E
Biotech Europe May 15–17. Wembley Conf. Cntr., London. O
DEC user May 15–17. Cunard Int. Hotel, Hammersmith, London Q1
Micro City May 15–17. Exhibition Complex, Bristol. F3
Scotelex June 5–7. Royal Highland Exhibition Halls, Ingliston, Edinburgh. O5
IBM System User Show June 12–14. Wembley Conf. Cntr., London. O
Qualex June 19–21. Corn Exchange, Brighton. D4
Surface Treatment & Finishing Show June 25–29. Birmingham. M
Leeds Electronics July 3–5. University. E
Networks July 3–5. Wembley Conf. Cntr., London. O
Cable July 10–12. Wembley Conf. Cntr., London. O
Laboratory Sept. 4–6. Barbican, London. E
Testmex Sept. 11–13. Grosvenor Ho. Pk. Lane, London. E
Personal Computer World Show Sept. 19–23. Olympia 2, London. M
Building & Home Improvement Sept. 25–30. Earls Court, London. M
Computer Graphics Oct. 9–11. Wembley Conf. Cntr., London. O
Software Expo Oct. 16–18. Wembley Conf. Cntr., London. O
Drives, Motors & Controls Oct. 24–26. Harrogate Exhibition Cntr. E
Computers In The City Nov. 20–22. Barbican, London. O
Data Security Nov. 20–22. Barbican, London. O

D4	Network ☎ 0280 815226
E	Evan Steadman ☎ 0799 26699
F3	Tomorrow's World ☎ 0272 292156
M	Montbuild ☎ 01-486 1951
O	Online ☎ 01-868 4466
O5	Institute of Electronics ☎ 0706 43661
Q1	☎ 01-242 8697
S	IFSSEC ☎ 01-387 5050
T	Trident ☎ 0822 4671

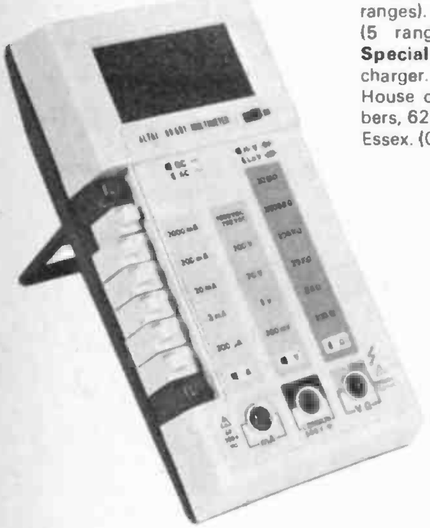
MULTIMETERS

buyer's guide

A multimeter is one of the most essential pieces of test equipment for the hobbyist. This buyer's guide has been designed to show you a selection of the meters currently available. Although it cannot cover all the models it should at least put you on the right road to the type of meter you require. Please note all the prices are inclusive of VAT but not p&p. Only one supplier is listed for each meter but many of the models are available from more than one source.

Model: BBC MA5D. **Ranges:** Voltage a.c./d.c. 300mV–1000V (5 ranges). Current a.c./d.c. 300μA–20A (6 ranges). Resistance 3kΩ–20MΩ (5 ranges). Capacitance 300nF–3000μF (5 ranges). Decibels (5 ranges). **Special Features:** Built-in battery charger. **Price:** £265·00. **Supplier:** House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex. (0799 24922).

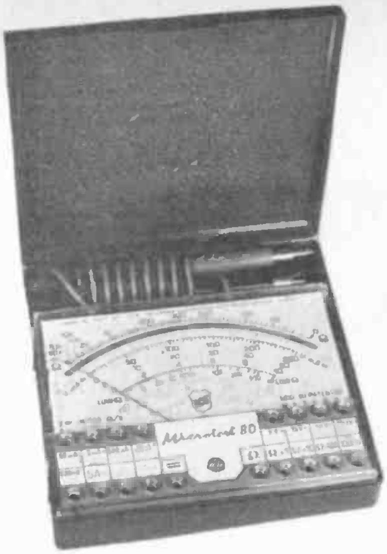
Model: Hung Chang HM101. **Ranges:** Voltage d.c. 10V–1000V (4 ranges). Voltage a.c. 10V–1000V (4 ranges). Current d.c. 0–100mA (1 range). Resistance 0–1MΩ (2 ranges). Decibel range. **Price:** £8·60. **Model:** HM102. **Ranges:** Voltage d.c. 250mV–1000V (8 ranges). Voltage a.c. 10V–1000V (5 ranges). Current d.c. 50μA–500mA (5 ranges). Resistance 0–6MΩ (4 ranges). Decibel range. **Price:** £13·22. **Supplier:** House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex. (0799 24922).



Model: DD601 (YK32K). **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 200mV–750V (5 ranges). Current d.c. 200μA–2A (5 ranges). Current a.c. 200μA–2A (5 ranges). Resistance 200Ω–20MΩ (6 ranges). **Special Features:** Diode test facility. **Price:** £42·50. **Supplier:** Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex. (0702 554155).

Model: Philips PM2544. **Ranges:** Voltage d.c. 0–1000V (4 ranges). Voltage a.c. 0–1000V (4 ranges). Current d.c. 0–10A (2 ranges). Current a.c. 0–10A (2 ranges). Resistance 0–10MΩ (5 ranges). **Special Features:** The PM2544 is also a signature analyser and timer/counter. **Price:** £983·25. **Supplier:** Pye Unicam Ltd., Sales Dept., York Street, Cambridge. (0223 358866).

Model: Pantec Zip. **Ranges:** Voltage a.c./d.c. 2V–500V (4 ranges). Resistance 2kΩ–2MΩ (4 ranges). **Special Features:** Auto-ranging. Direct entry probe allows one-handed operation. **Supplier:** Pantec, Carlo Gavazzi (UK) Ltd., 162–164 Upper Richmond Road, Putney, London. (01-785 9022).



Model: Microtest 80 (YB84F). **Ranges:** Voltage d.c. 0·1V–1000V (6 ranges). Voltage a.c. 1·5V–1000V (5 ranges). Current d.c. 50µA–5A (5 ranges). Current a.c. 250µA–2·5A (5 ranges). Resistance 500Ω–5MΩ (5 ranges). Capacitance 1µF–25000µF (4 ranges). Decibels (5 ranges). **Price:** £27·00. **Supplier:** Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex. (0702 554155).

Model: Metex 3000. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 200mV–700V (5 ranges). Current d.c. 200µA–10A (6 ranges). Current a.c. 200µA–10A (6 ranges). Resistance 200Ω–20MΩ (6 ranges). **Special Features:** Diode test facility and zero check. **Price:** £32·77. **Supplier:** House of Instruments. (0799 24922).

Model: Avometer 1001. **Ranges:** Voltage d.c. 240mV–1000V (7 ranges). Voltage a.c. 10V–1000V (5 ranges). Current d.c. 0·1mA–1A (5 ranges). Resistance 5Ω–2MΩ (2 ranges). **Price:** £32·77. **Supplier:** House of Instruments.

Model: BBC M2012. **Ranges:** Voltage d.c. 200mV–650V (5 ranges). Voltage a.c. 200mV–650V (5 ranges). Current d.c. 2mA–2A (4 ranges). Current a.c. 2mA–2A (4 ranges). Resistance 2kΩ–20MΩ (5 ranges). **Price:** £102·92. **Supplier:** House of Instruments. (0799 24922).

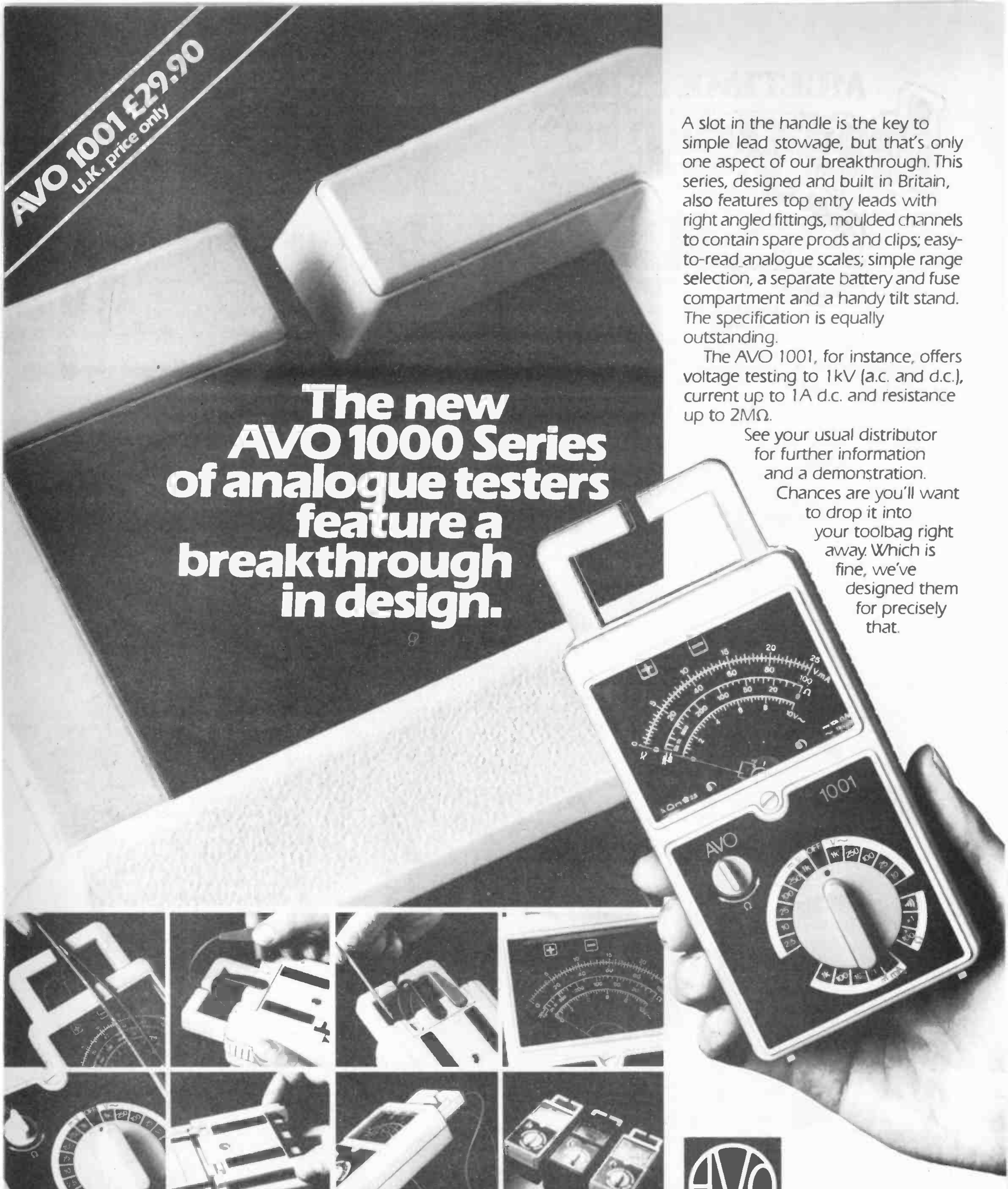
Model: Pantec Dolomiti. **Ranges:** Voltage d.c. 150mV–1·5kV (9 ranges). Voltage a.c. 5V–1·5V (6 ranges). Current d.c. 50µA–5A (6 ranges). Current a.c. 5mA–5A (4 ranges). Resistance 500Ω–50MΩ (6 ranges). Decibels (6 ranges). **Special Features:** Universal signal injector. **Price:** £57·61. **Supplier:** Alcon Instruments Ltd., 19 Mulberry Walk, London SW3 6DZ. (01-352 1897).

Model: DME1400. **Ranges:** Voltage a.c./d.c. 200mV–1000V. Current a.c./d.c. 200mA–1A. Resistance 200Ω–20MΩ. **Special Features:** Autoranging or manual selection, low resistance 'bleeper' and sample hold function. **Price:** £270·25. **Supplier:** Telonic Instruments Ltd., 2 Castle Hill Terrace, Maidenhead, Berkshire. (0628 73933).

Model: BBC MA3E. **Ranges:** Voltage a.c./d.c.100mV–1000V (9 ranges). Current a.c./d.c. 10µA–10A (7 ranges). Resistance 1Ω–20MΩ (5 ranges). Decibels (9 ranges). **Price:** £112·20. **Supplier:** House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex. (0799 24922).

Model: Avometer Model 8 Mk 5. **Ranges:** Voltage d.c. 100mV–3000V (9 ranges). Voltage a.c. 3V–3000V (8 ranges). Current d.c. 50µA–10A (7 ranges). Current a.c. 10mA–10A (4 ranges). Resistance 2kΩ–20MΩ (3 ranges). Decibel range. **Special Features:** Automatic cut out. **Price:** £145·00. **Supplier:** House of Instruments. (0799 24922).

Model: YK375. **Ranges:** Voltage d.c. 0·25V–1000V (6 ranges). Voltage a.c. 10V–1000V (4 ranges). Current d.c. 25µA–10A (10 ranges). Resistance 2kΩ–20MΩ (5 ranges). Decibels (8 ranges). **Special Features:** Range doubler facility which enables readings to be taken at lower ranges. **Price:** £19·95. **Supplier:** Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex. (0702 554155).



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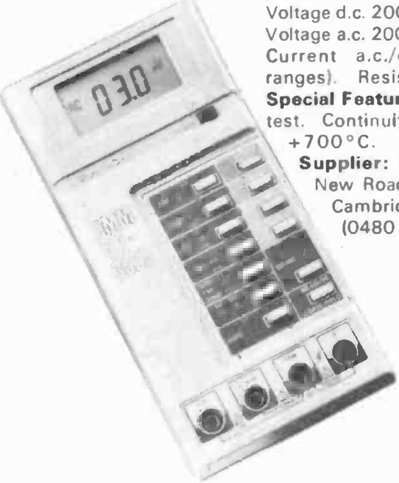
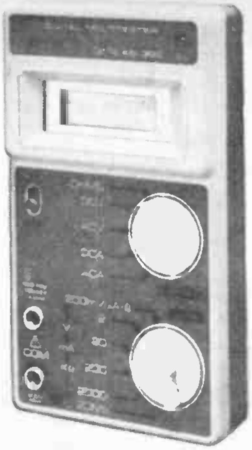
MULTIMETERS buyer's guide

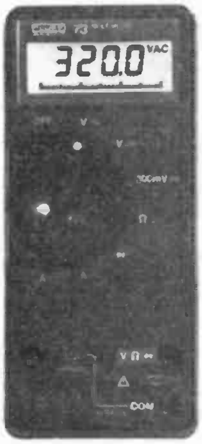


Model: Hitachi VR3525. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 2000mV–750V (4 ranges). Current a.c./d.c. 200µA–10A (5 ranges). Resistance 200Ω–20MΩ. **Special Features:** Autoranging. Diode test. Continuity. Temp. −20°C to +700°C. **Price:** £120·75. **Supplier:** Reltech Instruments, New Road, St. Ives, Huntingdon, Cambridgeshire PE17 4BG. (0480 63570).



Model: ALT/AI KD30C. **Ranges:** Voltage d.c. 0–1000V (5 ranges). Voltage a.c. 0–700V (5 ranges). Current a.c./d.c. 0–1A (5 ranges). Resistance 0–20MΩ (6 ranges). **Price:** £37·95. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).

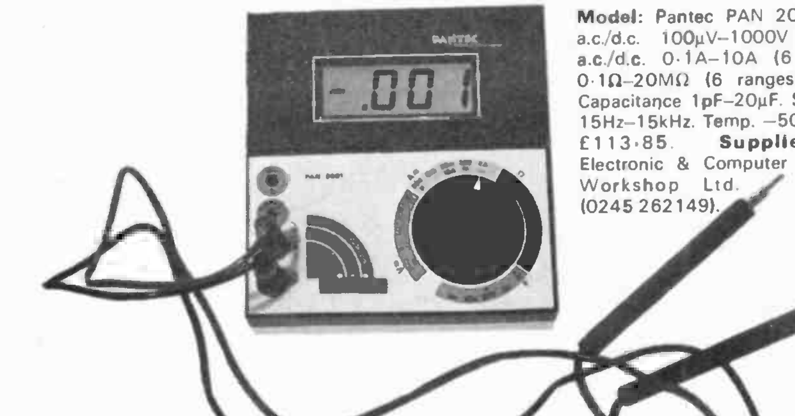
Model: ALT/AI KD305. **Ranges:** Voltage d.c. 0–1000V (4 ranges). Voltage a.c. 0–750V (2 ranges). Current d.c. 0–10A (4 ranges). Resistance 0–2MΩ (4 ranges). **Price:** £32·20. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).



Model: Fluke JF73. **Ranges:** Voltage d.c. 0–1000V. Voltage a.c. 0–750V. Current d.c. 0–10A. Current a.c. 0–10A. Resistance 0–32MΩ. **Special Features:** Digital and analogue. Autoranging. **Price:** £74·75. **Supplier:** Electroplan Ltd., PO Box 19, Orchard Road, Royston, Herts SG8 5HH. (0763 41171).

Model: Miselco Electro Super. **Ranges:** Voltage a.c./d.c. 100mV–1000V (9 ranges). Current a.c./d.c. 100µA–6A (8 ranges). Resistance 0-1MΩ (3 ranges). **Special Features:** dB scale. **Price:** £56·00. **Supplier:** Alcon Instruments Ltd., 19 Mulberry Walk, London SW3 6DZ. (01-352 1897).

Model: Fluke 8026B. **Ranges:** Voltage d.c. 200mV–1000V. Voltage a.c. 200mV–750V. Current a.c. 2mA–2A. Resistance 200Ω–20MΩ. **Special Features:** Diode test. Conductance: 2ms–200ns. **Price:** £207·00. **Supplier:** Electroplan Ltd., PO Box 19, Orchard Road, Royston, Herts SG8 5HH. (0763 41171).



Model: Pantec PAN 2001. **Ranges:** Voltage a.c./d.c. 100µV–1000V (5 ranges). Current a.c./d.c. 0·1A–10A (6 ranges). Resistance 0·1Ω–20MΩ (6 ranges). **Special Features:** Capacitance 1pF–20µF. Square wave generator 15Hz–15kHz. Temp. −50°C to +150°C. **Price:** £113·85. **Supplier:** Electronic & Computer Workshop Ltd. (0245 262149).

Model: AVO 2001. **Ranges:** Voltage a.c./d.c. 200mV–1000V (5 ranges). Current a.c./d.c. 200nA–10A (6 ranges). Resistance 200Ω–20MΩ (6 ranges). **Special Features:** Continuity. Diode test. **Price:** £98·21. **Supplier:** House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex. (0799 24922).

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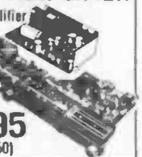

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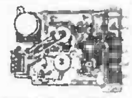

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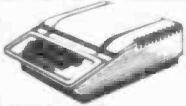

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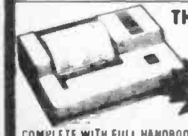

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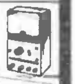

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a.c. V 10V, 30V, 100V, 300V, 1000V;
a.c. I 3mA, 10mA, 30mA, 100mA, 1A, 3A.
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Model: Beckman T90. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 0–600V (2 ranges). Current d.c. 200μA–2A (5 ranges). Resistance 200Ω–20MΩ (6 ranges). **Special Features:** Diode test. **Price:** £49·96. **Supplier:** Beckman Instruments Ltd., Mylen House, 11 Wagon Lane, Sheldon, Birmingham B26 3DU. (021-742 7761).

Model: ISI DM3350. **Ranges:** Voltage d.c. 0–1000V (4 ranges). Voltage a.c. 0–600V (4 ranges). Current a.c./d.c. 0–10A (2 ranges). Resistance 0–2MΩ (5 ranges). **Special Features:** Autoranging. Continuity. **Price:** £51·75. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).

Model: Anders AMM301. **Ranges:** Voltage d.c. 60mV–300V (7 ranges). Voltage a.c. 6V–600V (5 ranges). Current d.c. 0·03mA–600mA (4 ranges). Resistance 0–2MΩ (4 ranges). **Special Features:** dB scale. **Price:** £29·33. **Supplier:** Anders Electronics Ltd., 48-56 Bayham Place, Bayham Street, London NW1 0EU. (01-387 9092).

Model: Hitachi VR3510. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 2000mV–750V (4 ranges). Current a.c./d.c. 200μA–10A (5 ranges). Resistance 200Ω–20MΩ (6 ranges). **Special Features:** Autoranging. More accurate than VR3525. Continuity. Diode test. Temp. −20°C to +700°C. **Price:** £155·25. **Supplier:** Reltech Instruments, New Road, St. Ives, Huntingdon, Cambridge PE17 4BG. (0480 63570).

Model: Beckman HD100. **Ranges:** Voltage d.c. 200mV–1500V (5 ranges). Voltage a.c. 200mV–1000V (5 ranges). Current a.c./d.c. 200μA–2A (5 ranges). Resistance 200Ω–20MΩ (6 ranges). **Price:** £132·25. **Supplier:** ITT. (0279 29522).

Model: ALT/AI KD25C. **Ranges:** Voltage d.c. 0–1000V (4 ranges). Voltage a.c. 0–500V (2 ranges). Current d.c. 0–200mA (2 ranges). Resistance 0–2MΩ (4 ranges). **Price:** £27·60. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Road, Sutton, Surrey SM1 4RS. (01-643 1126).

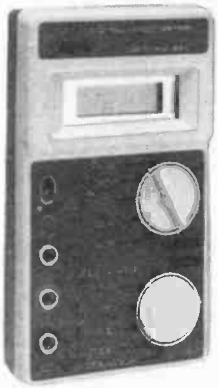
Model: Keithley 175. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 200mV–750V (3 ranges). Current d.c. 200μA–10A (6 ranges). Current a.c. 200μA–10A (6 ranges). Resistance 200Ω–200MΩ (7 ranges). **Special Features:** Autoranging. μP operated with memory (100 readings). IEEE bus. **Price:** £396·75. **Supplier:** Keithley Instruments Ltd., 1 Boulton Road, Reading, Berkshire RG2 0NL. (0734 861287).

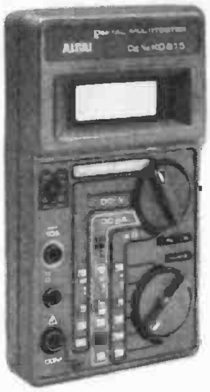
Model: Soar ME-531. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 2V–1000V (4 ranges). Current d.c. 200mA–10A (2 ranges). Current a.c. 200mA–10A (2 ranges). Resistance 200Ω–2MΩ (5 ranges). **Special Features:** Autoranging. Continuity. Diode tester. **Price:** £56·20. **Supplier:** Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex SS6 8LR. (0702 554155).

MULTIMETERS buyer's guide

Model: ALT/AI KD55C. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 200mV–700V (5 ranges). Current a.c./d.c. 200µA–10A (6 ranges). Resistance 0–20MΩ (6 ranges). **Special Features:** Overload indication. **Price:** £43. **Supplier:** Semiconductor Supplies International, Dawson House, 128/130 Carshalton Road, Sutton, Surrey. (01-643 1126).

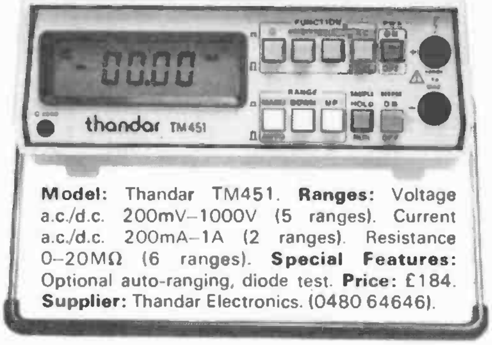
Model: ALT/AI KD615. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 0–750V (2 ranges). Current d.c. 200µA–10A. Resistance 0–20MΩ (6 ranges). **Special Features:** Overload protection, diode test facility. **Price:** £42·55. **Supplier:** Semiconductor Supplies International, 128/130 Carshalton Road, Sutton, Surrey. (01-643 1126).





Model: Keithley 179A. **Ranges:** Voltage d.c. 200mV–1200V (5 ranges). Voltage a.c. 200mV–1000V (5 ranges). Current a.c./d.c. 200µA–20A (6 ranges). Resistance 0–20MΩ (5 ranges). **Special Features:** Hi-lo range option, over-range indication. **Price:** £385. **Supplier:** Keithley Instruments Ltd, 1 Boulton Road, Reading, Berks RG2 0NL. (0734 861287).

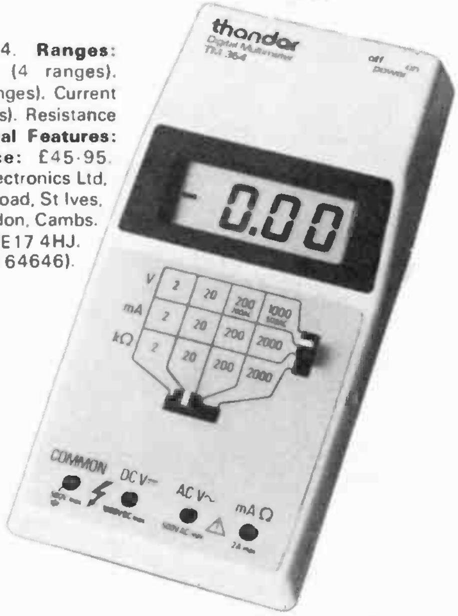
Model: Miselco T20 'Super'. **Ranges:** Voltage d.c. 100mV–1000V (8 ranges). Voltage a.c. 0V–1000V (5 ranges). Current d.c. 50µA–10A (10 ranges). Current a.c./d.c. 3mA–10A (6 ranges). Resistance 0–50MΩ (5 ranges). Decibels −10 to +61 (5 ranges). **Special Features:** Diode test facility, overload protection. **Price:** £42·25. **Supplier:** Alcon Instruments Ltd., 19 Mulberry Walk, London SW3 6DZ. (01-352 1897).



Model: Thandar TM451. **Ranges:** Voltage a.c./d.c. 200mV–1000V (5 ranges). Current a.c./d.c. 200mA–1A (2 ranges). Resistance 0–20MΩ (6 ranges). **Special Features:** Optional auto-ranging, diode test. **Price:** £184. **Supplier:** Thandar Electronics. (0480 64646).

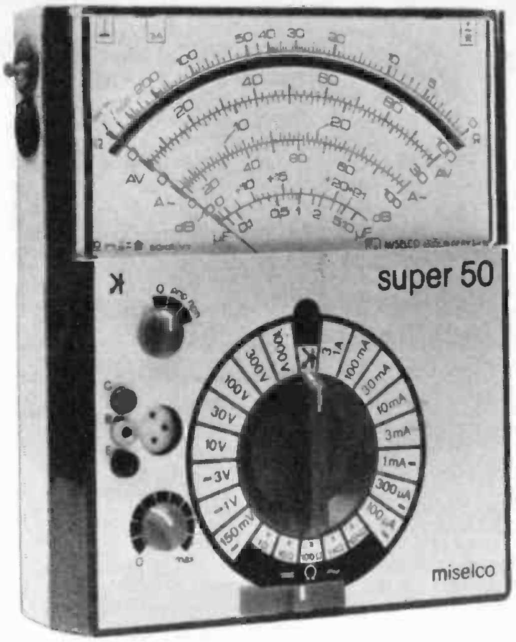
Model: Micronta (Tandy). **Ranges:** Voltage a.c./d.c. 2V–1000V (4 ranges). Current a.c./d.c. 2mA–2A (4 ranges). Resistance 0–2kΩ (4 ranges). **Special Features:** Diode test facility, overload protection. **Price:** £34·95. **Supplier:** Tandy stockists.

Model: Thandar TM354. **Ranges:** Voltage d.c. 2V–1000V (4 ranges). Voltage a.c. 0–500V (2 ranges). Current d.c. 2mA–200mA (4 ranges). Resistance 0–2MΩ (4 ranges). **Special Features:** Diode test facility. **Price:** £45·95. **Supplier:** Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambs. PE17 4HJ. (0480 64646).

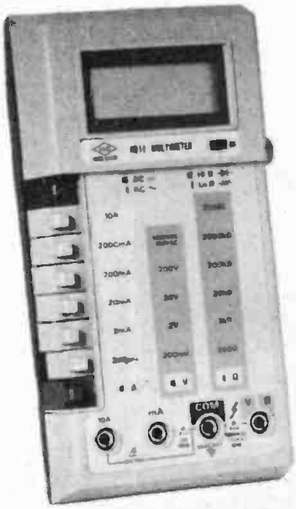


Model: Lascar LMM/100 (LH95D). **Ranges:** Voltage a.c./d.c. 0·1mV–1000V (5 ranges). Current a.c./d.c. 0·1µA–2A (5 ranges). Resistance 0–20MΩ (5 ranges). **Special Features:** Overload protection, display 'hold'. **Price:** £88·61. **Supplier:** Maplin Electronic Supplies Ltd., P.O. Box 3, Rayleigh, Essex SS6 8LR. (0702 552911).

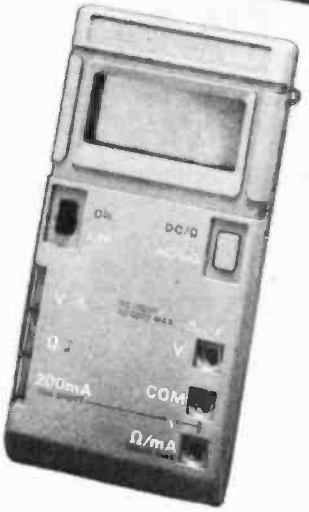
Model: Thandar TM356. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c. 200mV–750V (5 ranges). Current d.c. 200µA–10A (6 ranges). Resistance 0–20MΩ (6 ranges). **Special Features:** Diode test facility. **Price:** £109·25. **Supplier:** Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambs. PE17 4HJ. (0480 64646).



Model: Miselco 'Super' 50. **Ranges:** Voltage d.c. 150mV–1000V (8 ranges). Voltage a.c. 0–1000V (5 ranges). Current d.c. 20µA–3A (10 ranges). Current a.c. 3mA–3A (6 ranges). Resistance 0–50MΩ (5 ranges). Decibels −10 to +61 (5 ranges). **Special Features:** Diode test facility. **Price:** £50. **Supplier:** Alcon Instruments Ltd., 19 Mulberry Walk, London SW3 6DZ. (01-352 1897).



Model: Hung-Chang HC7030. **Ranges:** Voltage a.c./d.c. 100µV–1000V (5 ranges). Current a.c./d.c. 0·1µA–10A (6 ranges). Resistance 0–20MΩ (6 ranges). **Special Features:** Diode test facility, overload protection. **Price:** £49·95. **Supplier:** Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG. (0277 230909).



Model: DM 2350C. **Ranges:** Voltage d.c. 0·2V–1000V. Voltage a.c. 2V–600V. Current a.c./d.c. 200mA–20A. Resistance 0–2MΩ. **Special Features:** Auto-ranging, continuity 'buzzer'. **Price:** £67·85. **Supplier:** Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Rd., Sutton, Surrey SM1 4RS (01-643 0829).

Model: MIC-3300A. **Ranges:** Voltage d.c. 200mV–1000V (5 ranges). Voltage a.c 0V–750V (2 ranges). Current d.c. 200µA–10A (5 ranges). Resistance 0–20MΩ (6 ranges). **Special Features:** Diode test facility. **Price:** £48·30. **Supplier:** House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE. (0799 24922).

Model: Levell TM11. **Ranges:** Voltage d.c. 150µV–50kV (18 ranges). Voltage a.c. 50µV–50kV (19 ranges). Current d.c. 150pA–50A (24 ranges). Current a.c. 50pA–50A (25 ranges). Resistance 0–10GΩ (7 ranges). Decibels −90 to +50 (15 ranges). **Special Features:** Diode test, temp. sensor (7 ranges), amp output. **Price:** £189·75. **Supplier:** Levell Electronics Ltd., Moxon St., Barnet, Herts. EN5 5SD (01-440 8686).

Model: Fluke '73'. **Ranges:** Voltage d.c. 320mV–1000V. Voltage a.c. 3·2V–750V. Current a.c./d.c. 32mA–10A. Resistance 0–32MΩ. **Special Features:** Auto-ranging, diode test facility, additional linear display feature. **Price:** £74·75. **Supplier:** Electroplan Ltd., P.O. Box 19, Orchard Rd., Royston, Herts. SG8 5HH. (0763 41171).

Model: Trio DL-705. **Ranges:** Voltage a.c./d.c. 1mV–1000V. Current a.c./d.c. 10µA–200mA. Resistance 0–20MΩ. **Special Features:** Hi-lo range option, semi-auto-ranging. **Price:** £123·91. **Supplier:** Supercat Electronics Ltd., P.O. Box 201, St Albans, Herts. (0727 62171).

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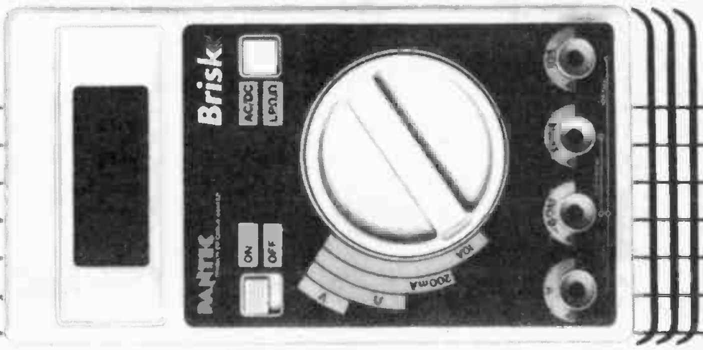

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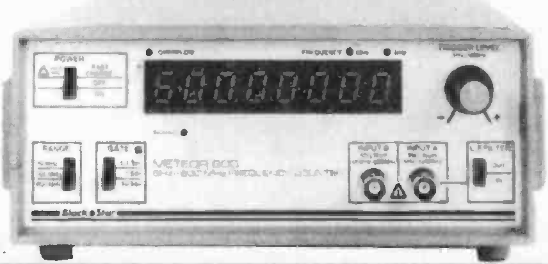

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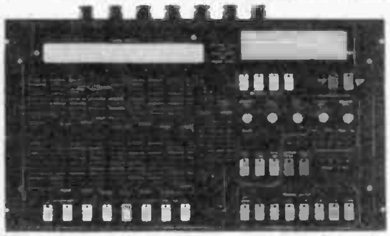

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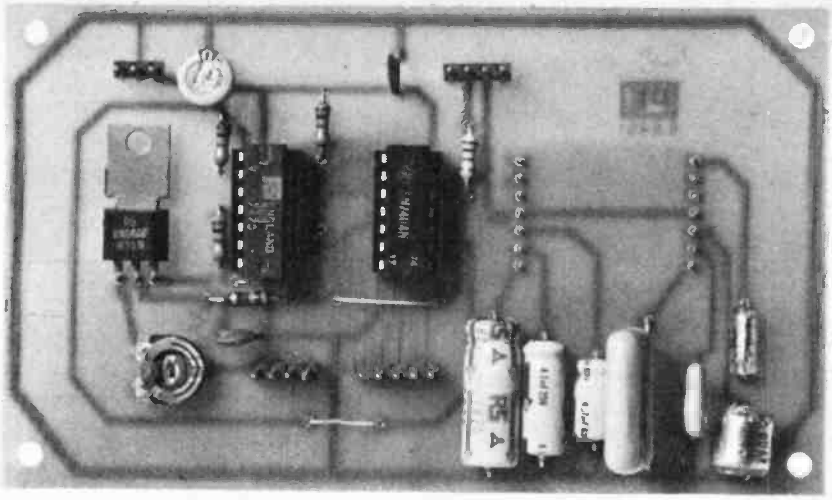


MICHAEL TOOLEY BA
DAVID WHITFIELD
MA MSc CEng MIEE

LOGIC SIGNAL GENERATOR

THIS month's Digital Project is devoted to the construction of a versatile signal source which will be invaluable for use in testing and fault diagnosis of digital circuits. The Logic Signal Generator provides four outputs which are fully TTL compatible. These consist of complementary square wave signals at both the nominal frequency (f) and at twice this value (2f). A fifth, variable amplitude, output of 1V peak maximum is also available. This output has a nominal 50 ohm impedance and is ideal for applications such as the calibration and general testing of both analogue and digital circuits.

The Logic Signal Generator unit uses low-cost readily available components and is assembled on a small single-sided p.c.b. As with all of the projects in this series, power for the Logic Signal Generator is derived from the separate regulated d.c. supply module which was described in the March issue of PE.

CIRCUIT DESCRIPTION

The complete circuit of the Logic Signal Generator is shown in Fig. 1. A Schmitt inverter, IC1f, forms a simple square wave oscillator where the frequency of operation is governed by switch selected capacitors, C1 to C7, together with the series combination of VR1 and R1. The capacitor values are selected to produce seven decade frequency ranges, and VR1 provides a continuously variable adjustment of the output frequency over a range of a little more than 10:1, thus ensuring a small overlap between switched ranges.

It should be noted that, although the output of this simple form of TTL oscillator has acceptably fast rise and fall times, the mark to space ratio is typically around 1:3. For most applications it is desirable to achieve as near unity a mark to space ratio as possible. In the Logic Signal Generator this is achieved by applying the oscillator output to an edge clocked bistable stage. Such a stage reacts solely to either the falling or the rising edge of its clock input, depending upon the particular i.c., and thus will generate a near perfect square wave regardless of the duty cycle of its input.

The oscillator output is buffered by means of IC1e and then taken to the JK bistable, IC2a, arranged as a binary divider with both J and K inputs taken to logic 1. The output of IC2a thus consists of a square wave of near unity mark to space ratio at exactly half the frequency of its clock input. Complementary outputs, Q and $\overline{Q}$, are taken to inverters, IC1b and IC1a, respectively. These gates act as buffers and help to minimise effects associated with loading at the output. A second bistable stage, IC2b, follows the first. This further divides the signal frequency to provide complementary outputs via IC1c and IC1d.

The $\overline{Q}$ output from IC2b is applied to the source follower stage, TR1. This provides a low impedance output which is adjustable in amplitude by means of variable and pre-set resistors, VR2 and VR3 respectively. Distributed supply decoupling is provided at h.f. by means of C8 and C9 and at l.f. by means of C10.

SPECIFICATION

GENERAL

Waveform:	Square, unity mark to space ratio.
Frequency:	Seven switched ranges covering:—

1	0·3Hz to 3Hz
2	3Hz to 30Hz
3	30Hz to 300Hz
4	300Hz to 3kHz
5	3kHz to 30kHz
6	30kHz to 300kHz
7	300kHz to 3MHz appx.

TTL OUTPUTS

Four fully TTL compatible outputs: f_{out}, $\overline{f_{out}}$, $2f_{out}$, and $\overline{2f_{out}}$.

VARIABLE OUTPUT

Single output at f_{out} continuously variable in amplitude to 1V peak maximum.
Output impedance nominally 50 ohm.

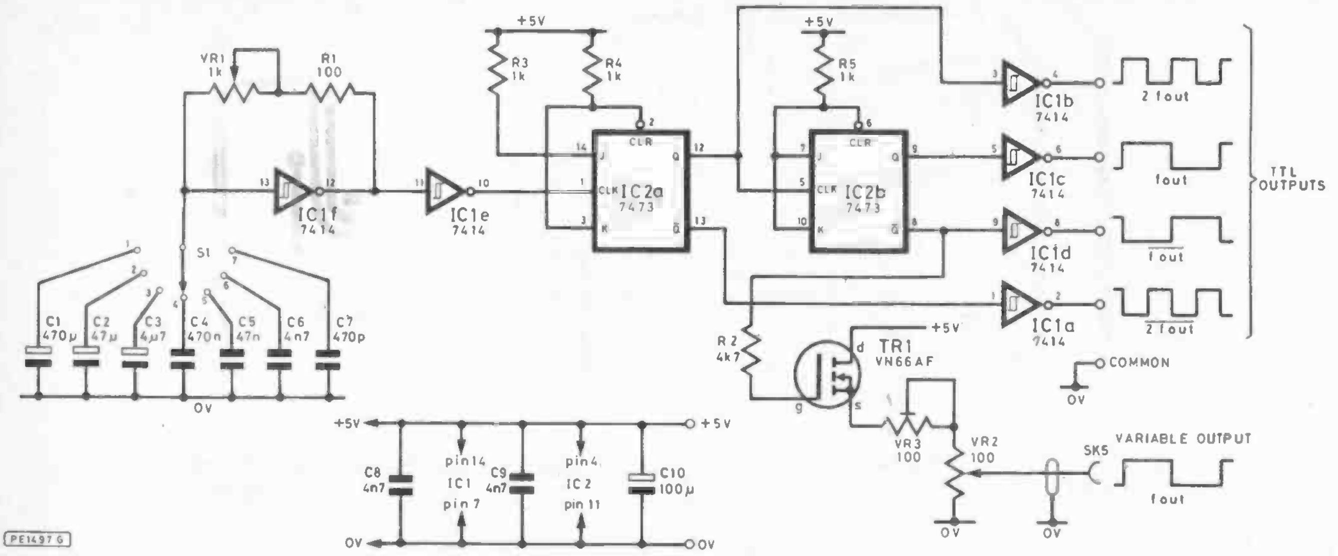


Fig. 1. Circuit diagram of the Logic Signal Generator

CONSTRUCTION

The Logic Signal Generator is built on a single-sided p.c.b. measuring approximately 120 x 70mm, the copper foil layout of which is shown in Fig. 2. The corresponding component layout on the top surface of the p.c.b. is shown in Fig. 3. Interconnections from the p.c.b. to the output sockets, potentiometers and power supply are all made via 0·1" matrix p.c.b. connectors, the wiring scheme for which is shown in Fig. 4.

Components should be assembled on the p.c.b. in the following sequence: d.i.l. sockets, p.c.b. connectors, links, resistors, capacitors, f.e.t., and rotary switch. Note that, unlike all of the other components, this last mentioned item is mounted on the copper track side of the p.c.b. Once assembly has been completed the underside of the p.c.b. should be carefully checked for solder splashes, bridges bet-

COMPONENTS . . .

Resistors

R1	100
R2	4k7
R3,R4,R5	1k (3 off)
VR1	1k carbon potentiometer
VR2	100 carbon potentiometer
VR3	100 miniature horizontal skeleton pre-set

All resistors 0·25W 5% carbon

Capacitors

C1	470µ 10V elect
C2	47µ 25V elect
C3	4µ7 63V elect
C4	470n polyester
C5	47n polyester
C6	4n7 polystyrene
C7	470p polystyrene
C8,C9	4n7 ceramic (2 off)
C10	100µ 16V PC elect

Semiconductors

TR1	VN66AF
IC1	7414
IC2	7473

Miscellaneous

P.c.b.
14-pin d.i.l. sockets (2 off)
3-way 0·1" p.c.b. plug and socket
4-way 0·1" p.c.b. plug and socket (2 off)
5-way 0·1" p.c.b. plug and socket
1P 7W p.c. mounting rotary switch
2mm sockets (5 off; 4 red, 1 black)
BNC socket

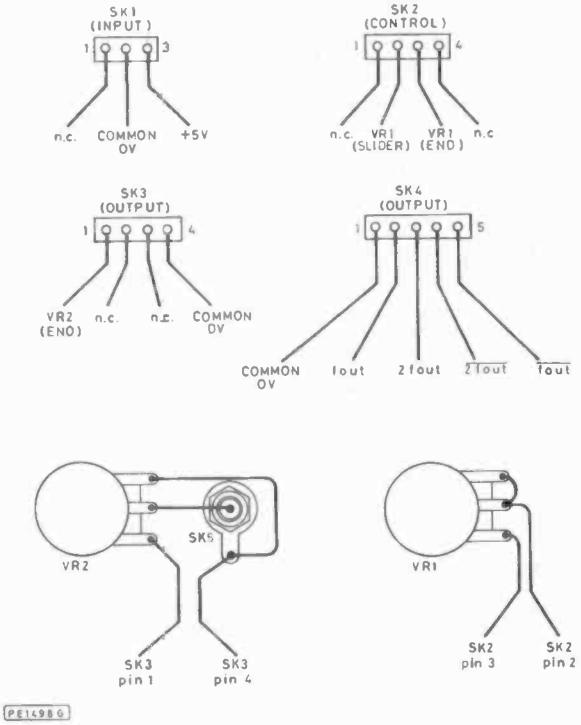


Fig. 4. Wiring interconnections

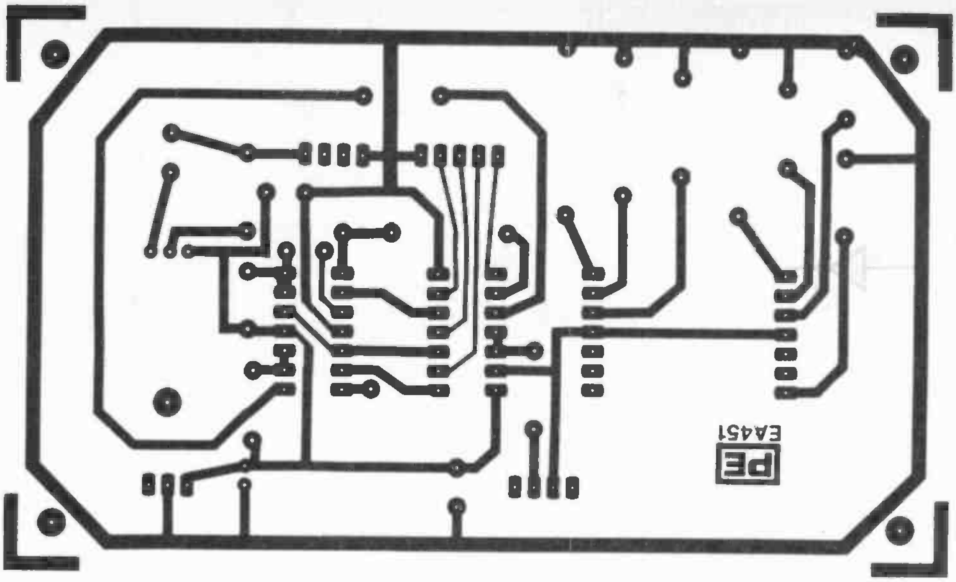


Fig. 2. P.c.b. design

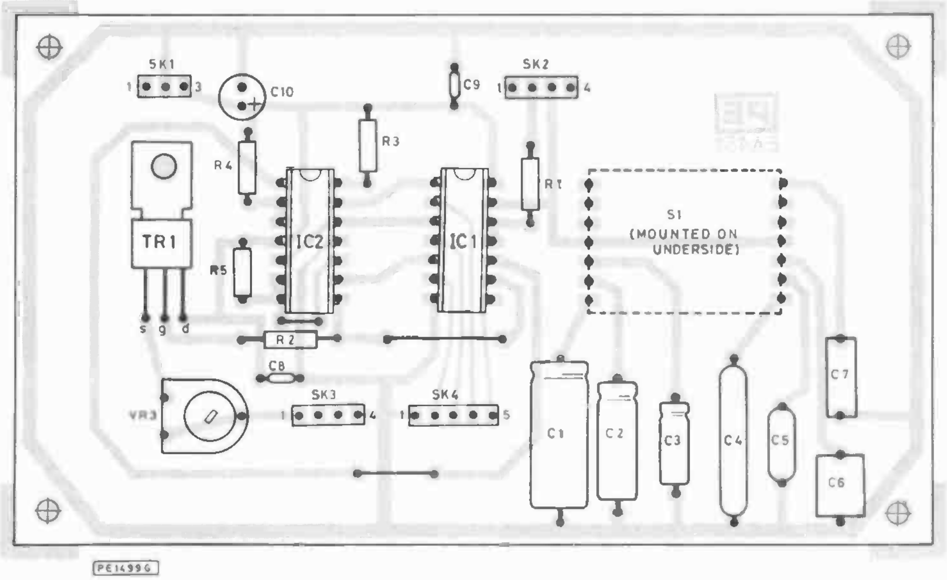


Fig. 3. Component layout

ween adjacent tracks, and dry joints. Finally, the i.c.s may be inserted in their respective holders, taking care to ensure the correct orientation of each device. Constructional details of the enclosure and off-board wiring have not been given since this will undoubtedly be a matter of preference for the individual constructor. Constructional details of a suitable power supply module were given in the March issue of PE.

TESTING AND CALIBRATION

Two commonly available items of test equipment are required in order to fully test and calibrate the Logic Signal Generator. These are an oscilloscope (preferably a dual beam type) and a digital frequency meter. Calibration should initially be carried out with the unit switched to range 4 (300Hz to 3kHz), VR1 set to maximum (fully anti-clockwise). The Y1 input of the oscilloscope should be connected to display f_{out} and the timebase should be adjusted to display two to four cycles of this waveform. The Y2 input should then be connected to each of the other TTL outputs in turn, and the correct frequency and phase relationship should be checked by reference to the Y1 display. The amplitude of each of the TTL outputs should also be checked and this should be in the range 3·5V to 4·5V.

The oscilloscope Y2 input should now be connected to the variable output and VR3 adjusted until the amplitude of output signal is exactly 1V. Finally, the digital frequency meter should be connected to the variable output and VR1 adjusted for a reading of exactly 1kHz. The scale fitted to VR1 should then be marked appropriately at this and at other suitably chosen frequencies. This completes the testing and calibration of the Logic Signal Generator and the unit is now ready for use. ★

sustain unit

R.A. Penfold

THE popular sustain effect for electric guitars is obtained using a form of compressor. Units of this type have fast attack and decay times so that they can respond with suitable rapidity to changes in the dynamic level of the signal from the guitar, and the compression characteristic gives an almost constant output level. This retains the fast attack each time a note is played, but the normal decay characteristic is eliminated, and a virtually constant volume level is maintained for the duration of each note. As a result, the normal, almost percussive sound of an electric guitar is modified to give a sound which is more like that of an organ.

Sustain units can be rather more complex than one might expect, and can have problems with noise levels. The noise results from the high gain that must be used to maintain the output at a suitable level once the input signal has substantially decayed. The gain (and noise) are at a maximum when there is little or no input signal, which, unfortunately, is when the noise is most noticeable.

This design is based on just one active device, and good noise performance is obtained by including a noise gate at the output. A useful additional feature is the ability to produce a good fuzz effect using the unit.

NE571

The integrated circuit used in the unit is an NE571. This device is primarily intended for noise reduction systems where one section is configured as a 2 to 1 compressor and the other is used as a 2 to 1 expander. A straightforward 2 to 1 compression characteristic would give a reasonable sustain effect, but would be less than ideal. With this type of compressor any change in the input signal level gives only half as much change in the output level. For example, boosting the input signal by 20dB (10 times) would give a rise in the output level of only 10dB (about 3 times). This greatly restricts the dynamic range of the output signal, but ideally a sustain unit should give an almost constant output level from any input signal of adequate strength, and an effective dynamic range of only a few dBs.

The block diagram of Fig. 1a shows the standard NE571 compressor configuration. R_a to R_d are bias and feedback resistors, but due to the inclusion of decoupling capacitor C_c there is no negative feedback at audio frequencies, and the operational amplifier exhibits its full open loop voltage gain. However, there is a second feedback path through C_d, R_e, and the gain cell. The latter is a form of voltage controlled resistor, and the greater the control voltage it receives, the lower its resistance. The control voltage is provided by the rectifier circuit, and this is driven from the output of the circuit.

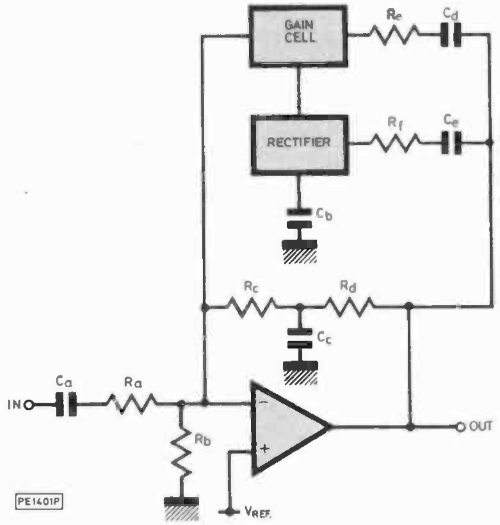


Fig. 1a. The normal NE571 compressor configuration

Therefore, as the input signal is increased, the output level rises, giving increased contol voltage to the gain block, which in turn provides more negative feedback. This feedback reduces the voltage gain of the amplifier, so that the rise in output level is limited, and the required compression is obtained.

There is an alternative form of compressor, and it is possible to reconfigure the NE571N to perform in this alternative mode. The block diagram of Fig. 1b shows this arrangement.

This is in most respects the same as the original set-up, and the only difference is that the rectifier circuit is driven from the input, not from the output. Previously, the output level of the circuit had to increase by a certain amount if there was a rise in input level, as some rise in output level was needed in order to increase the control voltage to the gain block and give a reduction in gain.

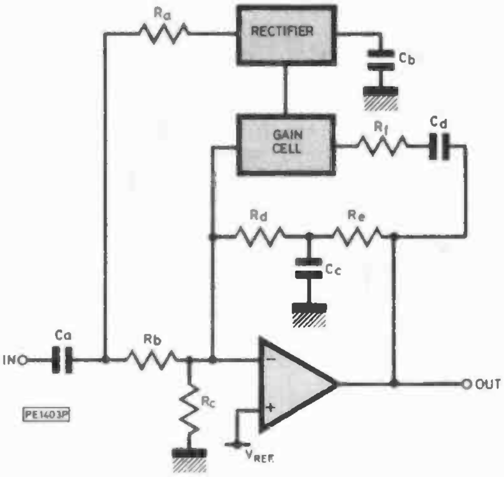


Fig. 1b. The compressor arrangement used in this design

With the second configuration this is not the case. An increase in the input amplitude reduces the gain of the amplifier, and the compression effect is independent of the output level. Low input levels have no significant effect on the gain block as the control voltage that is generated is too small, but above a certain threshold level a rise in input level causes a reduction in gain that stabilises the output at a constant level. In practice, there tends to be some variation in the output amplitude, but this can be kept to no more than a few dBs with careful circuit design, and the NE571N works well in this configuration.

EXPANDER

The NE571N can operate as an expander using the arrangement shown in Fig. 1c. Here the gain of the amplifier is determined by the negative feedback network which is formed by R_a, the gain cell, and R_d. The lower the resistance of the gain cell, the higher the circuit gain.

The rectifier is driven from the input of the circuit, and the higher the input level becomes, the larger the control voltage and gain of the amplifier. This gives the 2 to 1 expansion characteristic.

In theory, using an expander of this type at the output of the circuit would give a high level of noise reduction without impairing the sustain effect. With only the noise output from the sustain circuit there would be only a low input level to the expander, and it would consequently have a low level of gain. In fact, it would provide considerably less than unity gain, and the noise would be attenuated. With a reasonably high signal level applied to the input of the sustain circuit, a high output level is produced, and the expander therefore has a comparatively high level of gain, so that the signal from the sustain circuit receives a degree of amplification.

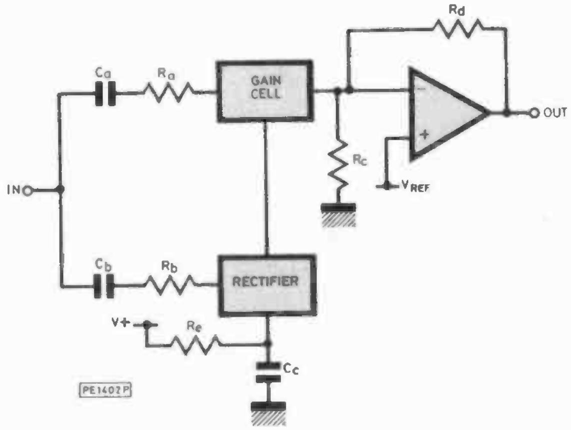
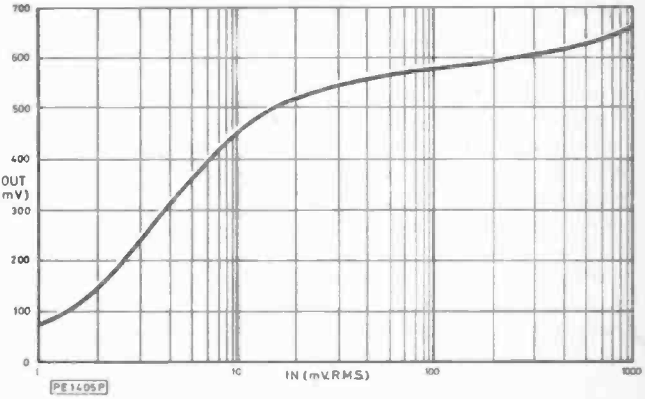


Fig. 1c. The NE571 as an expander

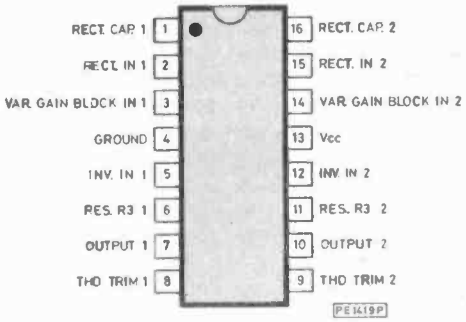
As stated earlier, in practice there is a small variation in the output level of the compressor as the input signal is increased above the compression threshold level. The expander would tend to exaggerate these variations and reduce performance. This problem can be overcome by using a less extreme expansion characteristic, but one which still gives sufficient expansion to give a useful degree of noise reduction. Resistor R_e provides a bias to the gain block which boosts the minimum gain of the circuit and gives a reduced amount of expansion. Strictly speaking, the circuit is an expander rather than a noise gate, as it does not simply gate the input signal on and off, but an expander used in this single-ended noise reduction role is often referred to as a noise gate.

A typical input/output characteristic of the sustain unit is shown in Fig. 2. As can be seen from this, a 40dB increase in the input signal (10mV to 1V) is compressed to a change in output of only about 3 to 4dB.

Fig. 2. Typical input/output characteristic of the sustain unit



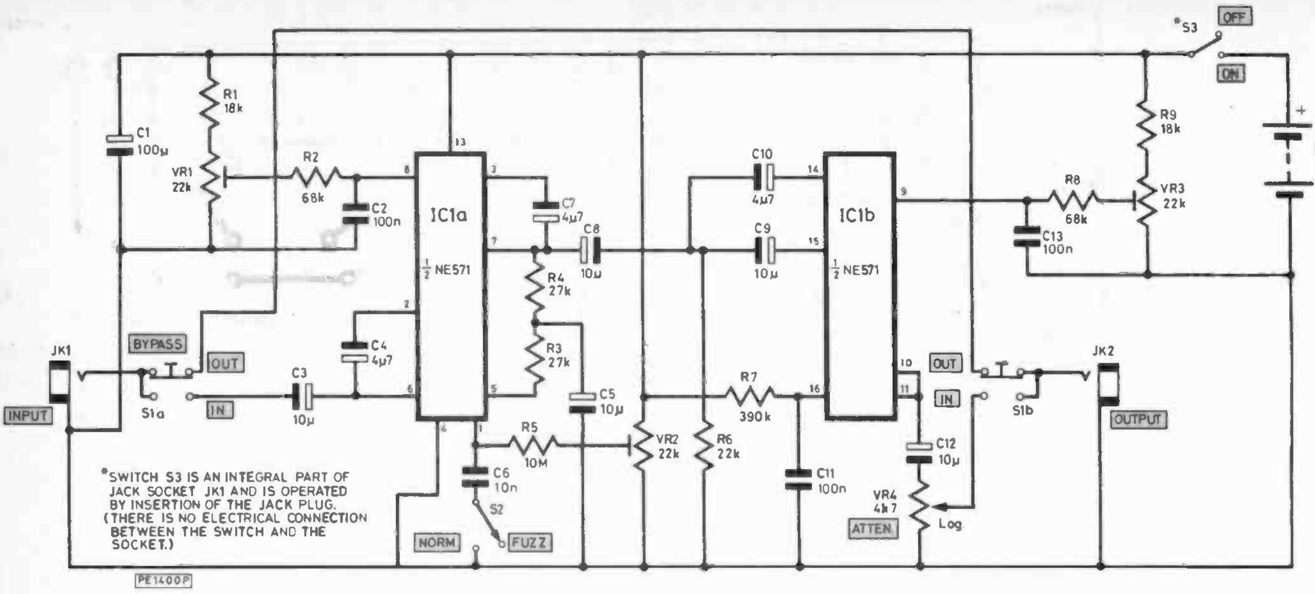
The NE571 pin connections



THE CIRCUIT

The full circuit diagram of the unit is shown in Fig. 3, IC1a is used in the compressor/sustain circuit and the expander/noise gate is based on IC1b. These closely adhere to the configurations of Fig. 1b and Fig. 1c, but some of the resistors shown in these diagrams are integral components of IC1 and do not appear in Fig. 3.

Switch S1 is a (foot operated) bypass switch which enables the effect to be easily switched out. Switch S2 can be used to switch out the smoothing capacitor in the rectifier circuit of the compressor so that the input signal modulates itself. This produces severe distortion that gives quite a good



*SWITCH S3 IS AN INTEGRAL PART OF JACK SOCKET JK1 AND IS OPERATED BY INSERTION OF THE JACK PLUG. (THERE IS NO ELECTRICAL CONNECTION BETWEEN THE SWITCH AND THE SOCKET.)

Fig. 3. The complete circuit diagram of the sustain unit

"fuzz" effect. The attack and decay times of the circuit need to be short, due to the rapid changes in the dynamic level of the input signal, but smoothing capacitors C6 and C11 must not be made too small or distortion performance suffers. It is, therefore, a matter of choosing values which give a good compromise between response time and distortion levels.

Potentiometer VR1 and its associated components enable the distortion performance of the compressor to be trimmed for optimum; VR3 is the distortion trim control for the expander. The gain of the circuit might be excessive for some guitars, and VR2 enables the gain of the compressor to be reduced by supplying a bias to the gain block; VR4 is the output level control.

Power is obtained from a small (PP3 size) 9 volt battery, and the current consumption is typically only about 3·5 milliamps. Switch S3 is the on/off switch, and this can be a set of isolated make contacts on the input socket, JK1.

CONSTRUCTION

A diecast aluminium box is ideal as the housing for a guitar effects unit, as boxes of this type provide screening against electrical noise and are very tough. Bear in mind that bypass switch S1 is a heavy-duty push-button type that is foot or toe operated, and that a simple folded aluminium box might not be able to take the sort of stresses to which the unit will inevitably be subjected. A 150 by 80 by 50mm diecast aluminium box was used as the case for the prototype.

The two controls and two sockets are mounted on the front panel of the unit, which is one of the 150 by 50mm sides of the case. With effects units it is common for the on/off switch to be part of the input jack, so that the unit is automatically switched on and off when the guitar is plugged into the unit and disconnected from it. This is usually very convenient in use, but an ordinary jack socket and separate on/off switch can obviously be used if preferred. A jack socket having isolated d.p.d.t. contacts is specified for JK1 merely because a socket having a single make contact does not seem to be available. No connections are made to most of JK1's tags.

Details of the printed circuit board are shown in Fig. 4. The NE571 is not one of the cheapest integrated circuits, therefore it is advisable to use a (16 pin) d.i.l. i.c. socket for this component. Fit Veropins to the board at the places

COMPONENTS . . .

Resistors

R1, 9	18k (2 off)
R2, 8	68k (2 off)
R3, 4	27k (2 off)
R5	10M
R6	22k
R7	390k
VR1, 2, 3	22k min skeleton pre-set (3 off)
VR4	4k7 log carbon

All fixed resistors are 0·25W 5% carbon

Capacitors

C1	100µ 10V axial elect
C2, 13	100n ceramic (2 off)
C3, 5, 8, 12	10µ 25V radial elect (4 off)
C4, 10	4µ7 63V axial elect (2 off)
C6	10n polyester
C7	4µ7 63V radial elect
C9	10µ 25V axial elect
C11	100n polyester

Semiconductors

IC1	NE571

Miscellaneous

S1	d.p.d.t. heavy-duty press-button switch
S2	Rotary on/off type switch
S3	Part of JK1
JK1	Standard jack socket with isolated d.p.d.t. contacts
JK2	Standard jack socket
B1	9 volt PP3 size

Diecast aluminium box, 150 x 80 x 50mm; printed circuit board; PP3 battery connector; two control knobs; Veropins; 16 pin d.i.l. IC socket; wire, etc.

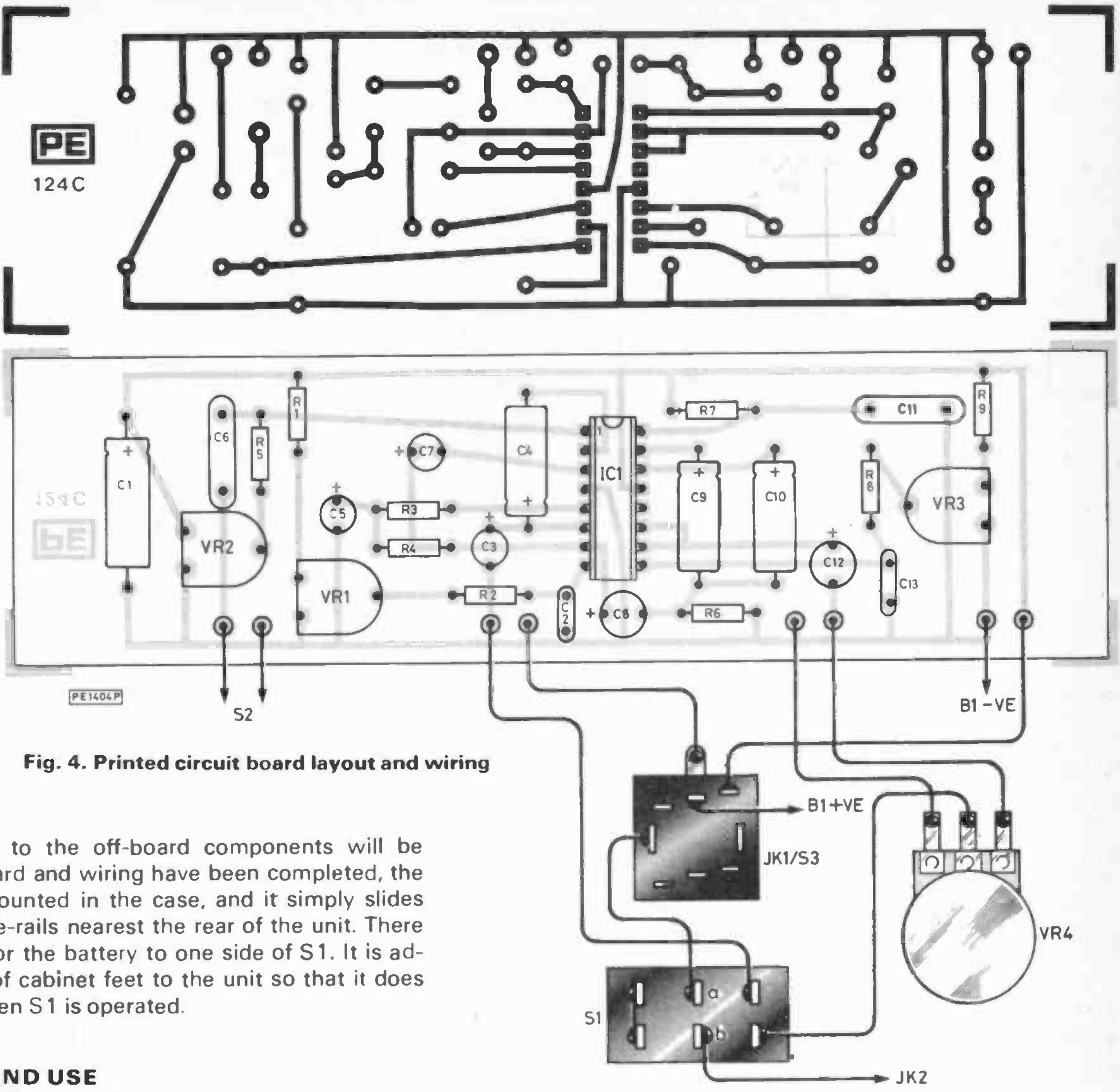


Fig. 4. Printed circuit board layout and wiring

where connections to the off-board components will be made. Once the board and wiring have been completed, the printed circuit is mounted in the case, and it simply slides into the set of guide-rails nearest the rear of the unit. There is plenty of space for the battery to one side of S1. It is advisable to fit a set of cabinet feet to the unit so that it does not slide around when S1 is operated.

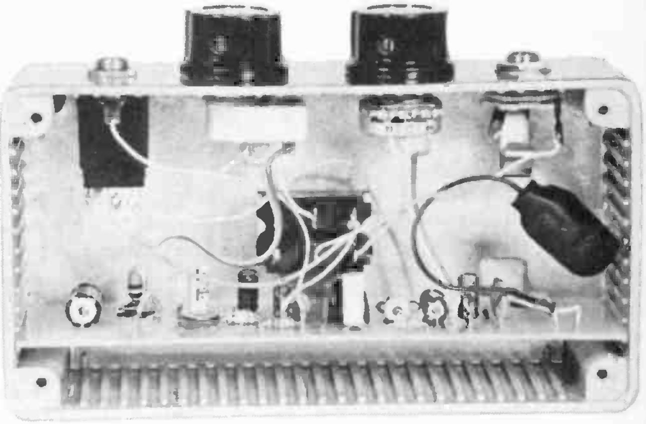
ADJUSTMENT AND USE

The guitar is connected to JK1 using a standard screened jack lead, and the output from JK2 is coupled to the guitar amplifier in the same way. Initially, all three preset potentiometers should be adjusted to a roughly mid-way setting. Using S1, it should then be possible to switch the sustain effect in and out, and with the effect switched in it should be possible to adjust the output level using VR4; this is adjusted so that the general volume obtained is much the same at both settings of S1. It is possible that a very high output guitar pick-up might give a slightly higher output than the sustain unit can provide, and the volume control of the guitar would then have to be backed-off slightly.

Potentiometers VR1 and VR3 are adjusted empirically to obtain optimum distortion performance. It is not essential to use sophisticated test equipment when doing this, and these presets can simply be adjusted to minimise audible distortion on the output. It is much easier to do this using a reasonably pure sinewave input rather than the signal from a guitar, but obviously any settings that give satisfactory results in practice can be used.

If the unit is used with a high output guitar, results will probably be better if VR2 is adjusted in an anti-clockwise direction. This reduces the gain of the circuit, which is otherwise almost certain to be excessive. A low output guitar will probably necessitate adjustment of VR2 in a clockwise direction to give a boost in gain. Otherwise, only a weak sustain effect is likely to be obtained. Really it is just a matter of using trial and error to find the setting which gives the best subjective results.

A point which has to be borne in mind when using any sustain unit is that it effectively boosts the gain of the guitar amplifier when the output of the guitar is at a low level. This increases the risk of problems with stray feedback, pick up of mains hum, etc., although in this case the built-in noise gate helps to minimise the risk of such problems. ★



AUDIO SIGNAL GENERATOR

Sine, triangular and square waves
Digital readout
Sweep ranging
Mains powered

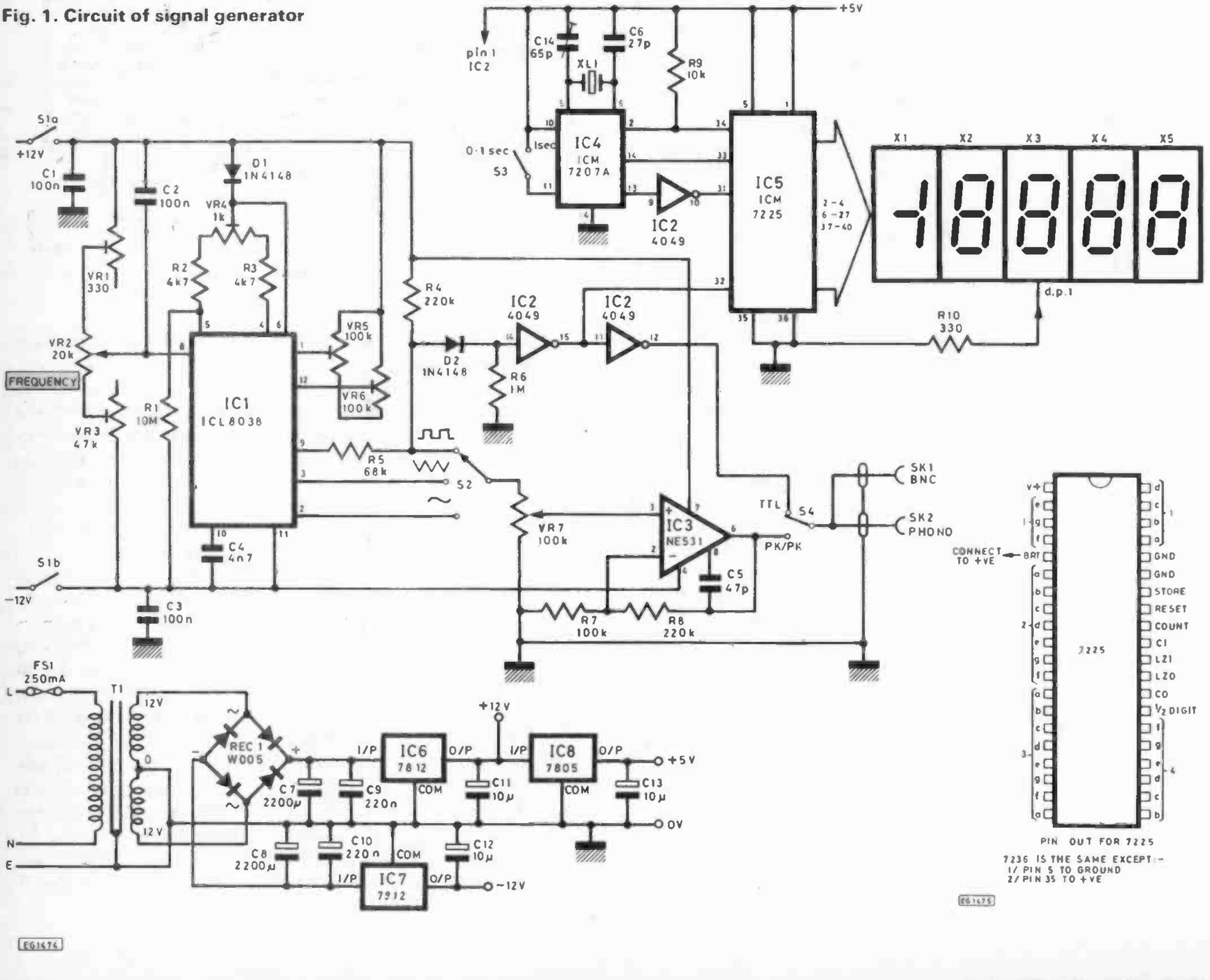
STEPHEN IBBS

THIS design provides gain control of sine, triangle and square waves via an op-amp buffer. It has a TTL output for logic applications, and gives digital readout accurate to ±1Hz. No switched ranges are used, the potentiometer giving a 1000:1 sweep range, and for this reason a multiturn pot is specified to enable accurate settings to be made easily. The unit is mains-powered, giving ±12V and +5V.

HOW IT WORKS

The heart of the signal generator is the ICL8038 voltage controlled oscillator with the following excellent features: low frequency drift with temperature, low distortion and high linearity, wide operating range (possible 0·001Hz to 300kHz), variable duty cycle from 2%–98% etc. The three waveforms are available simultaneously at pins 2, 3 and 9.

Fig. 1. Circuit of signal generator



COMPONENTS . . .

Resistors

R1	10M
R2,3	4k7
R4,8	220k
R5	68k
R6	1M
R7	100k
R9	10k
R10	330

All $\frac{1}{4}$W 10% carbon

Potentiometers

VR1	330 min preset
VR2	20k multiturn lin
VR3	47k min preset
VR4	1k min preset
VR5,6	100k min preset
VR7	100k lin (with S1)

Miscellaneous

S1—D.p.s.t.
S2—3 way rotary
S3—S.p.d.t.
S4—S.p.s.t.
XL1—5·24288MHz crystal
FS1—250mA fuse and holder
SK1—BNC socket
SK2—Phono socket
Display bezel
5-digit CA multiplexed display (GL9R03)
Centurion DX1 case
T1—0-12V, 0-12V 3VA p.c.b. mounting transformer

Semiconductors

IC1	ICL8038
IC2	4049
IC3	NE531
IC4	ICM7207A
IC5	ICM7225
IC6	7812
IC7	7912
IC8	7805
D1,2	1N4148
REC1	W005

Capacitors

C1–3	100n
C4	4n7 mica
C5	47p
C6	27p
C7,8	2200µ 25V elect
C9,10	0·22µ 25V tant
C11–13	10µ 15V tant
C14	5–65p trimmer

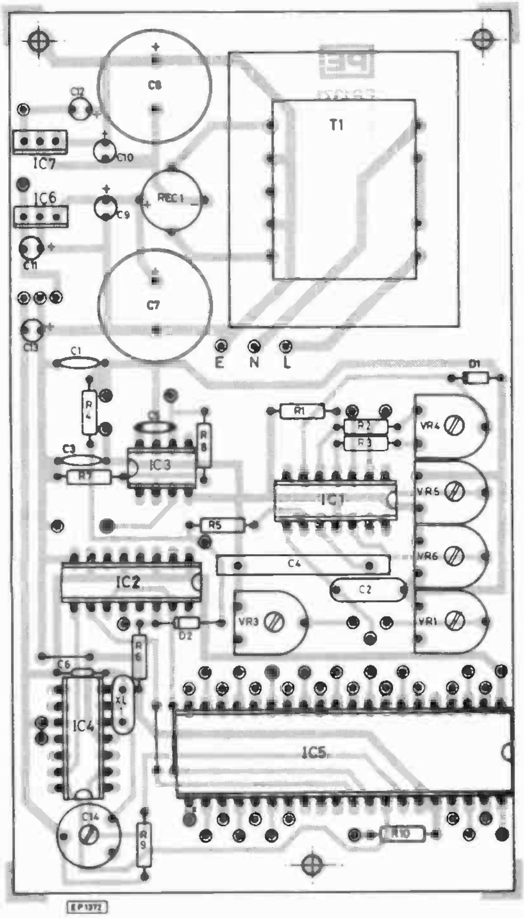


Fig. 2. Main board assembly

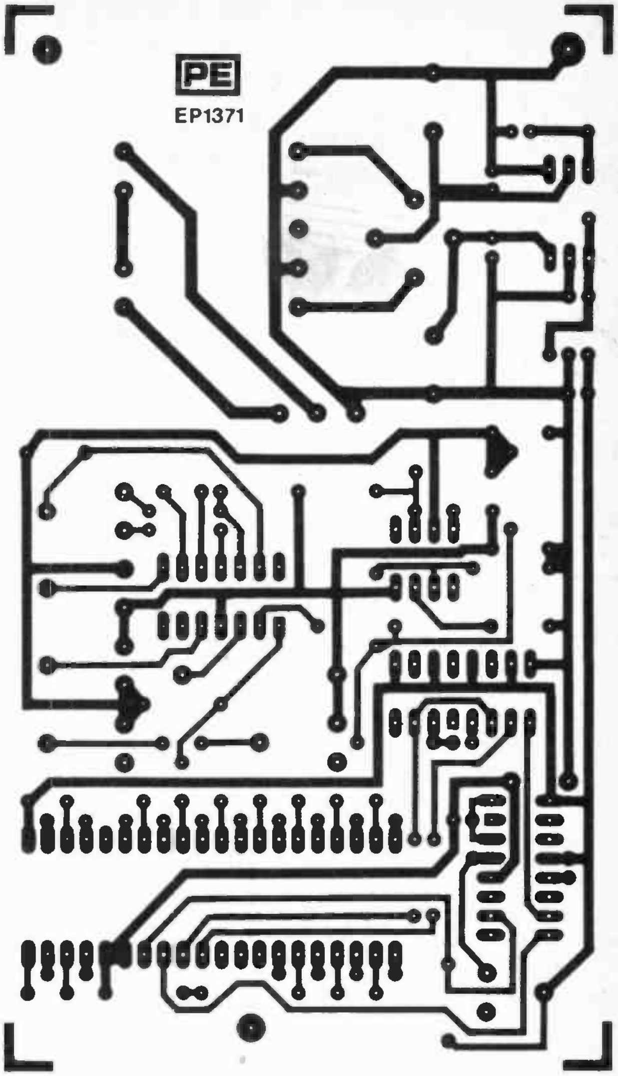


Fig. 3. Printed circuit of main board

The symmetry of the waveform can be affected by the external resistors on pins 4 and 5, and those readers who would like to vary the duty cycle to produce, e.g. short pulses or sawtooth waveforms, may like to experiment with these components. The frequency of the generator is a direct function of the voltage on pin 8, so by varying the potential divider formed by VR1, VR2, VR3, it is possible to obtain a 1000:1 sweep (i.e. 20-20,000Hz with the values selected). The presets are used to set the top and bottom limits. However, to obtain this sweep the voltage across R2 and R3 must decrease to nearly zero. This requires the highest voltage on pin 8 to exceed that at the top of R2 and R3 by a few hundred millivolts, and so D1 is included to lower the effective supply to the 8038. IC3 is included as an output buffer, and provides gain control by means of the potential divider at pin 3. The two presets on pins 1 and 12 minimise sine wave distortion, and according to the Intersil data it should be possible to reduce the distortion to 0·5% by adjusting these.

A split power supply is used because it enables all the waveforms to move symmetrically about 0V. The square wave is not committed, and so R4 is used as a load resistor. This output is also linked to two inverting gates of the 4049 which, being powered from the 5V line, gives a TTL compatible square wave signal available at the output terminals, and is used for the digital display.

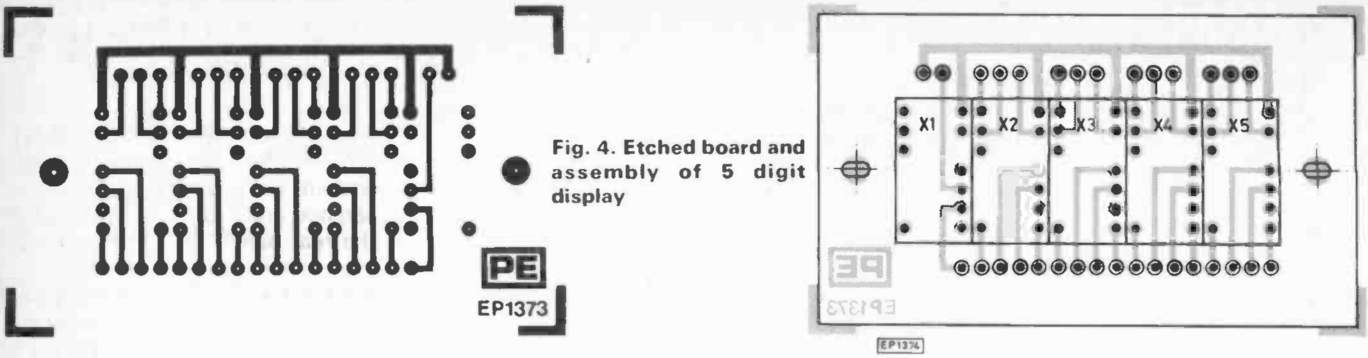


Fig. 4. Etched board and assembly of 5 digit display

An ICM7225 is used, being the simplest means of providing frequency readout. It drives a 4½ digit CA display direct, with the CA line to 5V, but needs its store, reset, and gating pulses in a specific sequence, and this is done by IC4, an ICM7207A designed for just such a purpose. This gives a 1s gate (0·1s if pin 11 is connected to 5V) to give readings of Hertz, and IC2 inverts the count inhibit output to provide the gating input to the 7225. For readers who wish to use a CC display (possibly the miniature FND357) the 7225 can be replaced with the 7236. Though the data sheets specify this as a device for driving vacuum fluorescent displays, it will also drive the CC type. The pin out is exactly the same as the 7225 except that pin 5 should be grounded and pin 35 (at present connected to 0V) should instead be connected to +5V. Otherwise simply connect the display segments as shown, and the CC line to 0V.

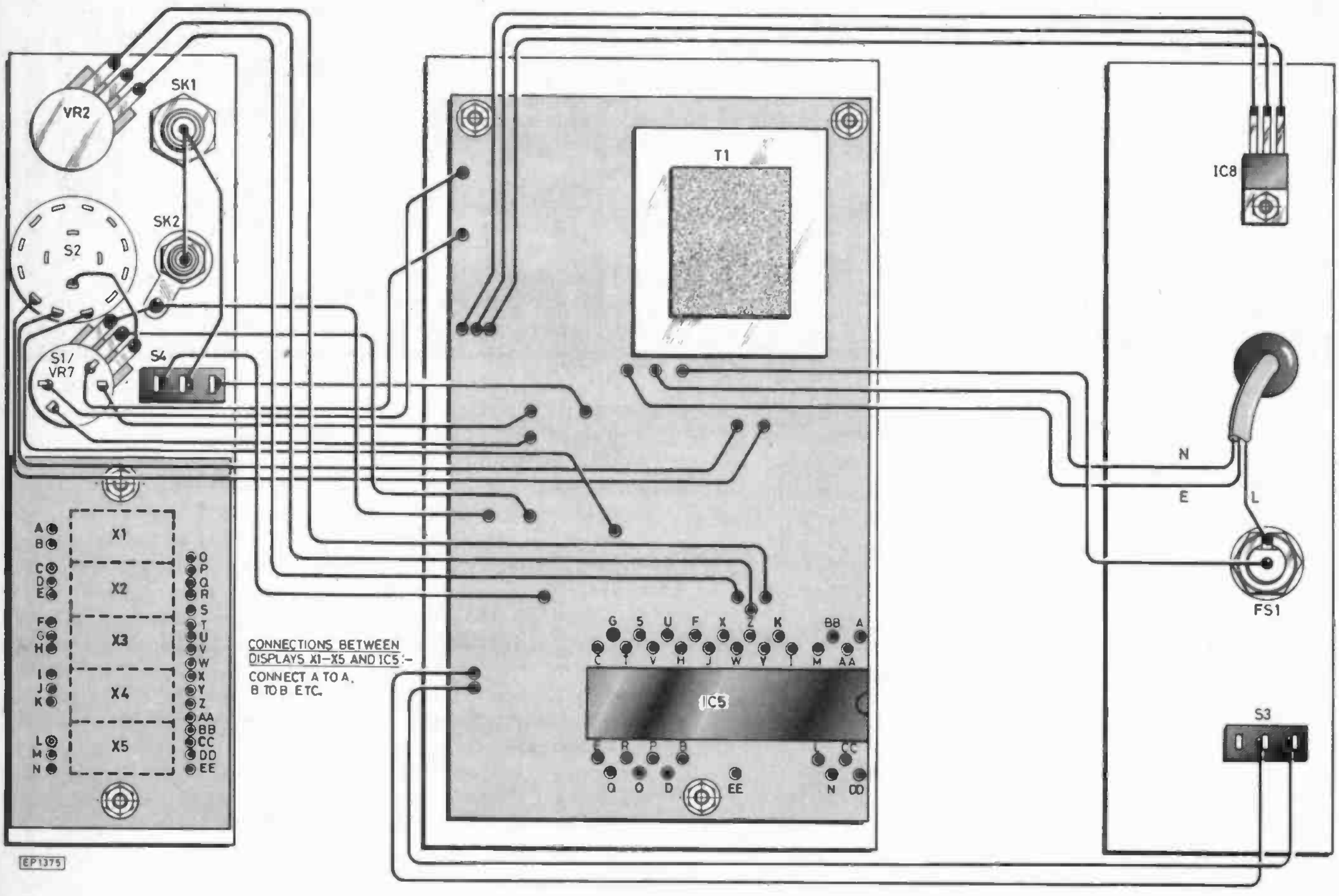
The power supply is straightforward and consists of a 3VA, 0-12, 0-12V transformer arranged in a 12-0-12V centre tapped configuration. The secondary a.c. is then rectified and smoothed before being regulated by IC6 and IC7 to give ±12V controlled by S1. The 12V also feeds the 5V regulator which supplies IC2, 4, 5. This line is not switched because it would have meant that VR7, incorporating only a two-pole switch, could not be used. It is therefore made to power the decimal point of the least significant digit to show that the mains supply is on.

CONSTRUCTION

The project uses two p.c.b.s, details of which are given in Figs. 3 and 4.

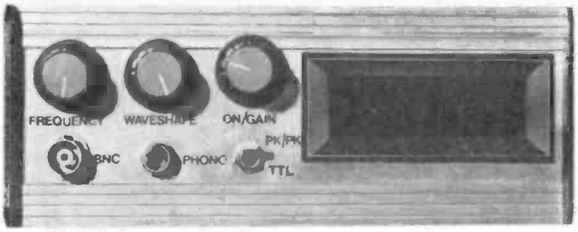
Mount the power supply components, making sure that the regulators are inserted the right way round. The 7805 is mounted on the rear panel.

After checking, attach a mains lead, switch on and make sure that ±12V and 5V appear at the 'out' pins. If all is well, switch off, and disconnect the mains before proceeding with the oscillator section. Two sets of holes are provided on the p.c.b. for C4 depending on whether polystyrene or silver



CONNECTIONS BETWEEN DISPLAYS X1–X5 AND IC5:–
CONNECT A TO A, B TO B ETC.

Fig. 5. Interwiring details of generator



mica is selected. This component needs to be of high stability to minimise frequency drift. Use Veropins for all interconnections to the p.c.b., and set all the presets to mid travel. Apply power and check, preferably with a scope, that the correct waveforms appear, and that adjusting the various presets causes some alteration to them. Check the TTL output on pins 15 and 12 of IC2 (one of them being an inversion of the other). Varying VR7 should alter the peak-to-peak level coming out of IC3 pin 6. Again if all is well, switch off, and insert the components associated with the digital readout. The digits are connected with ribbon cable to make possible fault-tracing easier. By monitoring pins 2, 13, 14 of IC4 it should be possible to see the count inhibit pulse switching at a 1Hz rate, and the reset and store pins producing short negative going pulses. Connecting pin 11 of IC4 to +5V will reduce the gate time to 0·1s, speeding up any change in reading, but this does reduce the resolution to 10Hz, and this can be included via a toggle switch if desired.

If everything is working satisfactorily, the p.c.b. can be bolted to the base panel of the Centurion DX1 case. It is a very tight fit, but the result is a neat compact unit.

A ten-turn pot was used for VR2 to make resolution easier but the author chose not to include a ten-turn dial, being superfluous with a digital readout. The display incorporates a bezel to improve the appearance and hide possible ragged edges. Drill two holes in the rear panel for the strain relief bush and mains fuse.

After a final check the unit can be calibrated by adjusting trimmer C14 with reference to a reliable source, but in practice it was found that setting it to mid travel was accurate enough for all but the most demanding purposes. VR5 and VR6 are adjusted to give a good shape to the positive and negative peaks of the sine wave, whilst VR4 alters the duty cycle, most easily set using the square wave output. VR3 is then adjusted to give a reading of 20kHz and VR1 a reading of 20Hz. These presets interact and repeated adjustments are necessary. Note that above 20kHz, the $\frac{1}{2}$ digit will remain lit, and give misleading results, so the prototype was set with a top limit of 19500 to avoid confusion. When these adjustments are complete, the case can be screwed together, and any front panel markings, e.g. Letraset, added. If readers are concerned about the buffer being a d.c. amp, it can easily be modified to one of the standard a.c. op-amp configurations. ★

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A set of parts to build a complete stand-alone alarm system which may be mounted on the wall, or placed on a shelf or table. A few soldered joints and simple assembly is all that is required to complete this kit; an external horn or bell can be used with the unit. For further details of this advanced ultrasonic system, see 'News and Market Place' in this issue.

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FILESHEET 15 NSC800

WE have now covered most of the common 8 and 16 bit multi-chip processor families, followed by their single-chip cousins, and the time has now come to take a look at the few remaining processors which either did not fit readily into those earlier categories or were not widely available when the series began.

In March we looked at the single-chip 8070 family, and I highlighted the uninspiring microprocessor track record of its manufacturer, National Semiconductor, which despite some very good ideas had not been able to shake the market stranglehold enjoyed by the Intel, Zilog, Motorola, "big-three". In the next two file articles we are therefore going to examine two other, fairly new, devices from the National stable which are expected by their sponsor to break the existing mould and to turn the "big-three" into the "big-four". See what you think!

First let's look at the National NSC800, an interesting 8 bit multi-chip design which is already beginning to take-off well in the expanding market for battery operated microprocessor systems where its low power CMOS technology gives it an instant advantage.

It all started with the development by National of a new CMOS processing technology which combined, for the first time, the functional density of NMOS with the low power requirements of CMOS. National called this technology P²CMOS, and set about the task of designing a new processor to make use of it.

In order that they might capitalise on their new technology as quickly as possible, before everyone else could catch up, National decided not to face the certain delays involved in a brand new architecture, but to use an existing architecture instead. The trouble was, National did not have a suitable 8 bit NMOS processor of their own since their indigenous 8060 (SC/MP) design was becoming obsolete and their other 8 bit processor, the 8080A, was just a second source to the Intel design which itself was well past its prime. National therefore examined all the offerings of their competitors and decided that the impressive success of the Zilog Z80 and its powerful instruction set was the act they wanted to follow. Unfortunately, they also felt that the un-multiplexed Z80 bus structure was not as neat as that of the multiplexed Intel 8085, and so they decided to use their P²CMOS technology to demonstrate that you *can* have a cake and eat it too, by building a CMOS Z80 with an 8085 bus interface. The NSC800 was born!

Of course there were CMOS microprocessors already available, particularly the RCA 1802, but these early devices had to pay quite a price for their low power consumption and suffered from low operating speeds and a primitive architecture. By having the capability to put the Z80 register and instruction set inside a package using the efficient 8085 bus interface, running at the full Z80 clock rates of up to 4MHz and with a low power consumption to boot, National felt they were bound to produce a winner.

To back up the impressive capabilities of the NSC800, National also designed two multi-function P²CMOS peripheral chips based on the Intel 8155 and 8355 devices, to allow the design of a system with 2K of ROM, 128 bytes of RAM, 42 I/O lines and two 16 bit programmable timers, but needing only three 40 pin chips.

The NSC800 and its support chips have been available for about 2 years now, and success has certainly been achieved to the extent that the National device has ousted the RCA 1802 from its position as the foremost CMOS processor, and has won ready acceptance in battery powered applications thanks to its powerful architecture and its ability to run the vast library of available 8080 and Z80 software, including the ubiquitous CP/M operating system.

Promising as this may be however, the NSC800 is unlikely to make National's fortune. For a start, the NSC800 is several times more expensive than the NMOS Z80, making it a natural choice *only* for battery powered applications, which taken together are a relatively small fraction of the total microprocessor market. Secondly, other manufacturers, particularly in Japan, have now introduced their own CMOS versions of both the Z80 and the 8085 microprocessors, and these have the great advantage that they can be plugged straight into an NMOS Z80 or 8085 socket, often with little or no circuit change. The NSC800 cannot be used in this way, and is therefore mainly specified for brand new projects where its special blend of Z80 and 8085 features can be used to advantage.

We therefore have to ask ourselves whether National have got it wrong again, by designing an admittedly superior product which in the end will be less successful than microprocessors which are simpler and therefore less expensive.

Only time will tell, but after reading more about the technical features of this excellent chip I am sure you will agree with me that National do at least *deserve* to succeed!

REGISTERS

The NSC800 has an almost identical register set to that of the Zilog Z80, which in its turn consists of a superset of the 8080/8085 registers. Register names remain the same as those used on the Z80, and anyone used to that processor, or even the earlier Intel 8080, will feel immediately at home with the NSC800.

Like the Z80, the NSC800 has two separate general purpose register banks each containing the AF, BC, DE and HL register pairs, and it has the usual 16 bit index registers IX and IY in addition to the Stack Pointer and the Program Counter. You may remember that the Z80 also had two unique 8 bit registers, I and R, which provided the base address of the Interrupt vector table and a dynamic RAM refresh count respectively. These have been retained on the NSC800 with the R register now having a modification to enable it to provide a full 8 bit count value rather than the 7 bit count of the Z80. This is the only obvious difference between the register sets of the two processors, and it confers the useful ability to refresh the newer 64K bit DRAM chips some of which have become a problem for the Z80 since it is only directly able to refresh 16K bit devices unless additional external hardware is used.

As I pointed out on File Sheet 3, the Z80 has a more comprehensive register set than any of the other 8 bit multi-chip processors, and the NSC800 is therefore very well endowed in this respect.

The flags in the F register are also identical to those of the Z80, and consist of the familiar Carry, Add/Subtract, Parity/Overflow, Half Carry, Zero, and Sign bits.

INSTRUCTION SET

The NSC800 has all the Z80 instructions, and, thank goodness, they all use the same mnemonics (for this reason we have not shown the instruction set here) so that any Z80 based machine with an assembler can easily be used to produce object code for the National processor.

Like the Z80, the NSC800 instruction set contains all of the 8080 instructions too, although as before, most mnemonics have been changed so that compatibility exists only at the object code level. The two additional 8085 instructions, RIM and SIM, which manipulated the Interrupt Mask and provided a serial I/O facility are missing from the NSC800 set however, and this is because the two serial I/O lines of the 8085, SID and SOD, have been sacrified to provide the new NSC800 pin functions Refresh and Power Save.

Although the RIM and SIM instructions are not available, some functions of the additional Interrupt Mask Register of the 8085, which provided individual status and enable flags for the three fixed

NSC 800 REFERENCE FILE SHEET

GENERAL

The use of low power CMOS technology combined with an 8085 bus structure and the full Z80 instruction set makes the NSC 800 a unique and interesting processor. This device has become very popular for battery powered applications, but due to a higher price tag than that enjoyed by NMOS prooessors and some recent competition from CMOS pin compatible versions of the Z80 and 8085 it may not turn out to be the great success that National had hoped for. It is without a doubt however the most powerful 8 bit CMOS processor available and is ideal for "few-chip" battery powered systems.

REGISTERS

The NSC 800 register set is identical to that of the Z80 except that the refresh counter register (R) is 8 bits (rather than 7 bits) long. This allows easy interface to the 64K RAM chips now available.

A (8)	F (8)	A' (8)	F' (8)
B	C	B'	C'
D	E	D'	E'
H	L	H'	L'
INTERRUPT VECTOR I	MEMORY REFRESH R		

INDEX REGISTER	IX
INDEX REGISTER	IY
STACK POINTER	SP
PROGRAM COUNTER	PC

ALTERNATE SET

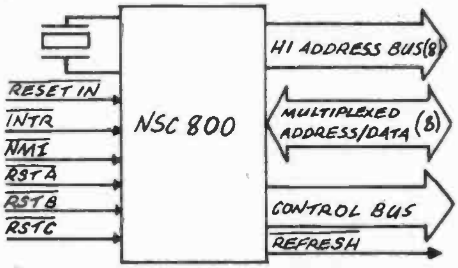
Like the Z80, the main register bank can be swopped with the alternate bank by issuing an Exx instruction.

FLAGS

D7	D6	D5	D4	D3	D2	D1	D0
SIGN	ZERO		HALF CARRY		PARITY & OVERFLOW	SUBTRACT	CARRY

INSTRUCTION SET AND SOFTWARE

The NSC 800 uses the full Z80 instruction set with no additions or deletions, and uses standard Z80 mnemonics so that any Z80 based system can be used for software development. It is upwards compatible with the 8080 and 8085 at the object code level apart from the two 8086 specials RIM & SIM. It is fully compatible with the CP/M O.S. and therefore has access to a very large software library.



BASIC SINGLE CHIP CPU CIRCUIT

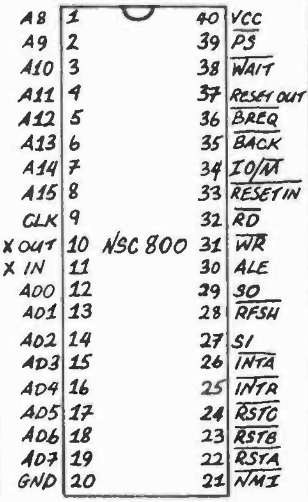
PERFORMANCE DATA

	NSC 800
MEMORY ADDRESS RANGE :	64K
I/O ADDRESS RANGE :	256
CLOCK FREQUENCY :	2·5MHz*
POWER SUPPLIES :	+3 → +12v
INTERRUPTS :	$\overline{INT}$ $\overline{NMI}$ $\overline{RSTA}$ $\overline{RSTB}$ $\overline{RSTC}$

* NOTE : 4MHz VERSION ALSO AVAILABLE

BENCHMARKS

	NSC 800
ADD REGISTER TO ACCUM	1·6µs
OUTPUT ACCUM TO PORT	4·8µs
MOVE FROM MEMORY TO MEMORY	6·4µs



NSC 800 VERSUS Z80 AND 8085 A COMPARISON:

FEATURE	NSC 800	Z80	8085
1 SUPPLY VOLTAGE	3→12	5	5
2 CONSUMPTION	50mW	750mW	850mW
3 DYNAMIC RAM RFSH	YES	YES	NO
4 INTERRUPTS	5	2	5
5 ON CHIP CLOCK	YES	NO	YES
6 NO. OF INSTRUCTIONS	158	158	80
7 NO. OF REGISTERS	22	22	10
8 BLOCK INSTRUCTIONS	YES	YES	NO
9 TECHNOLOGY	CMOS	NMOS	NMOS
10 PACKAGE PINS	40	40	40

MANUFACTURERS

ORIGINATOR : NATIONAL SEMICONDUCTOR

2ND. SOURCES : SMC, EUROTECHNIQUE

SUPPORT CHIPS

THE NSC 800 PERIPHERAL CHIP FAMILY IS MODELLED ON THAT OF THE 8085 AND INCLUDES THE NSC 830 ROM, I/O (LIKE 8355) AND THE NSC 810 RAM, I/O, TIMER (LIKE 8155) BOTH IN LOW POWER CMOS. Z80 AND 8080 PERIPHERALS CAN ALSO BE USED IF REQUIRED.

vector interrupts, have been retained in the NSC800 via a special 4 bit Interrupt Control Register (ICR). This register is unique to the NSC800 and has to be accessed via an OUT instruction to I/O address OBBH. Anyone who is familiar with the 8085 will soon find that the NSC800 RST A, B and C interrupts which are intended to be similar to the RST 5.5, 6.5 and 7.5 of the 8085, are in fact quite different in some respects, so be careful!

There is no need for me to examine the NSC800 instruction set in detail, since this was done quite adequately in the Z80 file article. Suffice to say that those useful bit Set, Test, and Reset, instructions, BCD Shifts and Block Moves are all alive and well.

Since all the instructions are the same you would expect the addressing modes to be the same too, although National have put their stamp on things by renaming the Extended mode of the Z80 as the Direct mode, which is an improvement, I suppose.

SOFTWARE

With full 8080 and Z80 compatibility there is definitely no shortage of software for the NSC800 since it can share the huge existing library built up for those processors over the years. The CP/M disc operating system provides the easiest gateway to this library, although whether it is likely that the low power advantages of the NSC800 could ever be fully appreciated in a system which uses a couple of floppy disc drives is quite another quesion!

More important perhaps, is the possibility of using an existing Z80 based personal computer as a host development system for battery powered NSC800 target systems. Almost any Z80 system with an assembler and a PROM programmer could be used, including the humble Sinclair Spectrum, but a system with floppy discs and running the CP/M DOS would be ideal.

So far as I am aware, there are no personal computers which actually use an NSC800 CPU, but this is only of academic importance to the programmer.

INTERFACING

The NSC800 is not pin compatible with either the Z80 or the 8085, although it most closely resembles the latter. Some of the 8085 pins which have similar functions on the NSC800 have been renamed by National to confuse the enemy, so that TRAP becomes NMI and Ready becomes Wait. Some other pins have changed not only their names but also their functions. In the 8085 two pins HOLD and HOLDA provide a handshake to permit other devices to request, and then use, the data and address buses. In the NSC800 these functions are provided by the aptly named BREQ and BACK but with the difference that the logic polarities have been inverted to be the same as those of the Z80.

The new function RFSH is also identical to the Z80 pin of this name, but with the previously mentioned advantage of an 8 bit refresh address being provided on the multiplexed bus. The PS input pin is unique to the NSC800 and complements the low power operation of the CMOS processor by invoking a very low power standby mode in which the processor clock is suspended to reduce consumption. Since it is intended that the processor itself should control this pin in most circumstances, it would seem more appropriate to provide this function via a special instruction rather than by external hardware, but in its present form it does also provide the useful facility of a single step mode when driven by a couple of external latches.

The P²CMOS technology of the NSC800 confers several other advantages in addition to low power consumption. Instead of the usual rigidly imposed 5 volt power supply voltage, the NSC800 can operate over a 3 to 12 volt range and does not need tight voltage regulation. Noise immunity too, can be better in CMOS systems, and the low internal heat dissipation makes it possible for some NSC800 versions to be specified for the very wide ambient temperature range of −55 degrees C to +125 degrees C.

The 8085 bus structure is a good choice for the NSC800 since it multiplexes the 8 low order address bits with the data bus to save package pins for other functions. In systems using standard peripheral components such as 27C16 CMOS EPROMs or 16K static CMOS RAM chips the bus has to be demultiplexed externally using an 8 bit CMOS latch such as the MM82PC12. An 8085-like Address Latch Enable (ALE) output is provided to capture this address information from the multiplexed bus.

For many applications however, it may not be necessary to use a separate address latch since the two special I/O devices coded NSC810 and NSC830 contain internal demultiplexing circuitry for this purpose.

The NSC810 is a 40 pin P²CMOS device which features 128 bytes of static RAM, 22 parallel I/O lines and two programmable 16 bit timer/counters. In most respects this device is similar to the 8155 from the 8085 family but it differs in having two timer counters instead of one, each having superior features to the single 8155 circuit.

The NSC830 is also a 40 pin P²CMOS device, but in this case containing 2K bytes of masked ROM and 22 I/O lines. Masked ROM is of no use for low volume applications of course, but there is a companion device, the NSC831, which only has the I/O lines. Unfortunately there is no EPROM version equivalent to the 8755.

The NSC800 is particularly well endowed with interrupt inputs and modes, inherited from both the Z80 and the 8085 and providing a high level of compatibility with both devices.

There are four fixed vector interrupts, NMI, RSTA, RSTB and RSTC, all of which result in a direct vector to locations in low memory. NMI is of course non maskable, but the other three can be individually masked by clearing the appropriate bit in the Interrupt Control Register (ICR), or collectively masked by issuing a DI (Disable Interrupts) instruction. The NMI interrupt input is edge triggered but the other three are all level sensitive; while the input pin is pulled low an interrupt is continuously asserted.

In addition to the fixed vector interrupts there is a single multimode interrupt INTR, which operates in the same way as the Z80 input of that name. This input can be set up by the program instructions IM0, IM1 and IM2 to respond in one of three different modes depending on the system configuration and the peripheral devices.

Interrupt Mode 0 is similar to the standard 8080 interrupt which requires an interrupting device to respond to the Interrupt Acknowledge output (INTA) by placing a suitable instruction on the data bus (usually a 3 byte Call, but one could use the simpler 1 byte Restart). This mode is particularly useful when a number of vectored interrupts need to be handled and the system includes an interrupt controller chip such as the Intel 8259.

Interrupt Mode 1 is the simplest mode since it turns the general purpose INTR pin into an additional fixed vector input making a new total of five. This is the most useful mode for many all-CMOS systems, since as far as I can discover, there is no CMOS equivalent to the 8259, and there are no CMOS equivalents to the Zilog peripherals either.

Interrupt Mode 2 is the most powerful mode since in this case the INTA output is used to read a single byte vector from the interrupting device which is subsequently concatenated with the contents of the I register to form a 16 bit pointer into a 128 entry vector table which can be located anywhere in memory. Unfortunately, the external logic required to generate the appropriate response is quite complex, and neither of the two National peripherals (NSC810 and NSC830) have the necessary facilities to support this mode, a surprising omission. Perhaps National intend (or intended) to produce an interrupt controller which supports this facility, but without it the only easy way to use Mode 2 is to choose NMOS Zilog peripheral chips such as the PIO and CTC devices.

Although National have not produced many CMOS LSI peripheral devices for the NSC800, they have performed much better in the provision of CMOS "glue" ports, since a useful range of gates, decoders and latches is available, all fabricated in P²CMOS.

APPLICATIONS

The NSC800 should be considered for all battery powered microprocessor applications since it offers a powerful architecture and instruction set, an excellent bus structure, and all the low power advantages of CMOS technology. If the need is to convert an existing NMOS8085 or Z80 system for a low power application, however, it may be easier to use one of the pin compatible CMOS versions of those processors (80C85, Z80C) which are now becoming available.

If the intended application is to be mains powered, then it is unlikely that the NSC800 could be considered cost effective unless the reduced cooling requirements or the particular attractions of a Z80 architecture and an 8085 bus are dominant factors.

A nice try National, but perhaps you should listen more closely to the market research team rather than allow those bells-and-whistles engineers to call the shots!

all in your JUNE issue!

HYPERCHASER

LIGHTING EFFECTS UNIT

A dynamic light sequencer using an EPROM for light pattern memory, allowing preset light shows to be initiated at the touch of a button. This robust, 4-channel unit also features "shimmer dimmer" for kinetic dance floor effects, and sound triggered effects. Zero voltage switching extends the life of the display lamps.

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JUNE ISSUE ON SALE FRIDAY 4th MAY 1984

15/4

VERNON TRENT *at Large!*

V.T.'s views and opinions are entirely his own and not necessarily those of PE

THE late David Cohen came into the radio business in Birmingham before the second world war. He began, as so many of the old pioneers did, by offering a battery-charging service. He then gradually extended his business into the retail and mail order equipment supply areas. His avowed policy—and you can't have better roots—was to sell competitive goods of a quality commensurate with what the man in the street could afford.

As well as being an ambitious man of business, David Cohen was also a patriot—which may seem a bit old-fashioned by today's cynical standards. So when Hitler got up to his tricks—which eventually, as we know, did him no good at all—David wound up his business, moved to London and offered to do whatever he could to help the war effort.

His son, Les, who now runs the firm which is still called Radio & Television Components Ltd., said: "My father, who was entirely self-taught, got a job as an inspector with EMI, then called The Gramophone Company. And I'm convinced he did a good job, because he was that sort of man. But when the end of the war came he was given the push. This is no criticism of EMI, with whom we still have friendly ties. It was the vogue. In those days, anyone who had a disability which prevented them going into the services, as in my father's case, tended to be regarded as a second-class citizen."

But, disability or not, the drive was still there. David launched himself into the Government surplus business. He built and marketed radio receivers made from broken-down Government equipment and housed in cabinets made out of ammunition boxes. Another venture, on the components side, was to acquire a consignment of dried-out Mullard electrolytics at 2/6d (12½p) each. He discovered a method of reforming them and sold them at £1 a time. The Cohen enterprise at that time was being run from the family's back garden and neighbours were not happy about the situation. So David took over premises in Acton, West London, and from there he edged his way into other spheres. One of them was stereo, using for the first time, Les claims, an integrated circuit.

Although the firm now concentrates on the retail and mail order trade—with the accent on the former—from the Acton branch and another in London's Edgware Road—it still manufactures such items as TV sound tuners, stereo cassette players in kit form and 125W power amplifiers.

Les, who literally learned the game at his father's knee, recalls how from his earliest years he was totally involved in the operation. "I was weaned on electronics," he says. "Just after the war there were very few toys about. At that time, with my father knee-deep in the Government-surplus trade, I never had such a thing as a train set for Christmas. Instead, I had a rubber dinghy. Or an ex-WD box-kite (used for meteorology) or a transmitter/receiver. My destiny was plain to see.

"The fascination of electronics," he continued, "is that there is always something new and exciting round the corner. But it is a matter for regret that so many of our young constructors lack the ability or interest to keep up with the pace. Why, some of them don't even know how to solder!"

Another of the tragedies of our time, thinks Les, is that 90 per cent of electronic equipment in use today is made outside the UK. "To think," he said, "that at one time we had it all in the palm of our hand. There were the great names like Murphy, Bush, Leak and a whole host of others, now dead and gone. And why? Poor marketing, perhaps? Complacency? Who knows? You know, someone once said that the perfect product would be designed by the British, made by the Germans and marketed by the French. How valid that is I don't know. But perhaps we're not as European in our thinking as we ought to be.

"Curiouser and curiouser"

"Deep down I like to think that I'm a good European. But now and then I can't help reminding myself that it's that strip of water between Dover and Calais that's saved our rather special way of life so many times. You just can't ignore that.

"Once upon a time we had a strong Commonwealth market that would take everything—including all the rubbish—we had to offer. And then when we went into the Common Market we lost a lot of friends.

"Today we seem to lack a sense of purpose. Go into any factory and you'll see people running around doing nothing. People just haven't come to terms with reality. The good times we knew in the past are, for goodness sake, over. It's now a matter of the survival of the fittest. Management don't, in the main, look far enough ahead. That's why we've lost out in so many markets. Our ceramics industry—once the envy of the world—has virtually gone. Our cutlery—once universally unrivalled—has gone. Our motor cycle industry has been killed stone dead.

"It would be foolish, of course, to deny that the Japanese goods which flood our markets are anything but excellent. But why is this so? Is it because of their total dedication to corporate objectives which, possibly because of differences in national outlook and temperament, we lack? Alright, this may be so. But what is more significant, I think, is that whereas, when we find a successful product we go on to discontinue it and put something we feel is even better in its place, the Japanese push and push and, only when they have completely captured that particular market, do they go on to update. Really, it's all so simple. In the audio area, for instance, it costs the same to make something within 1000th of an inch as a half-inch."

Napoleon designated the British as a nation of shopkeepers. Les thought it was Hitler, but I forgave him because he's a young man who probably didn't care much for history as a schoolboy—he was too tied up with electronics. But if Napoleon was right, isn't it time we did something about changing that image? It is laudable to be an efficient supplier. But it is even more laudable—and essential to ensure our economic future—that we should be a good salesman as well.

My goodness, Les. You *have* thrown the cat among the pigeons.

* * *

Electronics and its applications knows no bounds. Hotelier Peter Rudd, according to reports reaching my ears, is offering cut-price weekends at his Norfolk establishment for chronic snorers. Apparently he is prepared to give them accommodation in a special (sound proof?) wing, where their nocturnal snortings will be monitored and measured by night porters equipped with decibel meters. And there will be prizes for those generating the most ear-splitting row.

He goes even further than that, if my informant is to be believed. To ensure that the participants are worked up to maximum pig-noise capacity by night, he takes them on daytime visits to the neighbouring villages of Great and Little Snoring.

But it is clear that this lively inn-keeper is setting a trend which could spread. What about a similar facility for those who are prone to talking in their sleep? It is a well-known fact that the truth, the whole truth and nothing but the truth tends to emerge during mutterings in the wee small hours and it is important that this soul-baring should be handled in a controlled way. So why doesn't Mr. Rudd organise weekends for those with something on their minds? In the secure atmosphere of his hotel they would be able to babble away to their heart's content and purge their systems of what could otherwise be a death blow to marital harmony.

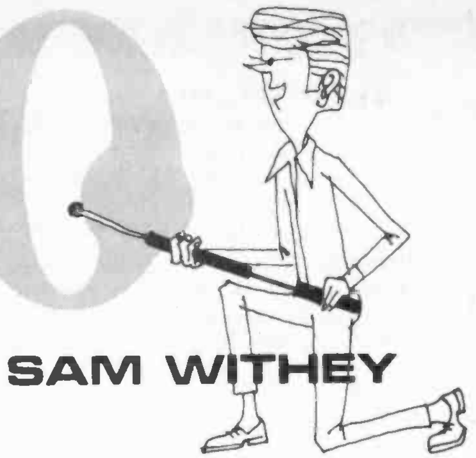
Whether such revelations should be taped by the prowling porters is quite another matter. But certainly a playback session—with immediate destruction of the recordings afterwards—would be a much more entertaining diversion than Monopoly.

* * *

Here's an odd remark attributed to Patrick Cody, managing director of STV, when announcing his company's plans. He's quoted as saying "we specialise in entertainment. *We make no pretence or apology for that.*"

Now, what did the gentleman mean? Surely, entertainment is what people are paying out their pounds for. So why should anyone pretend anything else? And why should an apology be forthcoming for a pledge to deliver the goods the client rightly looks forward to? As Alice said: "Curiouser and curiouser . . ."

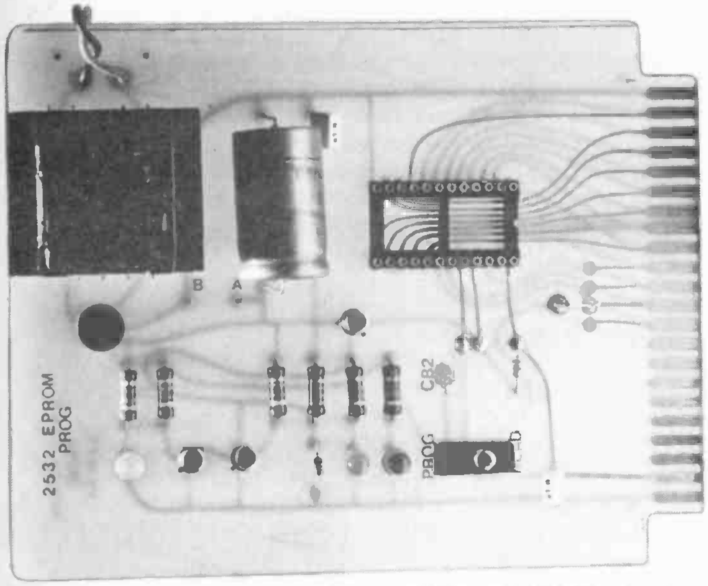
EXPANDING THE VIC 20



PART SEVEN

SAM WITHEY

2532 EPROM PROGRAMMER . . .



FOR AROUND £8

SINCE the Vic 20 ROM board described in Part 1 of this series is designed to accommodate 2 x 2532 EPROMs it was decided that there was little point in building a complex programmer for use with the Vic 20, even though it is possible to use 2716 EPROMs. Further to this, the falling cost of the 4K ROM is conducive to adopting it as a standard instead of the 2716. The programmer described here uses the minimum of components required to fulfil the necessary operations needed to test, read, program and verify a 2532 EPROM, instructions to the operator and other functions being carried out under software control. Unlike most microcomputers, the Vic 20 has address and data lines available at the expansion port, cutting the components count of the EPROM programmer by several costly i.c.s.

EPROM PROGRAMMING

When "clean" every bit in the memory matrix of an EPROM is set *high* and since these are presented on the screen of a computer in bytes, each byte has the Hex value FF (1111 1111). To program the EPROM, some of the bits are brought *low* to logic "0". The Hex value CA would be represented by the bit pattern 1100 1010. In order to bring the required bits *low*, a high voltage pulse of 50ms duration has to be applied to the bit in question. This is carried out by first of all applying a *high* (25V) voltage to Vpp (pin 21) and then applying the 50ms pulse at CE (pin 20) when pointing to the particular memory bit to be brought *low*. This is carried out sequentially throughout the 4096 bytes (32768 bits) contained in the 2532.

Programming is carried out in four stages. The first function of a programming sequence should be to check that the EPROM is clear, i.e. all bits set *high*. This is carried out in the Read mode. The second stage sets the programmer circuit to Program mode. Next is the actual programming, consisting of comparing with a 4K byte section of RAM bit by bit and bringing bits *low* where required. The third stage compares, or Verifies the programmed EPROM with the RAM section, indicating any bits left *high* that should have been brought *low* and listing them, before announcing that the operation is finished. Finally the EPROM board is returned to the Read mode before removal of the EPROM from its socket. Reading EPROMs is similar to Verification. For those possessing Vicmon, this has a facility built in. Because of the vast quantity of information being processed, it is usual to program in machine code, the whole sequence described above taking between 3 to 5 minutes for a 2532. Again, those who have Vicmon will find many subroutines in this package that they can use.

A typical programming sequence would follow these lines:

(a) Set Prog/Read switch to Read – Check
(b) Insert EPROM in socket – Check pin orientation
(c) Has Data been entered into RAM – Check
(d) Define Start and End of RAM area – Check
(e) Define Start and End of ROM area – Check
(f) Will total RAM fit into ROM?
(g) Check that ROM is clear. All bytes set at FF Hex
(h) Check that EPROM space is free of Data held in RAM
(i) Set Prog/Read switch to Prog. Apply 26V to Vpp
(j) Program – output bit pattern to start address – toggle CB2, 50ms pulse
(k) Output bit pattern to Start + 1 – toggle CB2
(l) Repeat until program count is complete
(m) Set Prog/Read switch to Read
(n) Verify that Data in EPROM is same as Data in RAM
(o) If correct – End
(p) If not, List Bytes that do not agree
(q) Do you want to re-run from (i)?
(r) If Yes, go to (i), otherwise – End
(s) If Verification now correct – End

EPROMs can be checked for "clear" by verifying with a RAM area set to FF Hex. They can be Read by POKEing Data into RAM instead of comparing as at the Verification stage. Note that the RAM address is not usually the address where the EPROM will normally reside when in use.

ERASING EPROMS

The transparent window on the upper surface of an EPROM is normally covered with an opaque label to protect it from extraneous UV light present in daylight and household fluorescent lighting. This label is removed and the window cleaned thoroughly. The EPROM can then be erased by exposure to a 2357A wavelength ultra violet light held approximately 1 inch from the transparent window for around 20 minutes. For those who wish to construct their own unit, the Philips TUV 15W tube is suitable. This replaces an ordinary 15" fluorescent fitting and can be bought for around £10. Care must be taken to ensure that the unit is sealed in a light proof case to prevent the emission of UV light that is harmful to the eyes and hands. Commercial units are fitted with press to make switches in the lid to ensure automatic cut-off when the lid is removed.

CIRCUIT DESCRIPTION

Because the basic Vic 20 has insufficient RAM on board, it is essential that it is fitted with a mother board and at least a 3K expander card before a 4K EPROM can be programmed. The board described in this part of the series is intended for insertion into the end socket of the mother board described in Part 1 (Oct. 83), but this does not prevent it being used with other models of mother board.

Two power supply lines are required by the programmer, +5V to power the on board devices and a +25V supply used in the programming mode. The +5V supply is present at the Vic 20 edge connector on the mother board, whilst the +25V can be derived from batteries or mains. Indeed, it is suggested that batteries should be used until the unit is suitably cased to ensure isolation from the mains voltages at the transformer. Provision is made for connections to a battery supply, 4 x PP3 in series, or a similar arrangement, at the terminals of C1. In this case the transformer, rectifier bridge (BR1), C1 and C2 should be omitted.

When the 30V-36V d.c. supply is turned on it is present at the collector of TR3, which forms part of the regulated power supply. D2 is a 27V Zener diode and the supply voltage across R4, D2 causes the Zener to conduct, holding the base of TR3 at 27V. This, in turn, because of the voltage drop across the base/emitter junction, produces approximately 26·4V at the emitter and Vpp. At the same time, green l.e.d. D3 is turned on, indicating that the 27V is present at the base of TR3.

At standby, Vpp needs to be held at +5V and this is provided from the edge connector supply by way of D4 simultaneously with the removal of the 26V level. TR1 and TR2 provide noiseless switching of the Vpp supply. When in Program mode, red indicator l.e.d. D1 is turned on and the base of TR1 is connected to the +5V rail through R2, turning it hard on. This produces 0V at its collector and the base of TR2, turning TR2 off. Its collector is now at 27V, that produced by the turning on of the Zener diode. As described earlier approximately 26V reaches Vpp. In Read mode, the +5V is removed, turning off the red l.e.d. and also TR1. TR2 is now biased by R3 and turns hard on, its collector falling to 0V. This has the effect of shorting out D2 and pulling the base of TR3 to ground potential. TR3 is turned off, as is the green l.e.d. and only +5V reaches Vpp through D4. For these who might like extra indicator l.e.d.s, provision is made for monitoring the 30V signal at BR1 via R6 and yellow D5.

DPDT switch S1 is used to switch between Program and Read modes. This switches off the +5V supply to the base of TR1 and at the same time selects CB2 (User Port) for Program mode or a RAM/ROM block (Expansion Port) for Read mode to be connected to CE. Address lines A0-A11 are connected to the Expansion Port on the underside of the double sided p.c.b. D0-D7 are also taken direct from the Expansion Port on the upper surface.

CONSTRUCTION

Construction is on a double-sided glass fibre p.c.b., measuring 11 x 14cm. Holes are drilled in the following sizes:

Transistors, Zener, 1N4148: 0·8mm
D.i.l. socket, l.e.d.s, resistors, capacitors: 1mm
Bridge rectifier, transformer, mains lead: 1·3mm
DPDT switch, holes to retain mains lead: 2mm

The board is uncomplicated as far as artwork is concerned, and for those who wish to draw their own boards with etch resist pen, it is suggested that holes are drilled first by using a photo copy or tracing of the pattern taped to the p.c.b. as a guide. The holes are then used as reference points for drawing lines. The bar joining the edge connectors is used in an electro-gold-plating process, but the thin lines are useful as a guide for drawing the edge connector bars.

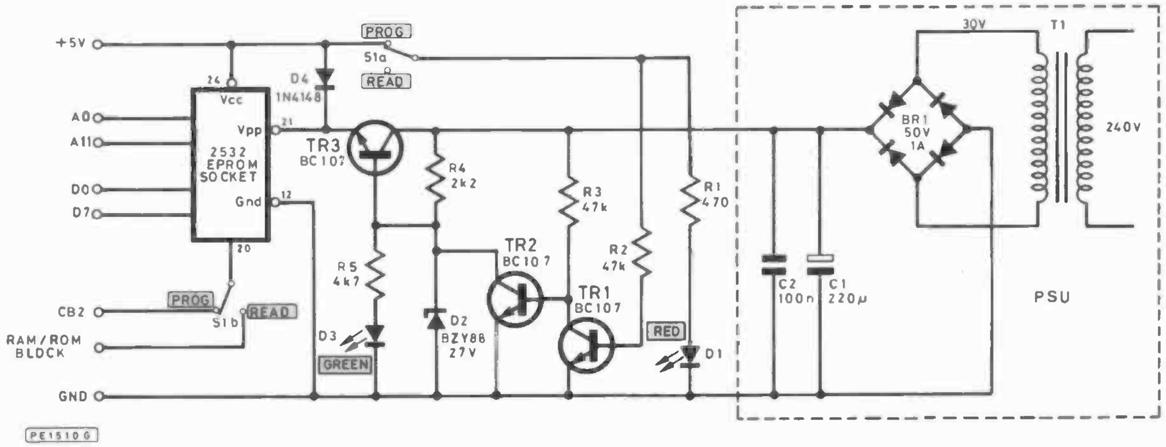


Fig. 7.1. Circuit diagram

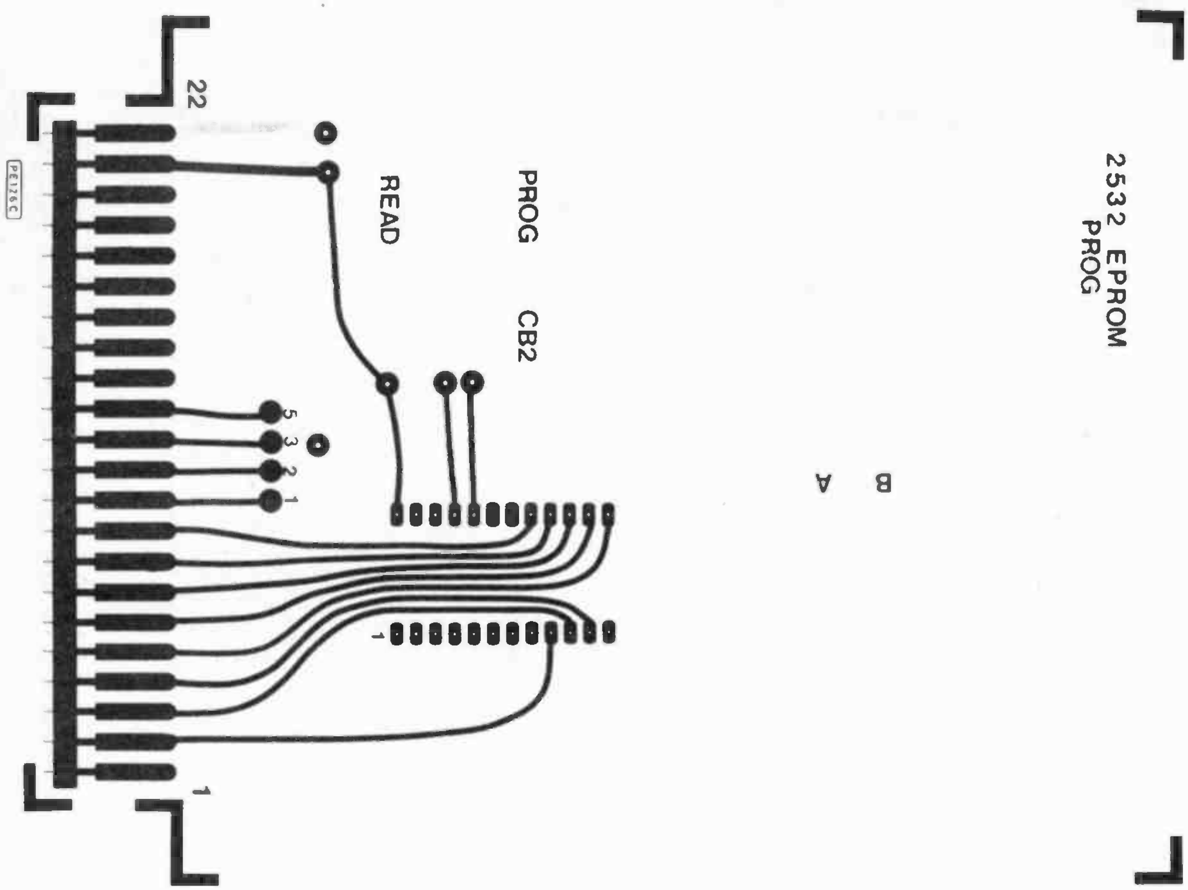


Fig. 7.2. P.c.b. track-side pattern (actual size)

THE VIC 20 SERIES . . .

Part 1 (Oct. 83) Motherboard, 8K RAM, 8K ROM expansions
Part 2 (Nov. 83) L.e.d.s & switches simulator
Part 3 (Dec. 83) 8-channel low voltage output driver board
Part 4 (Jan. 84) Mains voltage output driver, control line input interface
Part 5 (March 84) Two stepper motor drivers
Part 6 (April 84) ADC/DAC board
Part 7 (May 84) EPROM Programmer

It may interest constructors of the stepper motor interface to know that the SDB520 i.c. is available from: **Astrosyn (UK) Ltd.**, Old Outhouse, New Rd., Chatham, Kent ME4 4QJ. ✆ 0634 815175.

The above, and the following are also sources of stepper motors: **Stewart of Reading,** 110 Wykeham Rd., Reading, Berkshire RG6 1PL. ✆ 0734 68041.

In all construction work where no p.c.b. holder is available, it is advisable to start by mounting the lowest lying components first, in this case resistors and diodes. Always fit resistors with tolerance bands in the same direction. Ensure polarity is correct with diodes, cathode being indicated by a broad band for the Zener, D2 and by the coloured bands for D4. Since the anode of D4 is used as a through the board link it must be soldered on both sides of the board.

The screw holes on each side of the miniature DPDT switch are not required, so they should be snipped off and filed to make the board neater. It might be necessary to bend the tags slightly, but a few types were examined and all were 0·15" pitch as provided on the board. Care should be taken with the l.e.d.s as they can be destroyed by very little overheating. Do not insert beyond the lugs approximately $\frac{1}{4}$" from the l.e.d. and use crocodile clips or a pliers as a heat-sink on this section whilst soldering. The cathode of a l.e.d. is mostly indicated by a flattened side. Provision is made for a yellow l.e.d. as an indicator that the mains power is on. This was omitted from the circuit diagram because it is likely that it might be enclosed when shrouding the mains supply.

The long leads cut from the rectifier bridge make ideal pins for linking pins 20 and 21 of the socket to the underside of the board at the pads provided. A length can also be used to connect pin 20 CE by S1 to the edge connector Block selected. The programmer will use the lower 4K of a block, but if an 8K or 16K RAM pack is in use there must be RAM

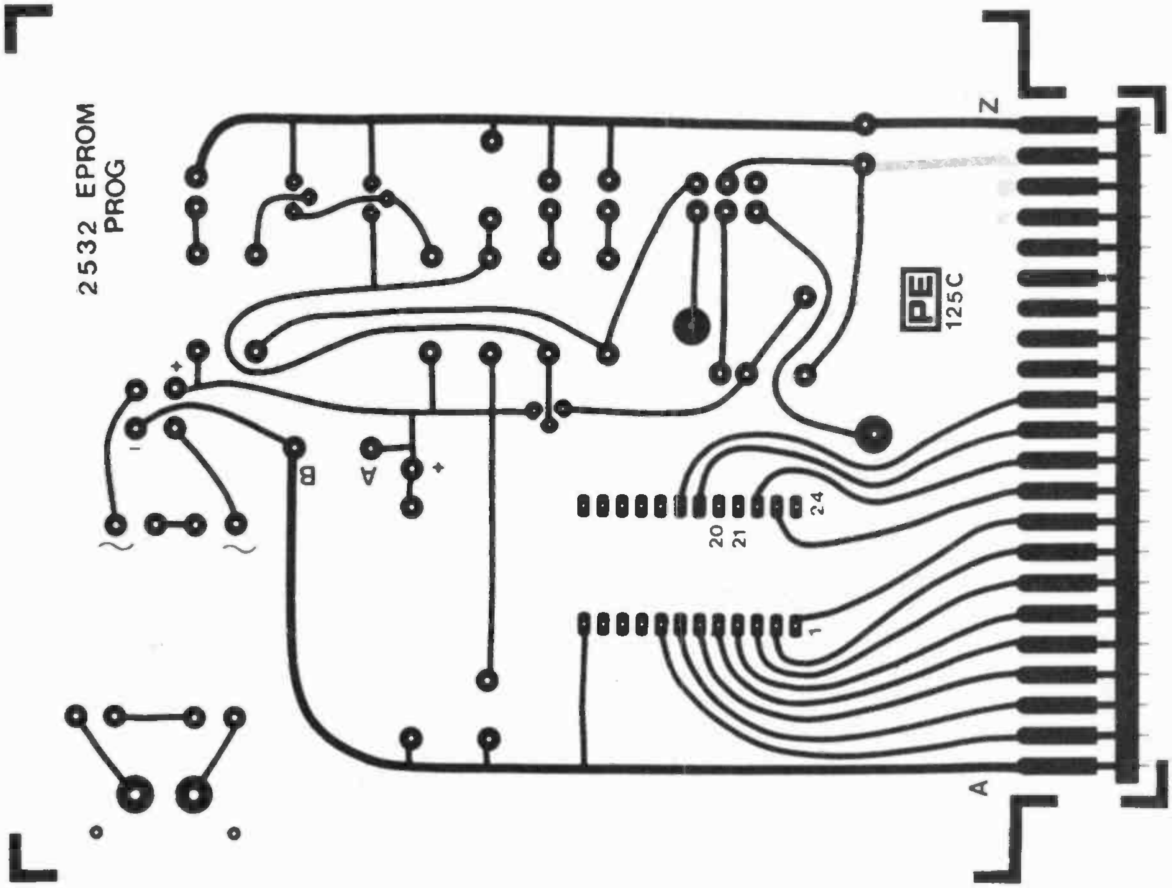


Fig. 7.3. P.c.b. component-side pattern (actual size)

at BLOCK 1 for the BASIC program to use and for storage of the data to be burnt into ROM. If most of the programming functions are to be carried out in machine code, these routines can reside in the onboard RAM. Capacitor C1 provides smoothing at the power supply, and whilst it is necessary to have an electrolytic with a working voltage of 50V to 63V, the capacitance value is not critical, 220μ being a suitable minimum value. Two holes are provided at the positive end because of varying shapes and sizes. For the use of the programmer in schools, where mains supplies are not allowed, batteries can be connected at points A, positive and B, negative. Four PP3 batteries in series make a suitable supply and these should last for years. Three PP3 are not sufficient as the supply must be above the Zener voltage (27V). If difficulty is experienced in buying PP3 connectors, these can be made from expended batteries.

The mains supply must be shrouded at the transformer for the safety of operator and equipment. Since it is necessary to raise the rear end of the programmer to the height of the mother board, a spacing block made from an audio cassette case is ideal for starters.

Capacitors C2 and C3 are included for noise suppression and may not be needed.

Connection of CB2 is to pin M on the User Port. The author identified this with a marker and connected up with a small croc-lead, insulated at the top side of one end with tape.

COMPONENTS . . .

Resistors

R1	470
R2,R3	47k (2 off)
R4	2k2
R5,R6	4k7 (2 off)

Capacitors

C1	220μ 63V elect.
C2	100n
C3	220n (see text)

Semiconductors

TR1-3	BC107 (3 off)
BR1	1A 50V rectifier stack
D1	Red l.e.d. (0·2")
D2	BZY88 27V Zener
D3	Green l.e.d. (0·2")
D4	1N4148 (or 914)
D5	Yellow l.e.d. (0·2")

Miscellaneous

S1 Miniature DPDT switch
24-way i.c. socket
P.c.b. mounting transformer (RS 207-835)
Printed circuit board (or stripboard)

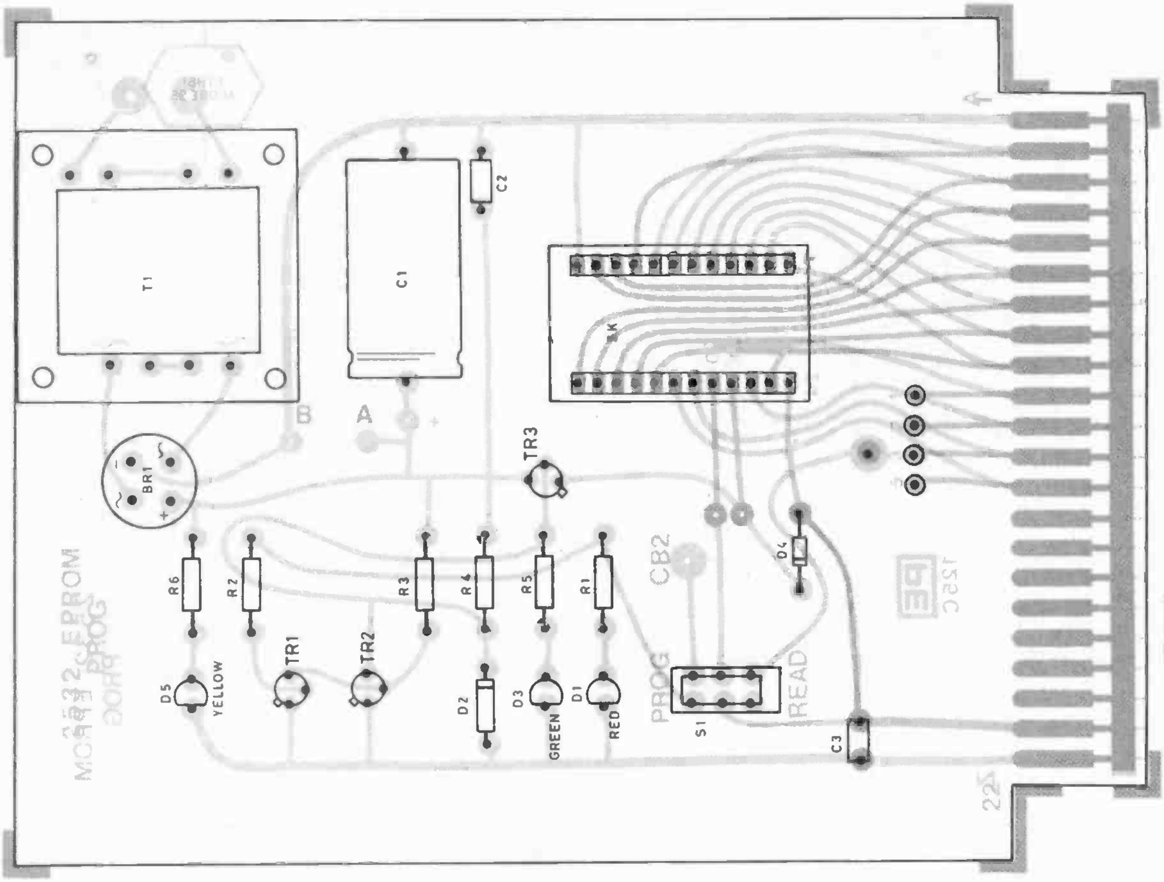


Fig. 7.4. Component layout

TESTING

Carry out visual check for short or open circuits. Without connecting the board to the computer, check that the 26V supply is reaching pin 21 of the socket. This is done by applying +5V at edge connector segment 21 and 0V at 22. Vpp, pin 21 should now change from +5V to 26V as Switch 1 is changed from Read to Program.

Without the 25V supply and with the board inserted into the expansion socket send alternating "high" and "low" signals from CB2 (37147) to pin 20, CE. Note: CB2 is mentioned because it produces an accurately timed square-wave pulse. However, for initial tests, by entering POKE 37138,225 set DDR user port for outputs and alternating I/O Register POKE37136,255 and POKE37136,0 an ON/OFF signal can be sensed at any segment from C to L.

If BLOCK 3 has been selected and a Vicmon chip is available, it should run from the programmer set to Read. Otherwise a programmed 2532 or 2716 can be inserted and Address and Data lines checked with the routine in Table 7.1.

The decimal value of the data at each location is scrolled up the screen. If contents of EPROM are known, this can be verified. If no EPROM is available, test Address and Data lines with a logic probe, analogue multimeter, or 'scope.

This completes tests that all functions necessary for programming and reading EPROMs are working correctly.

This is also the completion of the series on Expanding the Vic 20. The author wishes to thank all readers who have taken an interest in the series and wishes them success in their efforts at construction and application of the interfaces. It has been a challenge, to design low cost interfaces of original design that really work, and it is hoped that the notes that accompanied each part have helped newcomers to electronics, from computing, to understand a little of the functional problems associated with interfacing. ★

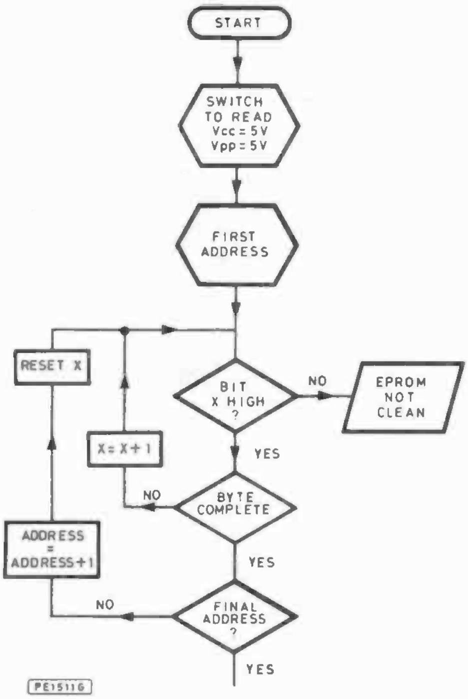


Fig. 7.5. Flowchart is a guide to the software required to check that an EPROM is fully erased

Fig. 7.6. Flowchart is a guide to the software required for EPROM programming

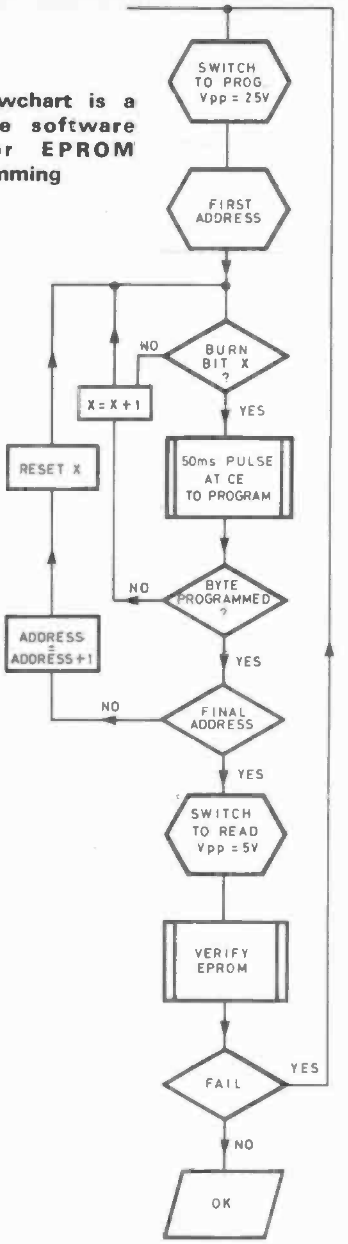


Table 7.1. 2532 or 2716 EPROM check routine

```
10 L=24576:REM Start address BLOCK 3
20 PRINT PEEK(L):REM Display decimal value at Start address
30 L=L+1:REM Move up to location 24577
40 GOTO 20:REM Repeat for consecutive addresses
```

BAZAAR

TEXAS Silent 700 printer. £180. Philips Power supply £30. Nova 820 Computer, Tektronix scope. Offers. Manuals. T. J. L. Haley, 8 Woodhall Gate, Pinner, Middx. Tel: 01-868 4221.

PRINTER Shinwah CP80 dot matrix with 3 ribbons. As new. £200. 01-941 0505. Ian Coram, 91 Rectory Grove, Hampton, Middx.

WANTED Nascom 2 unexpanded (if poss.) with manuals. Would consider non working unit. R. B. Carrier, 42 Lovelace Gardens, Southend-on-Sea, Essex SS2 4NU. Tel: 0702 67881.

OSCILLOSCOPE Philips PM3230 D.B. £100. Labgear teletext adapter £45. Write for detail. Wanted micro-doctor. S. Webb, 50 Leaders Way, Newmarket, Suffolk CB8 0DP.

TYPE 19 set power unit A.T.U. Etc: R1155: Quantity 2 and 6 volt valves: Offers. Tel: Sheffield (0742) 53595. Mr. W. T. Baker, 41 Kenwood Park Road, Sheffield, S7 1NE.

PHILIPS N1700 V.C.R., working and with tapes. £75 o.n.o. Tel: Poulton (0253) 886141. Mr. N. K. Basquill, 48 Whiteholme Drive, Carleton, Poulton-le-Fylde, Lancashire FY6 7PP.

UK101, fully expanded, £55. 8" disc drive with interface for above £220. Both together for £225. Danny Fellows, 26 Westbourne Avenue, Emsworth, Hants. PO10 7QU. Tel: (02434) 5548.

METRIX Wobbulator Type 210. Range 5-220 MHz: for I.f. alignment: switchable bandwidths with CCTP data. £35. W.H.Y. Mr. B. French, 162 St. Bernards Avenue, Louth, Lincolnshire LN11 8BH.

APPLE II Europlus 2 Drives NEC 12" Monitor. Basic Pascal Pilot Lisp Discs. Excellent condition. £850. P. G. Boud, 23 Cranebrook, Manor Road, Twickenham, Middlesex. Tel: (894) 4429.

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APPROX. 170 valves. Many types. Some rare. All new. S.a.e. for list. Offer required for lot. D. G. Frost, 107 High Street, Brampton, Huntingdon, Cambs. Tel: Hunt. 56041.

WANTED Practical Wireless December 1977 and November 1978. Buy or borrow. All reasonable expenses paid. F. J. Guppy, 51 Hedingham Road, Dagenham, Essex RM8 2NA. Tel: 01-593 0423.

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SEMICONDUCTOR CIRCUITS

TOM GASKELL BA(Hons) AMIEE

GAIN CONTROLLED PREAMPLIFIER (SL 6270C)

THE range of signal levels which can be obtained from modern microphones is very large indeed, varying from a few microvolts to several hundred millivolts. The differences in sensitivities of the microphones account for some of this signal range, although for any specific type of microphone the difference in signal level produced by a whisper several metres distant and a shout directly adjacent to the microphone is vast; ratios of thousands to one are typical. Because of the practical constraints of audio system design, we need to provide the means to control the gain of microphone amplifiers, such that the system can be optimised for most circumstances in which the microphone is likely to be used. The majority of audio systems have manual adjustment of microphone level, allowing the owner or operator of the system to decide on the optimum gain setting at any given moment.

Some form of automatic control, on the other hand, is an attractive concept in simpler systems. While such an arrangement may lack sufficient quality or sophistication for very high fidelity audio, it is ideal for such applications as cassette recorders, public address equipment, intercoms, etc. The Plessey SL 6270C gain controlled preamplifier (sometimes known as a Voice Operated Gain Adjusting Device, or VOGAD) is a very easy and economic way to provide such an automatic gain control facility. Fig. 2 shows a block diagram of the i.c.

The pre-amp has a balanced low impedance input, specifically designed to match low impedance microphones with an impedance of 300 ohms (typically) or less. The microphone MUST be a.c. coupled to the inputs, hence the use of C1 and C2. The output of the preamplifier is fed via an internal 680 ohm resistor, and the external capacitor C3 (to ensure a.c. coupling between stages), to an inverting main amplifier, the output of which is fed to the automatic gain control (AGC) detector. The output of this, in turn, is fed back to the gain controlling input of the pre-amp via an internal 2k resistor. Hence, if a large signal is generated by the microphone, the AGC 'loop' turns the gain of the pre-amp down, and if a small signal is generated the AGC loop turns the gain of the pre-amp up. As a result of the constantly changing gain of the preamplifier, the main amplifier output level tends to remain constant.

AGC PARAMETERS

Normally, the i.c. will be required to respond very quickly to large input signals, decreasing the pre-amp gain to minimise overload of the input stage. When the signal from the microphone drops to a low level again the AGC is allowed to increase the gain, but only relatively slowly in case other large signals are about to be generated. Without this slow 'decay' the system can sound very unpleasant, with a 'sucking' or 'pumping' effect on the audio signal as the gain is constantly changed. The time taken to turn the gain down after receipt of a large signal is known as the 'attack' time, and is determined by the value of C4. It approximates to:

Attack Time = 0·4ms per microfarad.

For a 47μF capacitor, this gives a 20ms attack time. The 'decay' time is the time taken to

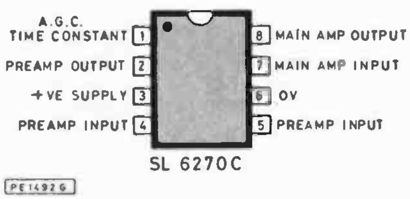

Fig. 1. Pinout and specification

Characteristic	Notes	Minimum Value	Typically	Maximum Value	Units
Supply Voltage	(All spec's measured at +6V, with input frequency = 1kHz)	4·5	6	10	V
Quiescent Current			5	10	mA
Temperature Range		−30		+85	°C
Input Impedance	Pin 4 or Pin 5		150		Ω
Input Impedance, total	Differentially between pins 4 & 5		300		Ω
Voltage Gain	72μV r.m.s. input to pin 4	40	52		dB
Output Level	4mV r.m.s. input to pin 4	55	90	140	$mV_{r.m.s.}$
Distortion (t.h.d.)	90mV r.m.s. input to pin 4		2	5	%
	10mV r.m.s. input to pin 4		0·3		%
Load Impedance	(Load of I/P of next stage) at pin 8	1·0			kΩ

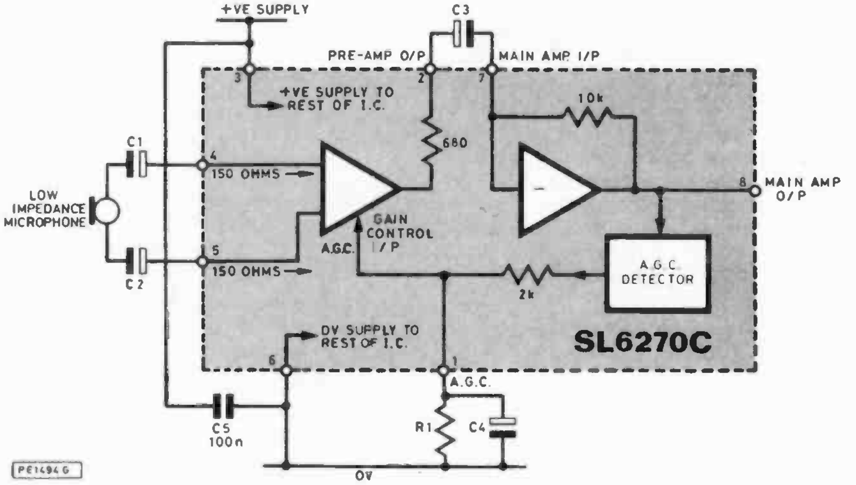

Fig. 2. Block diagram of the SL6270C

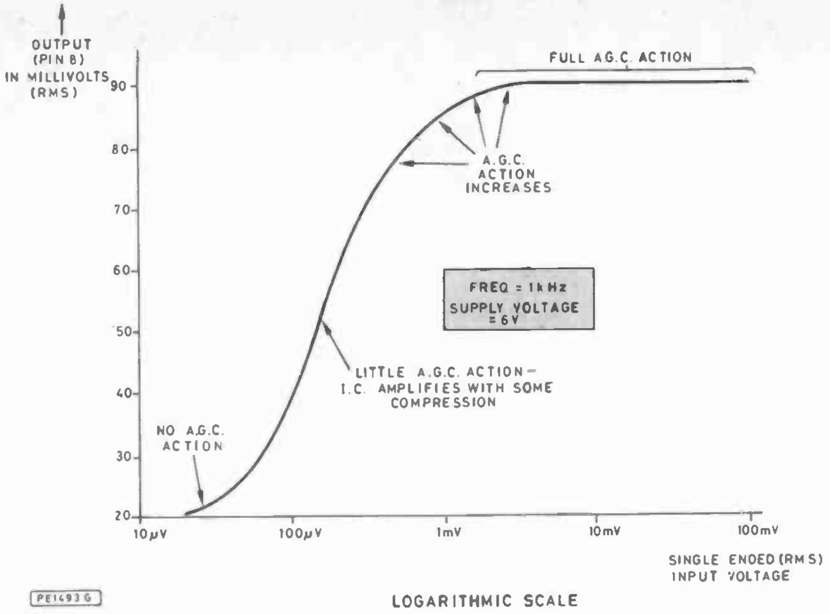

Fig. 3. Graph showing input against output (unbalanced input)

turn the gain back up again after the input signal level has dropped to its earlier level. This is determined by the combination of R1 and C4. For 1 megohm and 47 microfarads the decay is 20dB (a gain increase of × 10) per second, which should suit most applications. If required, the values of R1 and C4 can be altered to change these time constants.

Input signals of up to several tens of microvolts are amplified normally by 52dB (typically), as indicated in the specification of Fig. 1. As the level increases the AGC action gradually takes over, to eventually hold the output at a nominal 90mV (for a 6V supply) over an input range of over 50dB. Reducing the main amplifier gain will reduce both the dynamic range of the system and its sensitivity. Connecting an external resistor between pins 7 and 8 will reduce the gain; for a 1k resistor the reduction will be 20dB. Values of external resistor less than 680 ohms are not advisable. Full AGC action comes in at around 1mV for the standard circuit and 8mV with the external 1k resistor fitted. Fig. 3 shows a graph of input vs. output for the i.c.; note that there is some compression of the signal (i.e. the output variation is less than the input variation) prior to full AGC action. This also helps to keep the output signal reasonably constant in level.

PRACTICAL CONSIDERATIONS

There are many factors which affect the operation of this i.c. in practical systems. The first of these is frequency response; the SL 6270C has an open loop response of several megahertz, but it is normally intended for use in speech bandwidth systems. The frequency response is primarily defined by C3 and by a capacitor connected between pins 7 and 8 (C7 in Fig. 4). With the circuitry shown, and the values of 1µ and 4n7 for C3 and C7, the bandwidth is approximately 240Hz to 3·4kHz. The values of C1 and C2 can also affect the frequency response, so these are usually made quite large in value to ensure that only C3 affects the lower frequency limit.

Although a wide range of supply voltages can be tolerated, the supply itself must remain constant in voltage during operation of the circuitry. The AGC circuit is dependent on the supply voltage; change that voltage, and the AGC will clamp the output at a different level from the nominal 90mV specified at 6V supply. Hence, any ripple on the supply will modulate the output, and could lead to instability. Although the specification of Fig. 1 paints a pessimistic view of the distortion performance at higher input levels, the lower levels will be the norm, where the distortion is considerably less than 1%.

Finally, care must be taken with the inputs to the i.c. These should normally be a.c. coupled; if d.c. coupling is used the resistance between pins 4 and 5 must be less than 10 ohms. The inputs are arranged differentially to suit balanced microphones, although unbalanced signals can also be accommodated. Because of the low input impedance, crystal or high impedance microphones are not suitable for use with this i.c. Microphones supplied with many cheap cassette recorders, however, can often be ideal.

APPLICATIONS CIRCUIT

The circuit diagram of a 'baby alarm' is shown in Fig. 4; basically a one-way intercom used to monitor a child in a distant room. IC1 is an SL 6270C set up as previously described. C7 ensures stability by rolling off the gain of the main amplifier of IC1 at high frequencies. D1, R2, C5, and C6 decouple the power supply to IC1. Without this, the power amplifier, IC2, modulates the supply rail sufficiently to cause instability in the system. R3 is included to provide a small offset at pin 5 with respect to pin 4, again helping to prevent internal instability within IC1.

POWER AMP

IC2 is a simple power amplifier in a standard configuration. Note that the 'M' package (i.e. TBA 820M) should be used, since the TBA 820 has a different package type, incompatible with the given layout in Fig. 5. R6 and C14 provide bootstrapping, C13 provides frequency compensation, C11 reduces the effects of supply ripple, and C15 decouples the loudspeaker. C12 and R5 form a 'zobel' network, which helps to ensure stability when driving into reactive loads, and R4 sets the gain of the power amplifier, decoupled by C10. Finally, VR1 controls the gain of the system, and C9 decouples the power supply.

The circuit is designed to be powered by a 9V battery for safety and convenience, via D2 to protect against incorrect connection. Any type of loudspeaker will suffice, although its impedance should be at least 4 ohms, and preferably 8 ohms or more. A 0V feed for the microphone is provided if required for screening, etc. The microphone should be connected between the two inputs as shown, or between one input and 0V, in which case the unused input should be taken via its input capacitor to 0V. (Never connect pin 4 or 5 directly to 0V; always use a capacitor.) No heatsinking is normally required for IC2. In the interests of stability, it is strongly urged that the layout shown in Fig. 5 is closely adhered to. If the circuit still oscillates, and it isn't because of simple 'howlround' or acoustic feedback, try increasing the values of C6 and C9, change R2 to 330 ohms, and try a new battery in place of the old one. Note that all capacitor values are shown at 25 volt rating; in practice, 16 volt types are equally acceptable.

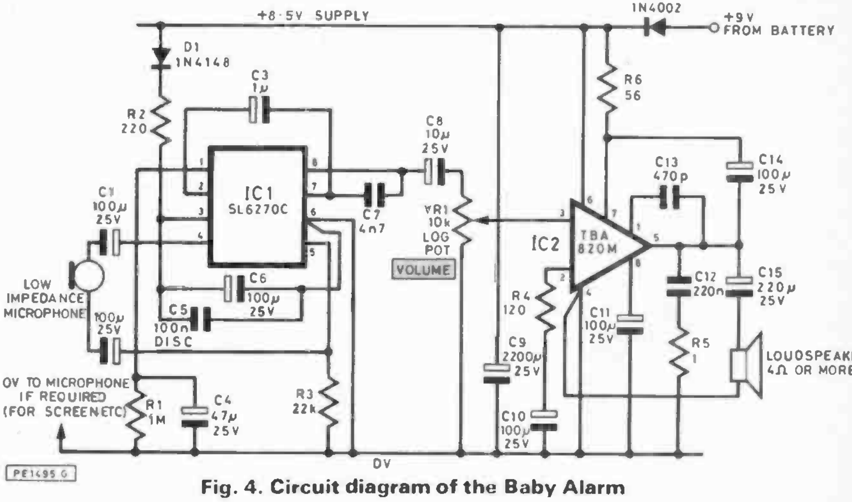

Fig. 4. Circuit diagram of the Baby Alarm

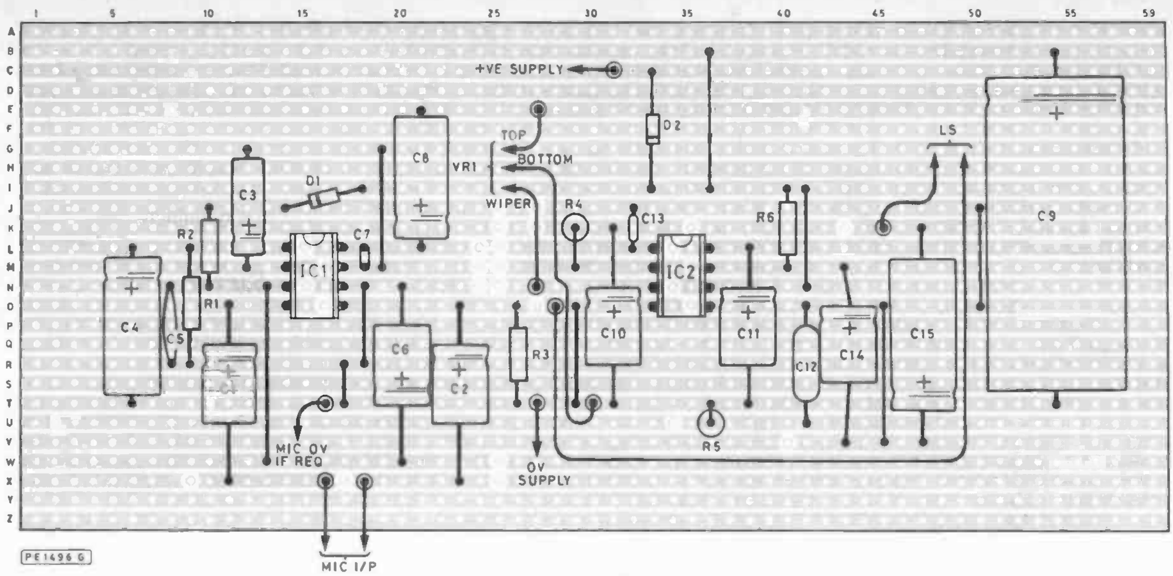

Fig. 5. Veroboard layout for the Baby Alarm

In use, the microphone is normally placed in the child's room, and is connected via screened cable to the unit in the required room; usually this is a kitchen, lounge, or parents' bedroom. The AGC action ensures that the child can be clearly heard, whether he or she is quietly complaining or shouting the house down! If required, the unit can be operated with the microphone local to the circuitry, and the speaker remote, although the volume will have to be preset, of course.

The SL 6270C will find many uses in public address, tape recording, and simple telecommunications projects. It can be obtained from **Watford Electronics**, and the TBA 820M can be obtained from **Cricklewood Electronics Ltd., 40 Cricklewood Broadway, London NW2 3ET.**

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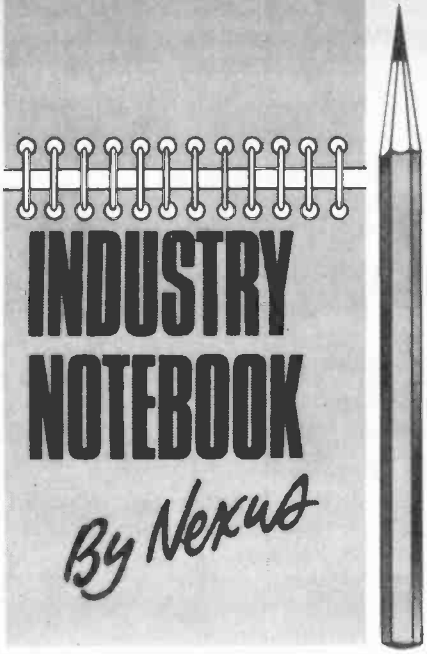

INDUSTRY NOTEBOOK

By Nexus

ET

Convergence was a fashionable catch-phrase a few years ago. It foresaw a coming together of discrete electronic technologies to provide powerful integrated systems. The most obvious outcome is Information Technology (IT) which integrated display technology, telecommunications and data processing to spawn a whole new sector of the electronics industry, of which more later.

In the defence field a newly fashionable in-phrase is Emerging Technology (ET) which is viewed by some military experts as a miracle alternative to theatre nuclear weapons. It has always been accepted that NATO forces would be outnumbered in manpower, tanks, guns and aircraft in the event of conflict. As a last resort to prevent catastrophic defeat it would be necessary to use tactical nuclear capability with the consequent risk of escalation to full rather than limited nuclear war.

It has also been argued that numerical advantage of men and materials of the potential enemy ought to some extent be counterbalanced by higher efficiency and technological superiority in one's own forces. ET would stretch this notion to its fullest extent. The brute force of the enemy would be blunted by super-sophisticated weapons of the conventional type.

It sounds good news for the industry. The giants in the defence sector such as Ferranti, GEC, Plessey and Racal together with dozens of smaller companies all stand to gain by a new impetus towards even more advanced systems. Again we see convergence, to integration in a single system of sensors for target acquisition, data processing for analysis, and terminal guidance for liquidation of threat.

Much of the technology is already available and is, in fact, in service. An example is Thermal Observation and Gunnery System (TOGS) being fitted to Britain's Chieftain and Challenger tanks. TOGS provides the ability to detect, track and engage targets by day or night in any weather without disclosing one's own position. At longer range there are precision guided munitions for artillery, and airborne stand-off weapons with fire-and-forget terminal guidance. Data processing is already commonplace in all the armed services in operational, logistical and administrative duties.

In a sense ET has already emerged but its supporters want it to emerge even more. The danger could come from over-sophistication and misplaced confidence in reliablility. And while the push-button war might be effective in large set-piece battles, technical superiority was ineffective against a peasant army in Vietnam, remains so in Afghanistan and would be equally so in any brush-fire conflicts involving infiltration, fifth-column support and street fighting.

Whatever the military merits, ET is a short-term political winner. If it led to a nuclear freeze the anti-nuclear doves would be mollified without damaging the morale of the hawks. My own guess is that the nuclear option will be maintained but not expanded while ET will receive a modest boost. But much will depend on the attitude of the new leaders in the Soviet Union and the result of the presidential election in the United States.

IT

Whereas ET for defence is of relatively low volume and very highly priced, the reverse is true for IT where high volume production and tumbling prices is now the name of the game.

That the great publicity drive for IT has been a staggering success is high-lighted in the nominations for this year's TOBIE Awards. The winners, chosen by ballot among readers of Electronics Times, are to be announced at the All Electronics Show Dorchester Ball on May 2.

Acronym composers at Imperial College must have had quite a struggle to arrive at ALICE (Applicative Language Idealised Computing Engine), an advanced computer nominated in the 'Research Achievement' category. Her distinctive feature is a high degree of parallel, as distinct from serial, processing to give very high operating speeds. ALICE uses the Inmos transputer.

Competing against ALICE are Project Universe, an expanded form of local area networks and an array processor which enables robots to 'see' what they are doing and perform more intelligently.

These are just a sprinkling of the 21 TOBIE contestants but the general thrust is clear. Every product or system is aimed at higher speeds, lower costs, greater productivity. In short, the regeneration of British industry or, from another viewpoint, a further threat to jobs.

But the IT revolution does provide extra work and more jobs. There is plenty of investment and new job opportunities in Scotland's Silicon Glen and reports from the United States suggest a strong black market in some semiconductor devices. Delivery times have lengthened from a few days into months and some short-supply items are said to be commanding as much as 20 times their list value. Speculative buying in the hope of big profit on re-sale is suspected. Monolithic Memories is but one firm with record order books who are monitoring all incoming orders to determine whether speculators might be distorting their usual projection of future demand. But MM have concluded that order growth is genuinely through demand.

Big Sister

Social conscience is a burden made even heavier when, after a quick check, I discovered that the Nexus home is nothing less than sexist. The total number of male plugs on my household and workshop appliances outnumber the demure female sockets with which they mate by over three to one.

A ridiculous assertion, of course, but no more silly than many calls for sexual equality from the Equal Opportunities Commission. In terms of numbers, electronic equipment manufacturers have always employed far more women than men, albeit in repetitive assembly work. But if we look in the R & D labs, at installation and commissioning engineers, and at management, males are predominant.

This year's WISE (Women in Science and Engineering) campaign hopes to get more girls in at professional level. At present of all our chartered engineers only one in a hundred is female. Of the new generation of engineering undergraduates at universities only 8·6 percent are female, in polytechnics only 3·2 percent.

Of course these figures cover all engineering disciplines. In electronics there is every reason to suppose that a better balance will be achieved naturally. The possibility of positive discrimination is unhealthy and I feel sure that thinking feminists would prefer employment by merit rather than by quota. So it's really up to the girls themselves. Electronics is a 'natural' for them, the opportunities are there and they only need to work hard at it to increase their numbers. Equal opportunity has existed for years and a *Big Sister* to force the issue is totally unnecessary.

The Old and the New

Professor Eric Laithwaite, famous for his work on magnetic levitation, has always contended that nature is more skilled at engineering than man. In fact he gets much of his engineering inspiration from the study of evolution, the continuous refinement of living structures over millions of years.

His example reminds us that we should never dismiss or discard earlier work. For instance the 'new' design of satellite communications aerials now being installed at Ealing and Madley don't use the conventional geometry. Instead they use the Gregorian, found to be more efficient in smaller sizes of dish. The principle is exactly that developed for an optical telescope by James Gregory, a Scottish mathematician who lived in the 17th century.

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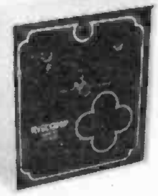

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DIGITAL ULTRASONIC DETECTOR US 5063

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NEW

- 3 levels of discrimination against false alarms
- Crystal control for greater stability
- Adjustable range up to 25ft.
- Built-in delays
- 12V operation

This advanced new module uses digital signal processing to provide the highest level of sensitivity whilst discriminating against potential false alarm conditions. The module has a built-in exit delay and timed alarm period, together with a selectable entrance delay, plus many more outstanding features.

ULTRASONIC MODULE US 4012

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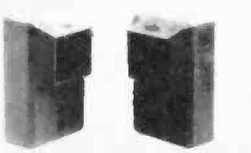
- Adjustable range from 5-25ft.

This popular low cost ultrasonic detector is already used in a wider range of applications from intruder detectors to automatic light switches and door opening equipment, featuring 2 LED indicators for ease of setting up.

INFRA-RED SYSTEM IR 1470 only £25.61 +V.A.T.



Consisting of separate transmitter and receiver both of which are housed in attractive moulded cases, the system provides an invisible modulated beam over distances of up to 50ft. operating a relay when the beam is broken. Intended for use in security systems, but also ideal for photographic and measurement applications. Size 80 by 50 by 35mm.

POWER SUPPLY & RELAY UNIT PS 4012

Provides stabilised 12V output at 85mA and contains a relay with 3 amp contacts. The unit is designed to operate with up to 2 ultrasonic units or 1 infra-red unit IR 1470. **Price £4.25 + V.A.T.**

SIREN MODULE SL 157

Produces a loud penetrating sliding tone which, when coupled to a suitable horn speaker, produces S.P.L.'s of 110dbs at 2 metres. Operating from 9-15V. **Price £2.95 + V.A.T.**

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This weather-proof horn speaker provides extremely high sound pressure levels (110dbs at 2 metres) when used with the CA 1250, PS 1865 or SL 157. **Price £4.95 + V.A.T.**

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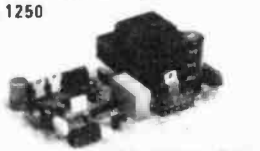
Single pole, 3-pos. key switch intended for use with the CA 1250. **Price £3.43 + V.A.T.**

ALARM CONTROL UNIT CA 1250



Price £19.95 + V.A.T.

The heart of any alarm system is the control unit. The CA 1250 offers every possible feature that is likely to be required when constructing a system whether a highly sophisticated installation or simply controlling a single magnetic switch on the front door.

- Built-in electronic siren drives 2 loud speakers
- Provides exit and entrance delays together with fixed alarm time
- Battery back-up with trickle charging facility
- Operates with magnetic switches, pressure pads, ultrasonic or I.R. units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes - full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for external loads
- Test loop facility

SIREN & POWER SUPPLY MODULE PSL 1865

only £9.95 + V.A.T.

NEW

A complete siren and power supply module which is capable of providing sound levels of 110dbs at 2 metres when used with a horn speaker. In addition, the unit provides a stabilised 12V output up to 100mA. A switching relay is also included so that the unit may be used in conjunction with the US 5063 to form a complete alarm.

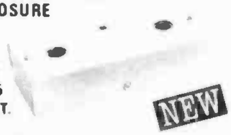
HARDWARE KIT HW 1250

only £9.50 + V.A.T.

NEW

This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 by 180 by 70mm

ULTRASONIC MOOULE ENCLOSURE



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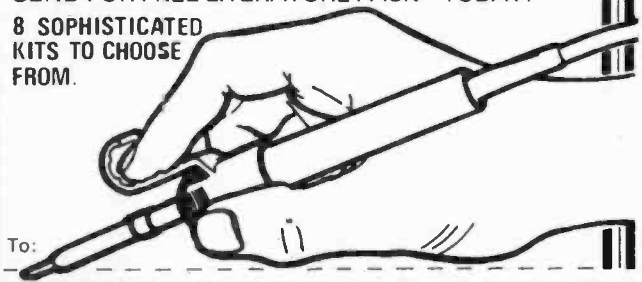

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PE

Patents Review

Copies of British Patents can be obtained from: The Patent Office, Sales, St. Mary Cray, Orpington, Kent (£1.75); and copies of Foreign Patents can be obtained from The Science Reference Library, 25 Southampton Buildings, London, WC2A 1AJ. (Prices on application.)

RF KEY-FINDER

Fig. 1

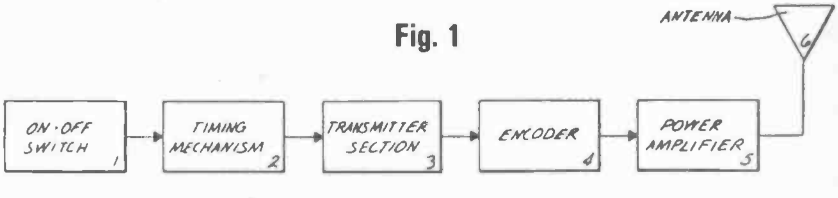
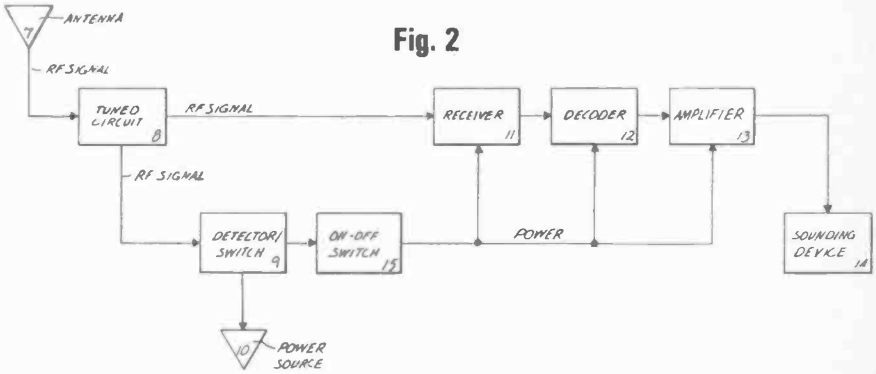


Fig. 2



European patent item 089667, from Thomas William Nyiri of San Marino, California is a quaint idea with interesting possibilities. The idea is to track down lost keys, purses and wallets by fitting them all with a miniature receiver that produces an audible or visible signal when triggered by a transmitted search signal. Fig. 1 shows the transmitter, which will usually be a hand-held battery powered gadget like a TV remote control. Chip 3 produces an r.f. signal on either CB or model-control frequencies. Encoder 4 chops the signal in a pre-arranged code. When the first stage of the receiver shown in Fig. 2 picks up a signal of correct frequency it triggers f.e.t. 9 to switch battery power 10 into the rest of the receiver. Decoder 12 distinguishes between random CB or model transmissions and a wanted search signal. It outputs to amplifier 13 and sound or light generator 14. The idea, of course, is to make the receiver small enough to attach to whatever it is you think you are going to lose. By using different transmission frequencies, or codes, one transmitter can search independently for several lost objects. The patent is rather short on detail but if the gadget could be made cheaply and small enough it would undoubtedly sell to anyone who routinely loses their car keys five minutes before they are due to leave home.

WRIST-WATCH THERMOMETER

A new British patent application 2118307 from the Citizen Watch Company of Tokyo suggests that wrist-watches with thermometers built-in may be the next consumer gimmick. A combined watch and thermometer can easily log temperature over a pre-set period of time, storing averages and maximum and minimum values. The snag, say Citizen, is finding an electrical element to measure temperature that is cheap, accurate and reliable. Thermocouples, for instance, are too expensive. A thermistor, a resistor which changes value with temperature, is cheap but difficult to use because the resistance changes value exponentially. Complicated circuits are needed to provide a linear readout. Citizen, in this very lengthy and detailed patent, explain how linearity may be quite simply achieved by using the thermistor to control the frequency of an oscillator circuit.

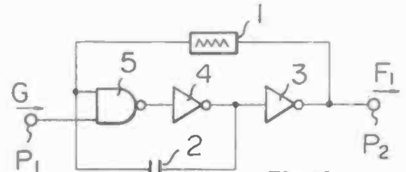
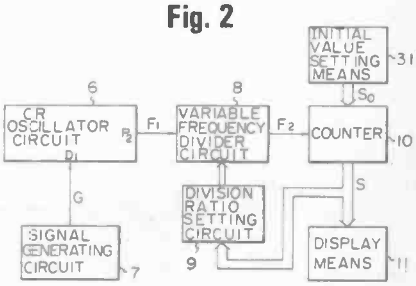


Fig. 1

Fig. 1 shows a CR oscillator circuit, with thermistor 1, capacitor 2, two CMOS inverters 3 and 4 and CMOS NAND gate 5. A control signal G is applied to input P1. When signal G is low CR oscillator is switched off. When signal G goes high, CR oscillates to produce pulse signal F1 at terminal P2 of frequency determined by resistance R of thermistor 1. The temperature value can be derived from the pulse rate, but correction is needed to compensate for the non-linear change of resistance. Fig. 2 shows the circuit. The CR oscillator of Fig. 1 is shown at 6, receiving control signals G from circuit 7 and outputting oscillator pulses to frequency divider circuit 8. The division ratio of circuit 8 is varied according to the cumulative number of pulses counted at 10. Variations in the ratio are set at 9 to compensate for the exponential characteristic of the thermistor. So the total pulse count at the end of a fixed time interval is directly proportional to temperature and is displayed at 11.

Readout will usually be on an LCD which also displays time. Citizen say that this circuit can be manufactured at "very low cost" and with a memory it is possible to arrange for ambient temperature to be measured and memorized at a fixed time each day, along with maxima and minima. The temperature readings taken can also be used to generate temperature compensation data for the clock circuits, to improve time-keeping accuracy.

Fig. 2



TECHNOLOGY UPDATE: SO SMDs

tomorrow's new breed of electronic component

ARE TODAY'S ELECTRONIC COMPONENTS LIKE THE DINOSAUR—TOO LARGE TO SURVIVE?

IT IS common knowledge that all electronic components, no matter what shape or size, have leads protruding from them . . . *isn't it?* After all, how else can they be soldered to a printed circuit board?

The answer to this question is investigated here, and it reveals a direction in equipment manufacture which is *not* common knowledge. A new technique is emerging; it's called SMA (Surface Mounted Assembly), and with it grows an army of leadless components called SMDs (Surface Mounted Devices). This development was spawned by the electronics industry in the face of fierce competition, and its urgent need to reduce assembly costs. In fact, components as we know them today will not allow further miniaturisation. Conventional devices represent a dead end.

SURFACE MOUNTED DEVICES

Leadless, surface mounted capacitors and resistors, commonly (and confusingly) called "chips", consist of small rectangular packages. These are of either plastic or ceramic construction, and are metallised at each end. Diodes, although they have a more recognisable body, also have metallised ends instead of leads, and all these devices are soldered by their metallised ends, directly to the *top surface* of the p.c.b.

SMDs have numerous advantages. They are smaller (allowing typically twice the p.c.b. packing density of conventional components), they are cheaper to use in end-product terms, and they are more reliable. Also, the absence of wire leads eliminates the radiating antenna effect that downgrades high frequency/switching performances in conventional components.

A high-performance car radio might comprise well over 500 components, and with such numbers it is easy to see why the SMD's high packing density and low profile appeals to forward-looking equipment manufacturers. Circuit board assembly costs can be as much as 50% lower than those for conventional "inserted" devices, so Mullard claims. The claim that SMDs are very much more reliable is nothing to do with their fabrication technology, but because they do not have to have leads or tags added, and because no lead-bending or cropping takes place during assembly—stages which frequently cause damage.

The Mullard SMD product line already covers some 80% of all component types which, according to the company, account for nearly all potential applications in the emerging digital era.

Who knows, in fifteen years' time, the hobbyist may need a magnifying glass and tweezers to handle components; components which it is already known, will be *too small* to accommodate printed values or colour codes. The development engineer too, will be forced into modular applications, rather than a breadboard approach to design. What else might the hobbyist one day need? A pot of glue!

GLUE?

The "pick-and-place" machinery used in automated SMA has to include a method of making the devices stay put until soldered. For without leads passing through to the other side of the p.c.b., these tiny devices would slide around during conveyance to the soldering station. The answer is glue. The pick-and-place must first daub a spot of glue on the underside of each component to be mounted, or drop a spot of glue on the p.c.b. itself. These special epoxy adhesives have been developed for short cure time (the boards are passed through an oven prior to soldering) and adequate viscosity.

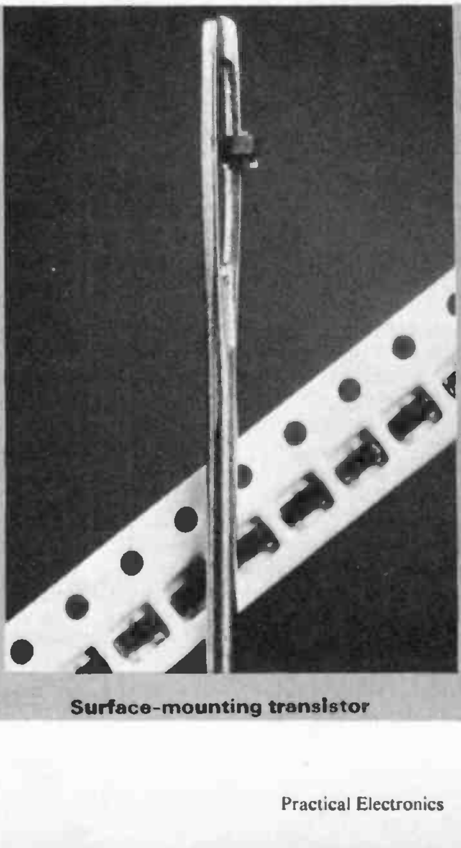
SURFACE MOUNTED ASSEMBLY

At the heart of the pick-and-place assembly machine is the "pipette". The Mullard system comprises a mechanical jaw for clamping the component to be placed (the terms "place" and "insert" have a sharp distinction now that leadless devices exist). The pipette also incorporates a vacuum sensor which uses an embodied microphone to verify the presence of the component being handled.

These production machines are extremely fast, and may be software or hardware controlled. Reliability is higher here too, it is claimed. A run of 100,000 component placements before a single error occurs is quoted by Mullard as typical, this being 10 p.p.m. as opposed to an often quoted error figure of 1000 p.p.m.

SMDs are supplied on reels of tape containing blister packs, and partial standardisation is already achieved in this area.

Real-estate savings to the manufacturer are considerable, too. SMA machinery occupies far less factory floor space.



Surface-mounting transistor

TERMINOLOGY

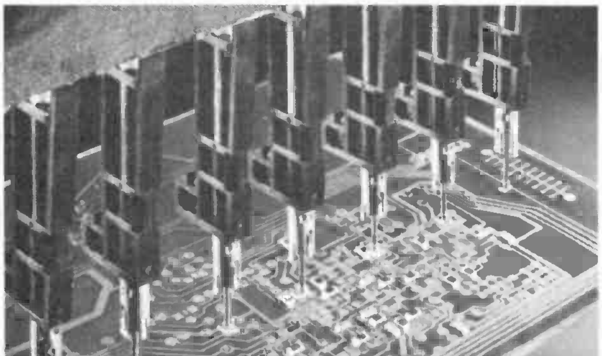
Over the last three or four years these new phrases have crept into the electronics press: "leadless chip carriers", "surface mounted devices" and "SO" devices. The "SO" package for i.c.s was defined by Philips (Mullard's parent company) back in 1967, and it then stood for "Swiss Outline", although the contemporary interpretation is "Small Outline".

At one time the surface mounted device and the leadless chip carrier were envisaged as exclusively the same thing, but in practice it will be found that surface mounting i.c.s have tabs on them for soldering. The same applies to transistors, although passive components *are* without leads.

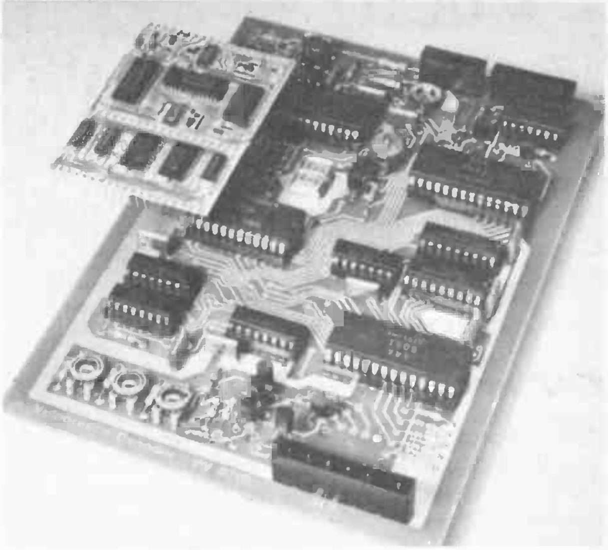
MULLARD

As the reader may have begun to suspect, Mullard has a major involvement in this development. As the UK's largest electronics component manufacturer, its activity in the area of SMD and SMA equipment manufacture virtually represents Europe's only horse in this race, in which Japan looks set for an unassailable lead (the Japanese are said to be producing 6 billion surface mounted resistors a year). Whilst it is not too surprising to learn that in Japan 40% of all electronic equipment already makes use of the technology, nor that Europe is only just beginning to look seriously at it, it *is* surprising to find reports that the US is still further behind. Now, at least, a source of expertise and hardware, from the devices themselves through to the automatic placement machinery is, in the shape of Mullard Ltd., available in Europe.

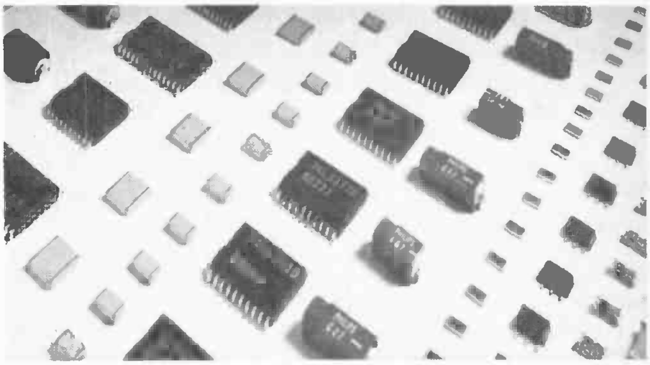
MCM III is a hardware-automatic placement machine accommodating up to 12 placement heads. A typical handling capacity is 200,000 component placements per hour. Photograph courtesy of Mullard Ltd.



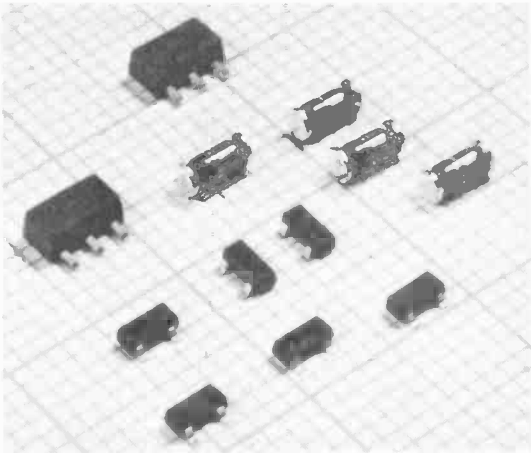
The unique pipettes of the Philips MCM range of automatic SMD placement machines



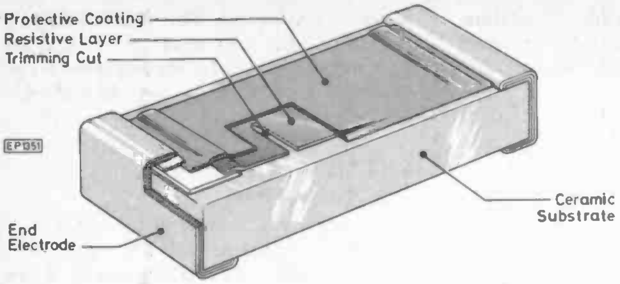
These boards fulfil identical functions. Generally, SMDs require only a third of the board space needed by conventional components. Photograph courtesy of Mullard Ltd. P.c.b. drilling is entirely eliminated



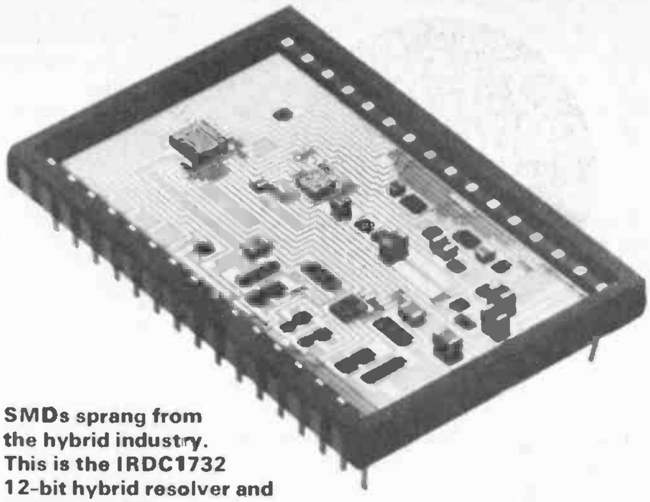
Examples of Mullard range of SMDs, including "chip" resistors, diodes, SOT package transistors, and i.c.s. All these miniature "chip carrier" outlines conform to international standards



A closer look at the SO transistors and diodes



Structure of a SMD, laser trimmed resistor



SMDs sprang from the hybrid industry. This is the IRDC1732 12-bit hybrid resolver and Inductosyn^{TM}-to-digital converter (for digital representation of angular or linear measurement). Photograph supplied by Analog Devices Ltd.

SOLDERING

One of the first questions to spring to mind when looking at a board full of SMDs is, how are they production-soldered when the connections, and the devices, are on the same side? The assembled p.c.b.s shown to the press by Mullard were wave-soldered in the conventional way, but of course the components, it was explained, are designed to survive the wave of solder too. An interesting, and obvious outcome of all this, is that a p.c.b. can be double-sided in terms of both copper tracks *and* components!

New techniques in wave-soldering have had to be developed because, for example, the components tend to cast a "shadow" in the wave, possibly leaving themselves unsoldered at one end.

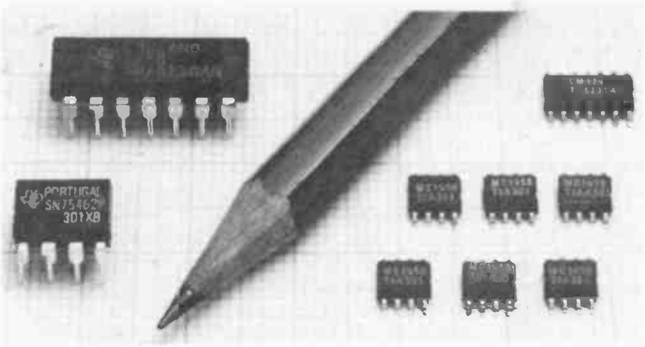
COST FACTORS

It is all very well the electronics industry concentrating progress on the integrated circuit; moving from MSI to LSI to VLSI etc., but i.c.s apparently account for around only 5% of the total equipment cost in current designs. Interconnect components (approximately 30 passives for each i.c. on average), on the other hand, are reported to account for nearly 25%. Mullard's specialists point out that if the trend towards miniaturisation, lower cost and failure rate, remains focused on i.c.s, a disproportionate cost relationship will soon arise.

It is obviously now necessary to develop the SMD, which, incidentally, *was originally devised by the hybrid manufacturing industry for mounting on the surface of substrates,* to rationalise equipment costs in the future. Moreover, new products will be possible *only* because of SMA—portable video equipment already depends heavily on the technique.

FUTURE

The development is important to industry *now,* the hobbyist later. But then, a glance through a late sixties copy of PE will reveal life at the dawn of the i.c. Not that long ago really, and today's hobbyist is not so far behind industry.



These SO i.c.s, launched by Texas Instruments less than a year ago, are shown compared to their d.i.l. counterparts. They take up one-third of the board space, and are available in alternative packages to many of TI's more popular i.c.s. These SO packages started life at 1·6 times the cost of their conventional alternatives, but may already be on a price parity

Industry sources suggest that by next year one-quarter of all equipment manufactured will contain SMDs. Another five years, and this figure will be one-half, which represents around 100 billion SMDs worldwide. ★

BAZAAR

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HALL effect K/Board 83 keys parallel ASCII output metal framed p.c.b. New, unused. £35 inc. (0782) 550684. N. L. Smith, 31 Meadow Avenue, Wetley Rocks, Stoke-on-Trent ST9 0BD.

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28K VIC 20, 40/80 column card, machine code monitor joystick. Lots of cassette games. Only £250 o.n.o. Alan Van Winkelen, 51 Pound Lane, Thorpe St. Andrew, Norwich NR7 0YN. Tel: (0603) 35735.

WANTED cased twin 5¼" disc drives c/w p.s.u. interface and D.O.S. for Cegmon BAS.5.X. UK101. Mr. K. Cotterell, 153 Whiteladies Road, Clifton, Bristol. Tel: Bristol 730785 (Evenings).

Space Watch...

THE ISAAC NEWTON TELESCOPE

British astronomers are celebrating 'first light' at the new observatory which is being constructed on the island of La Palma, one of the Canary Islands group. The Isaac Newton 2·5 metre telescope, currently the largest optical telescope that Britain has, is now operational, it is one of a trio of British telescopes now being installed at La Palma; they are being funded by the Science and Engineering Research Council (SERC). These telescopes form the core of a new International Observatory. The official name for the installation is the 'Oservatorio del Roque de los Machachos.'

The Isaac Newton telescope was first installed at Herstmonceux, Sussex at the site of the Royal Greenwich Observatory in the late sixties. In the 1970's it was decided by the SERC that the best place for the telescope would be in the northern hemisphere and in 1979 entered into an international agreement with Spain, the United Kingdom, Denmark and Sweden to build telescopes on the Spanish site at La Palma. As part of this agreement Spain was to provide a road to the peak, staff accommodation, power and telephone lines. In return the Spanish astronomers are guaranteed 20 per cent of the observing time. Also to share are the Dutch who are to have 20 per cent of the time on the three British telescopes. The Irish are also partners and would have 27 nights per year on the one metre telescope.

The two telescopes presently installed are a 'one metre' and the Isaac Newton. The third telescope is the William Herschel which has a primary mirror diameter of 4·2 metres, the mirror has just been completed at Grubb Parsons, the famous telescope manufacturers based in Newcastle-on-Tyne. This will be operational in 1986 on La Palma. There are other telescopes at the observatory. The Swedes have installed a 0·6 metre reflector and a solar telescope. There is also an Anglo-Danish transit circle for accurate star positioning.

The new telescopes on La Palma will re-establish the United Kingdom's leading role in optical astronomy and so complement the world-leading position it holds in most of the major branches of astronomy. This applies especially to radio, infra-red, X-ray and theoretical research. For more than three centuries now the Royal Greenwich Observatory has been a centre of excellence in astronomical research. Originally its purpose was to study the position and apparent motion of the stars. These observations were required to ascertain the longitude on the Earth and Time measurement data.

Since the end of the last century activities were widened to include astrophysics and much ground has been covered since. Indeed several volumes would be needed to give even notes of the work done. It was the inevitable expansion that finally led to the need for the Isaac Newton telescope. The changing emphasis finally led to the transfer of the Royal Greenwich Observatory from the Admiralty to the Science and Engineering Research Council in 1965. Later the Observatory was transferred to Herstmonceux Castle, Sussex. It has of course retained the title of Royal Greenwich Observatory. This extended the telescope facilities throughout the whole of the astronomical community.

The results have been quite outstanding, the extended facilities have helped to develop some of the world's most sensitive detectors of light for use on telescopes, providing a continuity of development that university research departments cannot always maintain. Of the contribution to astrophysics of course there is a formidable record. In recent years astrophysicists have become interested in objects which are very faint optically. Much of this work has appeared in *Spacewatch*. Many have been found by radio astronomy, satellites and probes. Sometimes this is because the sources, such as quasars, are so far away or because they are so faint, the optical telescope constantly needs updating.

Of course most observations of very dim objects have to be carried out using large telescopes. Many of the observations have been made with telescopes in the USA and in Australia. An Anglo-Australian telescope is based in New South Wales. There is still work to be done by large earth-based telescopes but they must be at suitable sites. The particular demands that are determined by the nature of the research must be observed if the results are to be valid. In many cases satellites have confirmed the accuracy of data gathered on Earth. With the aid of the sophisticated techniques available to earth-based telescopes, whose sensitivity has beeen enhanced thereby, there is the benefit of extra-terrestrial back-up.

The 4·2 metre William Herschel telescope was designed for La Palma. This telescope has special light detectors which have been supplied by the Royal Greenwich Observatory and will ensure a sensitivity second to none. This is one of the reasons that the SERC are funding this project. The decision to make this site available to all researchers, from anywhere in the world, is the truly democratic way of knowing more about our place in the Universe.

It is to this end also that the new large infra-red telescopes have been funded. These have the Island of Hawaii as their site. The parent organisation of the large infra-red instrument, the Royal Observatory of Edinburgh, has already shown its worth and has also demonstrated how the techniques of remote control can be such that the researcher does not have to be present at the telescope site. The control and remote viewing can be done from the comfort of the home station. Much of this has been described in detail in previous issues of *Spacewatch*. The other telescope at Hawaii is the 'millimetre-wave' telescope. This will help to resolve the unexplored area of the spectrum between infra-red and radio wavelengths.

EXTRA-TERRESTRIAL OBSERVATION

It is necessary to make proper reference to the extra-terrestrial activity. The observations from the Earth are complemented by instruments above the atmosphere. This covers a whole new field because the absorption by the atmosphere is no longer an obstacle. The SERC has supported the researchers in universities. This has been put into effect at Leicester University and University College, London. These two have contributed very well as pioneers in X-ray astronomy.

British astronomers have also a large stake in satellites investigating the Universe in the infra-red and ultra-violet. This was the IRAS and the International Ultra-Violet Explorer. The data from IRAS, which has now ceased its mission, will take a decade to analyse.

On the interpretive side university astronomers and researchers of the RGO and the ROE are keeping the UK at the forefront in theoretical astronomy especially cosmology which deals with galaxies, quasars within them and more recently the black holes. So the new International Observatory will take learning into the next century.

THE WILLIAM HERSCHEL TELESCOPE

This was named after the Musician/Astronomer. He was the remarkable man who in 1781 discovered the planet Uranus. Of course originally it was called Herschel, after its discoverer. His skill as a telescope maker was quite exceptional. The telescope that bears his name in commemoration is very much larger than those which he made. The present telescope has a primary mirror which is 4·2 metres in diameter. It is the third largest in the world. So the man who should be called the father of observational cosmology will be honoured again in tribute by the users of this instrument. The exceptional viewing site together with the use of the most modern light detectors will give this telescope the advantage over others. Although its mirror is smaller than those of the American or Russian telescopes it will be able to see farther than either.

The telescope itself, which was once the only step between the observer and his target, has to use intermediate apparatus for research purposes. Again modern techniques dispense with the human being and give the human a more accurate picture of what is taking place. This instrumentation is superior indeed to the human. It does however furnish data which enables the human to think with reliable 'known' information. So it is now possible to determine a situation without the need to 'see' directly. Fortunately it is possible to expound a good deal about these techniques, they will be explained more fully in a forthcoming issue of *Spacewatch*.

Frank W. Hyde

INTRODUCTION TO DIGITAL ELECTRONICS

MICHAEL TOOLEY BA DAVID WHITFIELD MA MSc CEng MIEE

O & A Level Part Eight

WE shall begin this month with a practical example of the use of J–K bistables and logic gates in the form of a traffic lights simulator. For simplicity we shall only concern ourselves with the most basic form of traffic lights once encountered at road works, i.e. those which consist of two lights only; red and green. This is a system with which most of us are all too familiar. Even so, it is worth reminding ourselves of the sequence of events in such a system.

Let us assume that the traffic lights are labelled TL1 and TL2. The sequence of operation of the lights should follow the pattern:—

TL1	TL2
red	red
red	green
red	red
green	red
red	red
etc.	etc.

In fact there will be two lamps fitted in each traffic light unit. If we refer to these separately as TL1(red), TL1(green), etc. and use a 1 to denote 'light on' and a 0 to denote 'light off', we arrive at something which is more akin to a truth table as shown in Table 8.1.

TL1		TL2	
RED	GREEN	RED	GREEN
1	0	1	0
0	1	1	0
1	0	1	0
1	0	0	1
1	0	1	0
etc	etc	etc	etc

EG1390

Table 8.1. Truth table for the Traffic Lights

There are two things to note from this:—

1. The red and green lamps in either traffic light are always complementary. Thus:

$$\text{TL1(red)} = \overline{\text{TL1(green)}}$$
and
$$\text{TL2(red)} = \overline{\text{TL2(green)}}$$

2. The sequence of operation consists of four distinct states repeated over and over again.

For the purpose of this example we shall assume that each state occupies the same time interval. In practice, and dependent upon the traffic flow and separation of the traffic lights, this may not be the case. In any event, we shall require a clock in order to define our basic unit of time, i.e. the time interval for any one of the states in the sequence. The clock can take the form of any one of the several circuits previously described but, for convenience, we shall use the clock oscillator provided within the Logic Tutor. This will give us a basic time interval (clock period) of approximately 1 second: long enough for us to see what is happening, but far shorter than would be acceptable in practice!

The four logic states, corresponding to those shown in the Table 8.1, can be generated by two J–K bistables in conjunction with some additional logic. The J–K bistables operate as binary dividers (as discussed in Part Seven), and the additional logic is used to decode the bistable outputs (Q and $\overline{Q}$) into the required logic 1 and logic 0 states to activate the four lamps: TL1(red), TL1(green), TL2(red), and TL2(green). The basic arrangement of the logic control system is shown in Fig. 8.1.

The four states produced by the two bistables will follow the normal binary counting sequence. If the bistable outputs are labelled Q1 (LSB) and Q2 (MSB) we arrive at the sequence:—

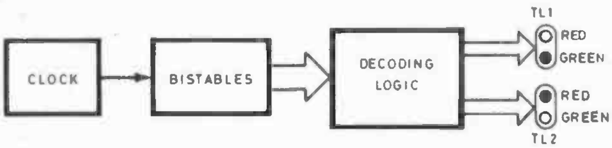
Q2	Q1
0	0
0	1
1	0
1	1

Combining this sequence with the truth table which we saw earlier gives the complete truth table shown in Table 8.2. Here we have shown 'inputs' from the simple binary counter and 'outputs' required from the decoding logic. Now we are confronted with the problem of what must go into the decoding box!

INPUTS TO DECODER		OUTPUTS FROM DECODER			
Q_2	Q_1	TL1 (RED)	TL1 (GREEN)	TL2 (RED)	TL2 (GREEN)
0	0	1	0	1	0
0	1	0	1	1	0
1	0	1	0	1	0
1	1	1	0	0	1

EG1391

Table 8.2. Complete truth table



EG1392

Fig. 8.1. Basic block schematic of the traffic light simulator

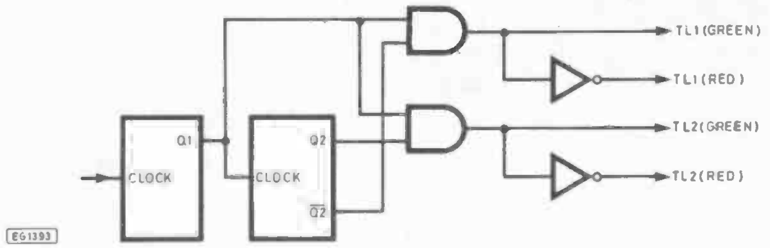


Fig. 8.2. Logic arrangement of the traffic light simulator

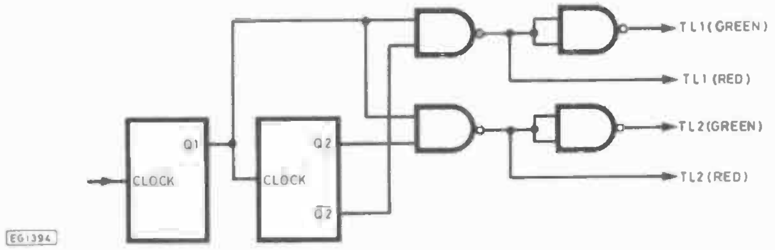


Fig. 8.3. Improved version of Fig. 8.2

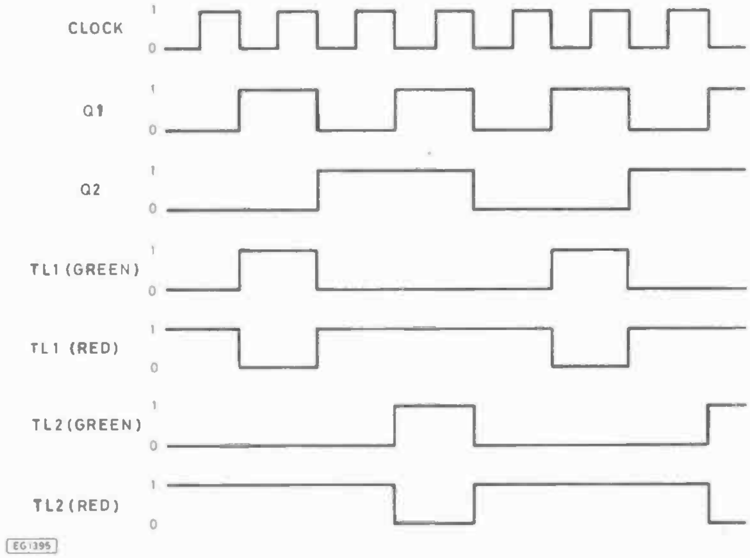


Fig. 8.4. Timing diagram for the traffic light simulator

If we concentrate on the green lamps only (remember that the red lamps are always the opposite) we can readily develop the Boolean expressions from the truth table:—

$$TL1(green) = Q1.\overline{Q2}$$

and

$$TL2(green) = Q1.Q2$$

The red lamps are simply the complement of the above:—

$$TL1(red) = \overline{Q1.\overline{Q2}}$$

and

$$TL2(red) = \overline{Q1.Q2}$$

Again, concentrating on the green lamps initially, TL2(green) can be generated very easily by applying the Q1 and Q2 outputs to an AND gate. For TL1(green), however, we will require Q1 to be AND'ed with $\overline{Q2}$. Happily, this is no great problem since our J–K bistable provides us with a $\overline{Q}$ output! We can now, tentatively at least, sketch out the logic arrangement of our traffic lights controller, adding inverters between the red and green outputs. This arrangement is shown in Fig. 8.2.

Rather than use a mixture of AND gates and inverters (which would require two integrated circuits in the decoding section) we could just use one quad two-input NAND i.c., as shown in Fig. 8.3.

The circuit can now be assembled on the Logic Tutor. Insert the 7473 dual J–K bistable into socket A and the 7400 quad two-input NAND into socket B. Carefully ensure that pin 1 aligns with socket 1 in each case. The following links should then be connected:—

A1	to	clock	(clock input)
A2	to	A3	
A3	to	A16	
A4	to	+5V	(supply)
A5	to	A14	(Q1)
A6	to	A7	
A7	to	A12	
A10	to	B14	($\overline{Q2}$)
A11	to	B2	(Q2)
A12	to	logic 1	
A13	to	0V	(supply)
A14	to	B1	
A16	to	logic 1	
B1	to	B15	
B3	to	B4	
B4	to	B5	
B5	to	D4	(TL2(red))
B6	to	D3	(TL2(green))
B7	to	0V	(supply)
B10	to	D1	(TL1(green))
B11	to	D2	(TL1(red))
B12	to	B11	
B13	to	B12	
B16	to	+5V	(supply)

Total of 24 links.

The keen student will doubtless wish to further develop the simulator. The following exercises are suggested:—

1. Incorporate extra gating so that a red warning light is available to the workmen which indicates that either one of the traffic lights is showing green.

2. Improve the operation of the lights by increasing the period for which a green light shows. Make this equivalent to two clock cycles. (Hint: It will be necessary to use a further 7473 J–K bistable).

3. Devise a system for controlling three lamps in each traffic light obeying the following sequence:—

TL1	TL2
red	green
red/amber	amber
green	red
amber	red/amber
red	green
etc.	etc.

4. Devise an arrangement for controlling a 'Pelican' pedestrian crossing. This type of crossing uses a conventional three-lamp traffic light to control vehicles and a two-lamp light to control pedestrians, with an audible output during the period for which the pedestrian light is a continuous green.

INTRUDER ALARM FOR THE ELECTRONIC SHOP

(A practical design example)

As a 'grand finale' in the use of TTL, we have included an example of the design of a simple intruder alarm for the electronic shop which we first met in Part Two. This example has been chosen so that it illustrates many of the logic elements and techniques previously discussed.

Let us imagine that the owner of the shop requires an intruder alarm to protect the premises during the hours in which the shop is closed. The shop is to be fitted with magnetic window and door switches. For the purpose of this example we will assume that only two switches have been fitted, although in practice it would be a fairly simple matter to add as many additional switches as required. The switches are a type which open whenever the door or window is open, and close whenever the door or window is closed. These "normally closed" switches can be arranged to generate a 0→1 edge whenever the respective door or window is opened by means of the arrangement shown in Fig. 8.5.

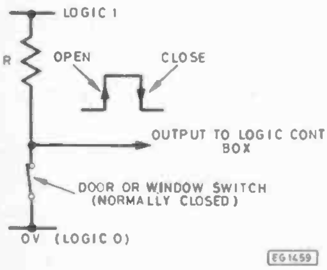


Fig. 8.5. Method of generating a pulse when a window or door is opened

The intruder alarm is to have a control panel located just inside the door (so that it remains visible from the outside), and a keyswitch is to be placed in the wall adjacent to the door. The shopkeeper requires that a warning light be incorporated in the control panel to remind him that either the door or the window has been left open, thus enabling him to check the state of the premises at the end of the day before locking the door and setting the alarm.

Once triggered by an intruder, the alarm is to activate an audible warning device which is to be repeatedly pulsed on and off. For test purposes, when the audible warning device is temporarily disconnected, a further warning light is to be incorporated into the control panel to show that the alarm has been set off. The exterior keyswitch is used to set the alarm to the active state and to reset or disable it before entering the premises. The switch is connected to produce a logic 1 in the set/active condition and logic 0 in the reset/disabled position. The keyswitch is to activate a further warning light so that the shopkeeper is aware of the state of the alarm before unlocking the door.

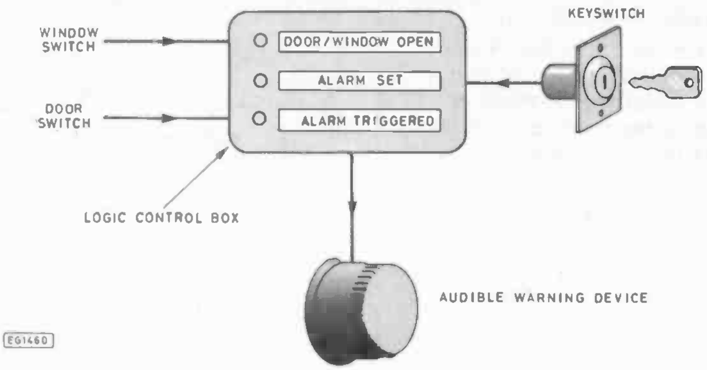


Fig. 8.6. Essential components of the intruder alarm for the electronic shop

The essential components of the system are shown in Fig. 8.6. Having established the operational features and nature of the external components, we shall now concentrate on the contents of the logic control box. This is where our experience in digital electronics can really be put to the test! In order to keep things simple we shall follow the design process through stage by stage and readers may wish to use the Logic Tutor to verify each section in turn. We shall start by combining the logic outputs of the window and door switches but, before we do, it is a good idea to list the functions of the various switches and indicators that we will be using on the Logic Tutor:

S1	window switch	(logic 1 when window open)
S2	door switch	(logic 1 when door open)
S3	alarm set/reset	(logic 1 to set, 0 to reset)
D1	door/window open	
D2	alarm set (active)	
D3	alarm triggered	

The logic outputs from the window and door switches, S1 and S2 respectively, need to be combined in an OR gate in order to provide a logic 1 output whenever either or both of them is open. This could be carried out quite simply using a single two-input OR gate, as shown in Fig. 8.7.

Before making a final decision as to which type of gate we should employ, it is worth considering the requirements of the next stage in the logic system. This would have to be a bistable element simply because an essential property of an intruder alarm is that it "remembers" that it has been triggered, providing a warning until someone arrives to disable it. Almost any type of bistable which has a CLEAR or RESET input would be suitable. We shall settle for a simple 7474 D-type. Remember that, with a D-type bistable, data (in the form of a logic 0 or logic 1) is transferred into the bistable when there is a change of state at the clock input. Such a change can either be positive going (0→1) or negative going (1→0), depending upon the internal logic of the bistable. With the 7474 clocking occurs on a rising clock edge, and thus a 0→1 transition is required from the previous logic gate.

Fig. 8.7. Method of combining window and door open signals

An OR gate produces a 0→1 output whenever either one of its inputs is taken to logic 1. A NOR gate, on the other hand, produces an opposite, 1→0, transition under similar circumstances. Thus the OR gate is to be preferred.

Now we shall turn our attention to the bistable stage itself. The state of the Q output indicates whether, or not, the alarm has been triggered and thus, initially at least, the Q output should be logic 0. To ensure that it is, we can use the CLEAR input; this is simply connected directly to the keyswitch which provides logic 0 to reset the alarm.

(Note that the 7474 has a CLEAR input which is "active low"). The DATA input must be connected to logic 1 so that a logic 1 will be transferred to the Q output whenever a negative going clock input appears (i.e. when a window or door is opened).

The 'alarm set' indicator, D2, can simply be connected to the output of the keyswitch, S3, whilst the 'alarm triggered' indicator, D3, is taken directly from the Q output of the bistable. In a practical circuit, due to current sourcing limitations, such an indicator should be connected between the positive supply and $\overline{Q}$ output. The Logic Tutor's indicator diodes (D1 to D4) are, however, already buffered and may be used directly. The arrangement thus far is shown in Fig. 8.8.

The final stage is to provide an audible warning indication which is capable of being pulsed on and off. On the Logic Tutor we shall use a simple piezoelectric transducer to simulate such a device. Low power transducers, particularly those which are p.c.b. mounted, consume currents as low as 10mA or less from a nominal 5V supply, and may thus be connected directly to the output of a conventional TTL gate. In this respect, they should be treated in the same manner as an l.e.d. load, i.e. connected from the +5V supply to the output of the gate. In a practical circuit, a buffer would be required in order to sink sufficient current to activate a high output alarm transducer.

At this point our design strategy can be usefully changed so that we now work backwards from the output to the bistable stage. The transducer will be connected between the output of the final gate and the positive supply, thus a logic 0 output from the gate will be necessary in order to activate the alarm. The final gate must therefore be an inverting type (unless we use the $\overline{Q}$ output from the bistable!). If the gate is a two-input NAND, one input can be taken from the Q output of the bistable and the other can be supplied from a simple Schmitt TTL oscillator of the type which we met in Part Six. The timing components (resistor and capacitor) can be chosen so as to produce an output at an appropriate frequency in the range 1Hz to 4Hz.

The final circuit of the intruder alarm is shown in Fig. 8.9 and the relevant timing diagram has been shown in Fig. 8.10. It must be stated that the alarm does not provide all of the functions which one might expect to be present on a proprietary security system.

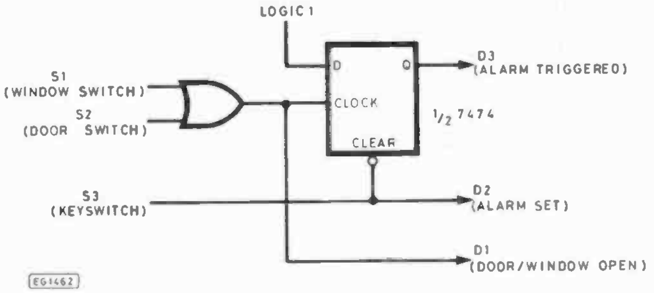


Fig. 8.8. Intruder alarm bistable arrangement

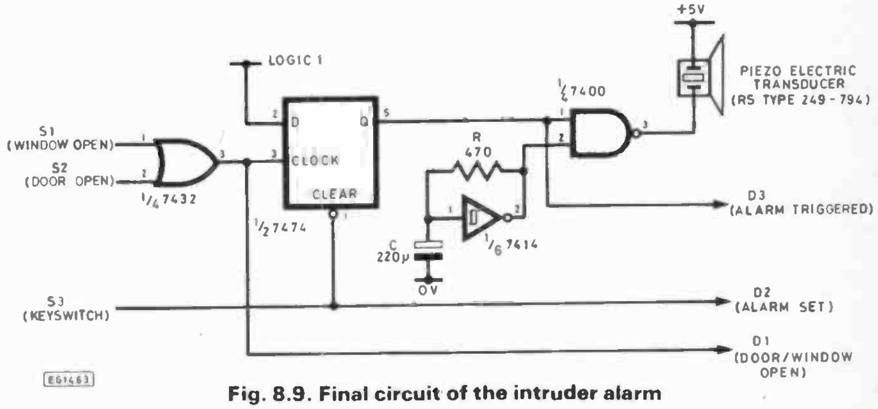


Fig. 8.9. Final circuit of the intruder alarm

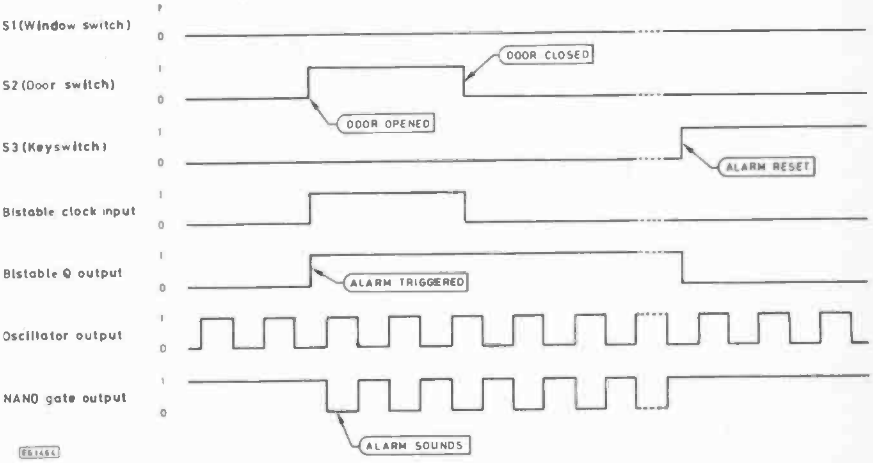


Fig. 8.10. Timing diagram for the intruder alarm

To simulate the complete intruder alarm system, insert 7432, 7474, 7400 and 7414 i.c.s respectively in sockets A, B, C and E of the Logic Tutor. In each case check that the device has been inserted with the usual orientation, i.e. pin-1 to socket 1. The following links are now required:

A1	to S1	(window switch)
A2	to S2	(door switch)
A3	to B3	
A7	to 0V	(0V)
A16	to +5V	(positive supply)
B1	to S3	(alarm set/reset)
B2	to logic 1	
B3	to D1	(door/window open indicator)
B4	to logic 1	
B5	to D3	(alarm triggered indicator)
B7	to 0V	(0V)
B16	to +5V	(positive supply)
C1	to B5	
C2	to E2	
C3	to piezoelectric transducer (−ve)	
C7	to 0V	(0V)
C16	to +5V	(positive supply)
E1	to E2	via 470 ohm resistor
E1	to 0V	via 220μF capacitor
E7	to 0V	(0V)
E16	to +5V	(positive supply)
S3	to D2	(alarm set indicator)
+5V	to piezoelectric transducer (+ve)	

(Total of 23 links)

DIGITAL ELECTRONICS

Readers may like to develop and extend the circuit incorporating some, or all, of the following suggested modifications:

1. Re-design the logic arrangement in order to replace the OR gate with the three unused NAND gates.
2. Add an input from a pressure sensitive mat to be placed behind the door. Assume that the mat has a 'normally open' switch. One of the unused inverters may be useful here!
3. Add an extra switch (to be located on the logic control panel) which allows the alarm to be tested without having to disconnect the audible warning device. The switch is to be a pushbutton type and should be used in conjunction with the unused bistable.
4. Add an extra output to activate an external alarm bell via a relay. The alarm bell is to be operated from a 12V battery (also external) and is to continue to operate in the event of an intruder gaining access to the premises and cutting the alarm bell connection to the control box.

Although this is the final part of our course, to complement the series, we'll be looking at CMOS devices next month and another Digital Project, the Oscilloscope Calibrator.

QUESTIONS

If you have any questions or queries you would like answered regarding our Digital Electronics series we would be pleased to receive them at our Editorial offices. All questions must be related to the course and we will publish as many questions and answers as possible. Also if you have any comments or observations about any part of the course we would be pleased to receive them.

The address to write to is: Practical Electronics, Digital Electronics Questions, Westover House, West Quay Road, Poole, Dorset BH15 1JG.

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DIGITAL ELECTRONICS

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Appearing every month, Micro-Bus now presents ideas, applications and programs for the most popular microcomputers and all micro-related projects so far published in PE. Ideas must be original, and payment will be made for any contribution featured.

NEW LOGIC TESTER

Sir — I am a regular reader of Practical Electronics and followed the early series of articles on interfacing the Compukit with great interest. One of the programs (UK 101 Logic Tester) given back in the February '81 issue proved quite helpful in getting to grips with the PIA. However, after a while a number of shortcomings became apparent, namely that it only polled port A, and the rate at which it did this was fairly low. The program enclosed solves both problems in that it polls both ports, and because it is in machine code, polls the ports very rapidly and displays the inputs on the screen.

The program, which operates under a 'Cegmon' monitor, fits neatly into page two from 0236 and leaves seven free bytes below the basic workspace. The program once loaded into memory is run by typing '0236G'. The sequence of events is then: the screen is cleared and the words 'PORT A' and 'PORT B' are displayed, the PIA is then configured so that all of the lines are set to input, next the input at port A is stored and each bit displayed (as with the basic program), the same is done for the input at port B, then checks for 'CTRL C' and 'CTRL A' are made before looping back to poll port A. By pressing 'CTRL C' the program may be stopped, and by pressing 'CTRL A' the PIA may be reconfigured; this may be useful if the reset button on the decoding module had been pressed.

As the program uses a number of subroutines peculiar to 'Cegmon', it will not, without modification, run under another monitor. However, should anyone require a fully portable version located at 0300 onwards, I would be pleased to send them a copy of the listing. (via the editor of PE).

As an extra, altering the contents of location 029F will change the rate at which the ports are polled.

Joseph Arrowsmith,
London

CEGMON PIA LOGIC TESTER

```
0235                               Store for port inputs.
0236  20  59  FE  JSR  FE59        Clear screen.
0239  A9  50      LDA  50          Put 'PORT A' and 'PORT B' on the screen.
023B  8D  12  D2  STA  D212
023E  8D  92  D2  STA  D292
0241  A9  4F      LDA  4F
0243  8D  D2  STA D213
0246  8D  93  D2  STA  D293
0249  A9  52      LDA  52
024B  8D  14  D2  STA  D214
024E  8D  94  D2  STA  D294
0251  A9  54      LDA  54
0253  8D  15  D2  STA  D215
0256  8D  95  D2  STA  D295
0259  A9  41      LDA  41
025B  8D  17  D2  STA  D217
025E  A9  42      LDA  42
0260  8D  97  D2  STA  D297
0263  A9  00      LDA  00
0265  8D  9D  EF  STA  EF9D        Access data direction register on port A.
0268  8D  9F  EF  STA  EF9F        Access data direction register on port B.
026B  8D  9C  EF  STA  EF9C        Set data direction for input on port A.
026E  8D  9E  EF  STA  EF9E        Set data direction for input on port B.
0271  A9  FF      LDA  FF
0273  8D  9D  EF  STA  EF9D        Code for peripheral register A.
0276  8D  9F  EF  STA  EF9F        Code for peripheral register B.
0279  A9  18      LDA  18          Alter subroutine to print up contents of port A.
027B  8D  F1  02  STA  02F1
027E  20  94  FB  JSR  FB94        Do 'CTRL C' check.
0281  AD  9C  EF  LDA  EF9C        Collect input on port A.
0284  8D  35  02  STA  0235        Store input at 0235.
0287  A0  10      LDY  10
0289  20  BF  02  JSR  02BF        Go to subroutine to determine which bits are on.
028C  A9  98      LDA  98          Alter subroutine to print up contents of port B.
028E  8D  F1  02  STA  02F1
0291  A0  10      LDY  10
0293  AD  9E  EF  LDA  EF9E        Collect input on port B.
0296  8D  35  02  STA  0235        Store input at 0235.
0299  20  BF  02  JSR  02BF        Go to subroutine to determine which bits are on.
029C  98          TYA              Transfer Y register to Accumulator.
029D  48          PHA              Push Accumulator onto stack.
029E  A0  08      LDY  08          Y register holds delay length.
02A0  20  E1  FC  JSR  FCE1        Do 'DELAY2'.
02A3  68          PLA              Pull Accumulator off stack.
02A4  A8          TAY              Transfer Accumulator to Y register.
02A5  A9  FE      LDA  FE          Check for 'CTRL A', if not pressed JMP 0279,
02A7  8D  00  DF  STA  DF00        if pressed do JMP 0263 to reconfigure ports.
02AA  2C  00  DF  BIT  DF00
02AD  70  0D      BVS  02BC
02AF  A9  FD      LDA  FD
02B1  8D  00  DF  STA  DF00
```

```
02B4 2C  00  DF  BIT  DF00
02B7 70  03      BVS  02BC
02B9 4C  63  02  JMP  0263
02BC 4C  79  02  JMP  0279
02BF 20  EB  02  JSR  02EB     Display Bit 0.
02C2 6A          ROR  A        Move Bit 1 to Bit 0.
02C3 20  EB  02  JSR  02EB     Display Bit 1.
02C6 6A          ROR  A        Move Bit 2 to Bit 0.
02C7 6A          ROR  A
02C8 20  EB  02  JSR  02EB     Display Bit 2.
02CB 6A          ROR  A        Move Bit 3 to Bit 0.
02CC 6A          ROR  A
02CD 6A          ROR  A
02CE 20  EB  02  JSR  02EB     Display Bit 3.
02D1 6A          ROR  A        Move Bit 4 to Bit 0.
02D2 6A          ROR  A
02D3 6A          ROR  A
02D5 20  EB  02  JSR  02EB     Display Bit 4.
02D8 2A          ROL  A        Move Bit 5 to Bit 0.
02D9 2A          ROL  A
02DA 2A          ROL  A
02DB 2A          ROL  A
02DC 20  EB  02  JSR  02EB     Display Bit 5.
02DF 2A          ROL  A        Move Bit 6 to Bit 0.
02E0 2A          ROL  A
02E1 2A          ROL  A
02E2 20  EB  02  JSR  02EB     Display Bit 6.
02E5 2A          ROL  A        Move Bit 7 to Bit 0.
02E6 2A          ROL  A
02E7 20  EB  02  JSR  02EB     Display Bit 7.
02EA 60          RTS           Return to main program.
02EB 29  01      AND  01       Mask off top 7 Bits.
02ED 18          CLC
02EE 69  30      ADC  30       Add ASCII character offset.
02F0 99  18  D2  STA  D218,Y   Print to screen.
02F3 88          DEY           Point STA D218,Y to the next print location.
02F4 88          DEY
02F5 AD  35  02  LDA  0235     Collect input data from storage at 0235, and return to
02F8 60          RTS           main subroutine.
02F9 00          BRK
02FA 00          BRK
```

CONTROLS

1) To start the program enter the monitor and type "0236 G".
2) Pressing "CTRL C" at any time will cause a warm start.
3) Pressing "CTRL A" at any time will cause the PIA to be configured for input. This may be used after the PIA has been reset.
4) The sampling rate may be changed by altering the value stored at location 029F. '00' gives a high sample rate whereas 'FF' gives a slow rate.

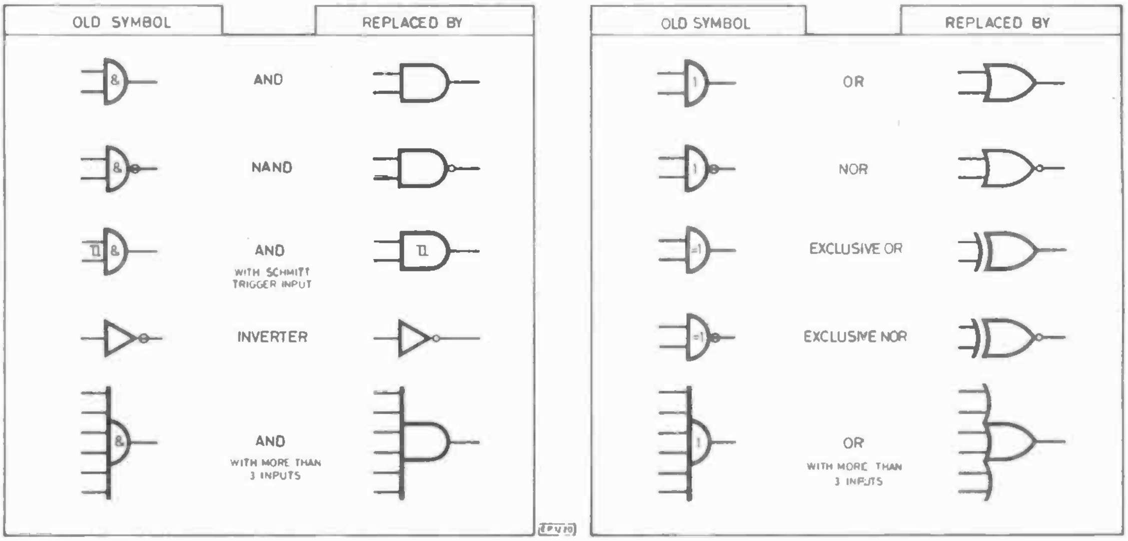
BASIC LISTING

```
 10 DATA 32,89,254,169,80,141,18,210
 20 DATA 141,146,210,169,79,141,19,210
 30 DATA 141,147,210,169,82,141,20,210
 40 DATA 141,148,210,169,84,141,21,210
 50 DATA 141,149,210,169,65,141,23,210
 60 DATA 169,66,141,151,210,169,0,141
 70 DATA 157,239,141,159,239,141,156,239
 80 DATA 141,158,239,169,255,141,157,239
 90 DATA 141,159,239,169,24,141,241,2
100 DATA 32,148,251,173,156,239,141,53
110 DATA 2,160,16,32,191,2,169,152
120 DATA 141,241,2,160,16,173,158,239
130 DATA 141,53,2,32,191,2,152,72
140 DATA 160,8,32,225,252,104,168,169
150 DATA 254,141,0,223,44,0,23,112
160 DATA 13,169,253,141,0,223,44,0
170 DATA 223,112,3,76,99,2,76,121
180 DATA 2,32,235,2,106,32,235,2
190 DATA 106,106,32,235,2,106,106,106
200 DATA 32,235,2,106,106,106,106,32
210 DATA 235,2,42,42,42,42,32,235
220 DATA 2,42,42,42,32,235,2,42
230 DATA 42,32,235,2,96,41,1,24
240 DATA 105,48,153,24,210,136,136,173
250 DATA 53,2,96,0,0,0,0,0
260 FORX=566TO762:READA:POKEX,A:NEXT
270 POKE11,54:POKE12,2:X=USR(X)
```

It is emphasised that material presented in Micro-Bus has not necessarily been proved by us. Neither can compatibility with *all generations* of the computer equipment to which it relates be guaranteed.

Software and hardware designs submitted should be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

LOGIC SYMBOLS



Simple PSU

STEPHEN IBBS

WHEN designing this power supply, I considered adding over-voltage protection, various forms of current limiting and alarms, but experience has shown that these can be more trouble than they are worth. Thus the design offered here has no embellishments, nor is it a revolutionary design. What it does offer is a simple to build, relatively cheap, simple to use power supply with some options open for variation.

Over a period of time it was found that the voltage range most used is 5 to 12 volts, with occasional drops to 2V to test l.e.d.s. Current requirements rarely exceeded 1 amp, so with these criteria in mind, various regulators were looked at, and finally the LM317 was settled upon. I selected the 317K which is capable of delivering 1·5A, but the p.c.b. has been designed to accommodate the 317M as an alternative, which will give 500mA for readers who require a less substantial power supply. The transformer can then be down-rated. Both regulators have built-in fold-back current-limiting and thermal protection.

A 12 volt transformer was used simply because I already had one, but if constructors want to be able to draw 15V at full current rating, the transformer should be upgraded to 15V or 17·5V. By limiting the range of the power supply it was possible to use two large clear meters to give voltage and current readings without having to resort to switched ranges etc.

HOW IT WORKS

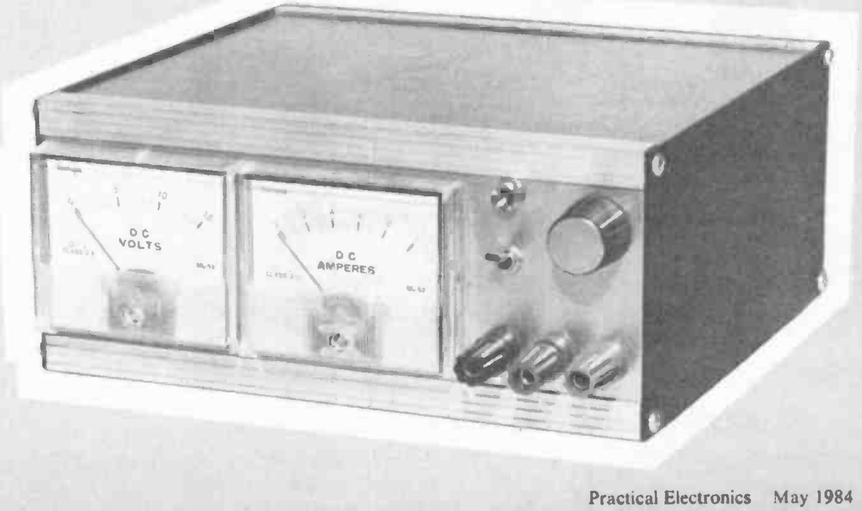
The secondary a.c. voltage is bridge rectified by REC1 and smoothed by C1. The resultant unregulated d.c. enters the IN pin of the 317, with C2 and C4 included to aid the stability of the regulator. The action of the i.c. is such that the output pin produces a voltage 1·25V higher than that on the ADJ pin, which is variable by means of the ratio between R1 and VR1. The circuit as described so far has a ripple-rejection factor of approx 65dB, but by adding a bypass capacitor C3 and a protection diode D1, this can be increased to approx 80dB. D1 is needed to provide a discharge path for C1 under output short-circuit conditions to prevent the capacitor discharging back into the i.c. For those readers who may be worried about the possibility of an input short circuit condition, another diode, D2, can be included to restrict the output to input reverse voltage. The d.c. regulated voltage then goes via the meter and the switch to the output terminals. A third socket for earth is also included.

CONSTRUCTION

It was decided for various reasons to use a Centurion case (WX3) and the finished result looks extremely professional. Once the case had been decided upon, the largest meters possible were selected to make readings easy, and the ML52 series fitted the bill perfectly.

Though few components are involved, it is recommended that for ease of construction a p.c.b. be used, and a suggested design is given in Fig. 2. A mains fuse is included and for safety reasons should not be omitted. Insert the components, including the i.c. if the 317M has been chosen (metal tab to the edge of the p.c.b.). Otherwise insert three Veropins for connection to the 317K, and Veropins for all other connections. Mount the p.c.b. in the case (in such a position that the 317M if used can be bolted via a mica washer to the rear panel). The 317K should be mounted on the rear panel, also with an insulating kit.

Theoretically a 2·2k potentiometer should produce a voltage output from 1·25V to 12·5V, but variable pots of this value are rare, 5k being much more common, so to avoid a cramped first half and a useless second half of the knob's travel, a 5·6k resistor is connected in parallel to make the effective resistance 0–2·6k approximately. This was then mounted, along with the other components on the front panel, which had been drilled and cut to suit. Mount the transformer, incorporating a solder tag for the earth wire, and drill a hole in the rear panel for the strain-relief bush. Next make all the necessary interconnections according to



WITH SIMULTANEOUS CURRENT AND VOLTAGE METERING

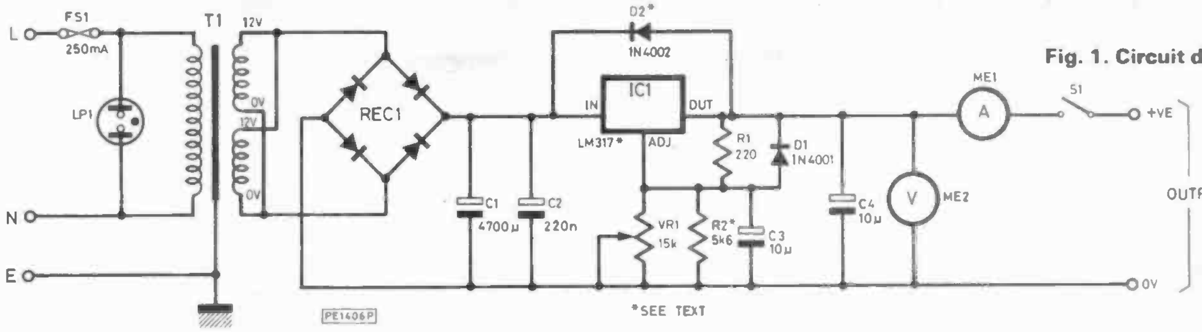


Fig. 1. Circuit diagram

COMPONENTS . . .

Resistors

R1	220 ¼W 5%
R2	5k6 (see text)

Capacitors

C1	4700µ 25V elect.
C2	220n 25V tant.
C3, 4	10µ 25V tant. (2 off)

Semiconductors

D1(D2)	1N4002
IC1	LM317K or LM317M (see text)

Miscellaneous

Centurion case	WX3	Ambit
ML52 meter	0–15V	
ML52 meter	0–1A	
BR1	SO4	

Terminal posts: red, black, green
Fuseholder and fuse 250mA (20mm)
SPST toggle switch
Neon
Nuts, bolts etc.

Transformer

T1	0–12, 0–12V 25VA

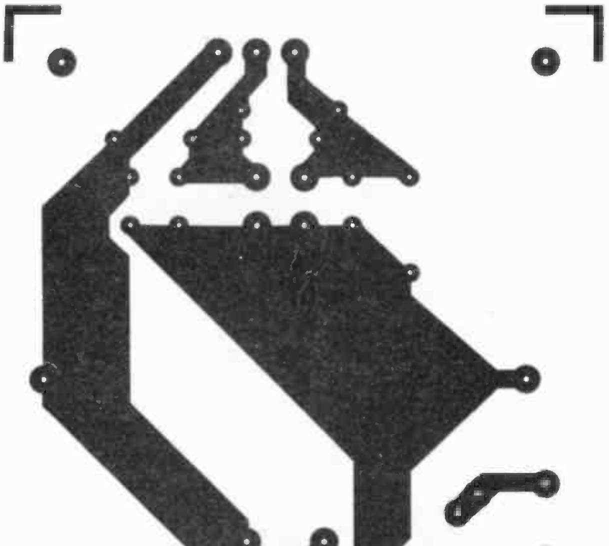


Fig. 2. Printed circuit board (actual size)

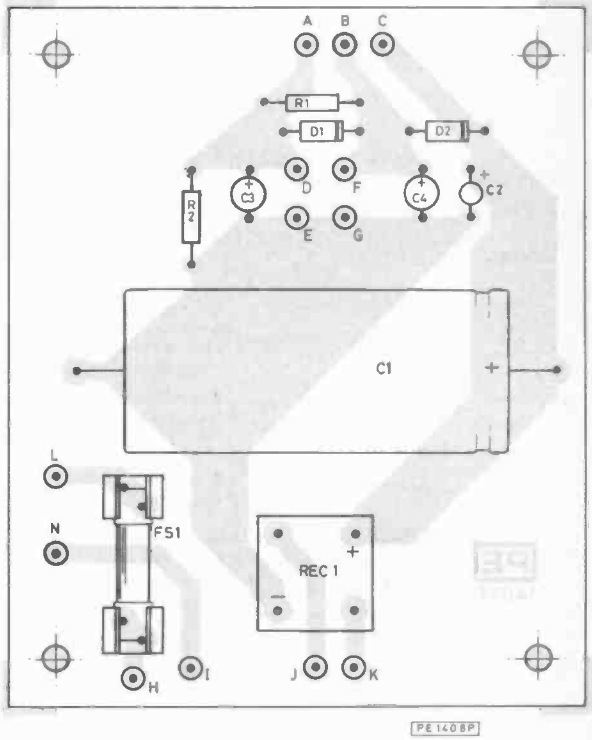


Fig. 3. Component layout

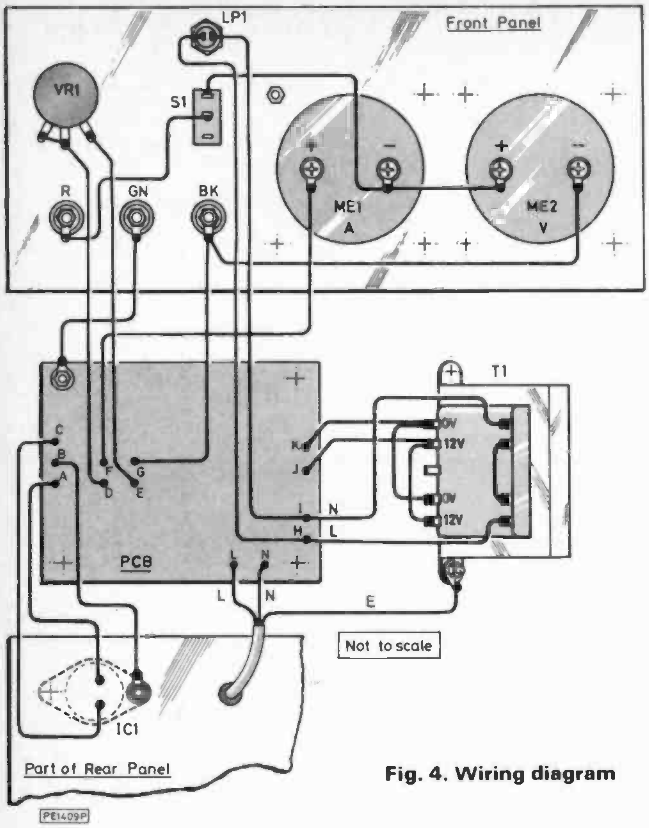


Fig. 4. Wiring diagram

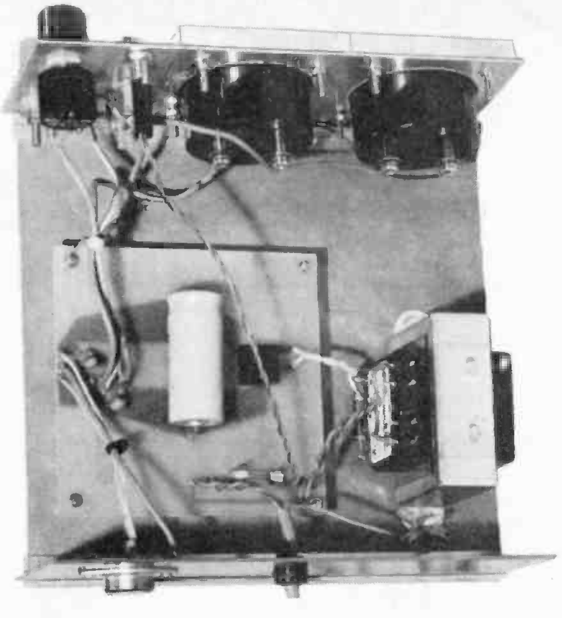


Fig. 4 and use thicker than normal wire for the output connections to avoid unnecessary voltage drops caused by lead resistance. Take care with the mains connections, particularly those to the neon as these can be easily touched inadvertently. After a final check the case can be bolted together and a useful piece of equipment added to the workbench. ★

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- Casing-High impact textured ABS
- Colour-Brown, front and base panels 1,6mm satin anodised aluminium

Hand Held Box

This box is moulded in two sections and has a textured finish. The battery compartment accepts a PP3 or nickel cadmium stack 25 x 45mm long. A circuit board 56 x 105mm may be mounted on three pillars in the base, location being provided by a 3mm spigot. The top moulding will accept a circuit board 71 x107mm.

- Material-Textured ABS
- Colour-Dark brown

Plastic Boxes
Type A
Plastic boxes consisting of a top and bottom moulding with front and rear aluminium panels, positively retained in the two halves.

- Top and bottom moulding-High ABS.
- Colour-Light grey top: dark grey base.
- Front and rear panels-Satin anodised aluminium 1,6mm thick.

Type B
Constructed of high impact polystyrene, these handsome two-toned grey boxes are suitable for wall mounting and free standing instruments. The two halves of the box are held together by screws inserted from the base.

- Material-High impact polystyrene
- Colour-Top light grey: base dark grey
- Panels-Satin anodised aluminium

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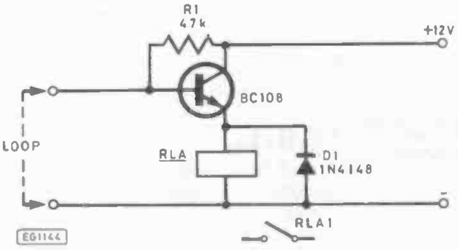
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not in the text.

INTRUDER ALARM

THE circuit is described in its simplest form in order to show how very easy it is to construct a reliable alarm system for your home, or workshop, at almost negligible cost. Some commercial products are cloaked in an air of mystery (particularly with regard to the prices) and talk is of infra-red, doppler and vibration detection systems, but with scant reference to false alarms, which seem to occur with increasing frequency as the circuitry grows more sophisticated.

My simple 'Intruder Alarm' (PE Mar 83 issue) was designed primarily for 'unattended' operation in boats and caravans, so a time and re-set circuit had to be provided, and although it could also be installed in the home, a 'closed-loop' system gives somewhat greater protection. The present circuit employs the absolute minimum of components and operates continuously when triggered, but a suitable timer circuit could be included to provide switch-off after a few minutes if desired.

The unit can be constructed on a small piece of stripboard and requires only two components plus the relay. (Although it is recommended that a small diode should be connected across the relay coil to protect the transistor from the back EMF's generated during operation). From Fig. 1 it will be seen that the transistor current will close the relay contacts until the base is connected to ground (shown dotted) whereupon conduction will cease. Nothing more is therefore required to produce a comprehensive and reliable system than this elementary circuit, together with a continuous loop shorting the base to ground, which would cause the unit to operate if it is broken at any point.

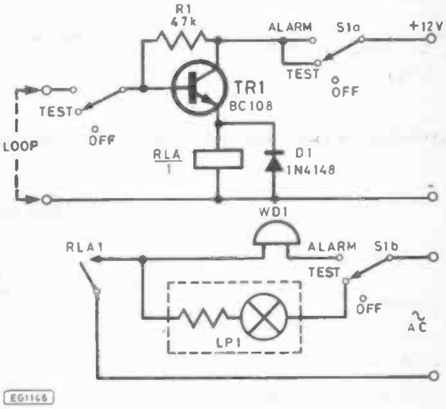


Consisting of a single wire fed around the property, possibly tucked under the edge of carpets, the loop is completed at opening windows and doors by magnetic latches, and by metal foil on the fixed glass. This self-adhesive tape can be arranged, for neatness, around the edge rather than across the panes if preferred; and some attention should be paid to the routing of this wiring in order to keep the total loop length as short as possible for efficiency as well as for economic reasons.

The reed switches are of the 'normally-open' type, whose contacts are held closed by the magnets. If a window is forced open, or the metallic tape torn by the glass being broken, the loop will no longer be complete and the relay will operate the alarm.

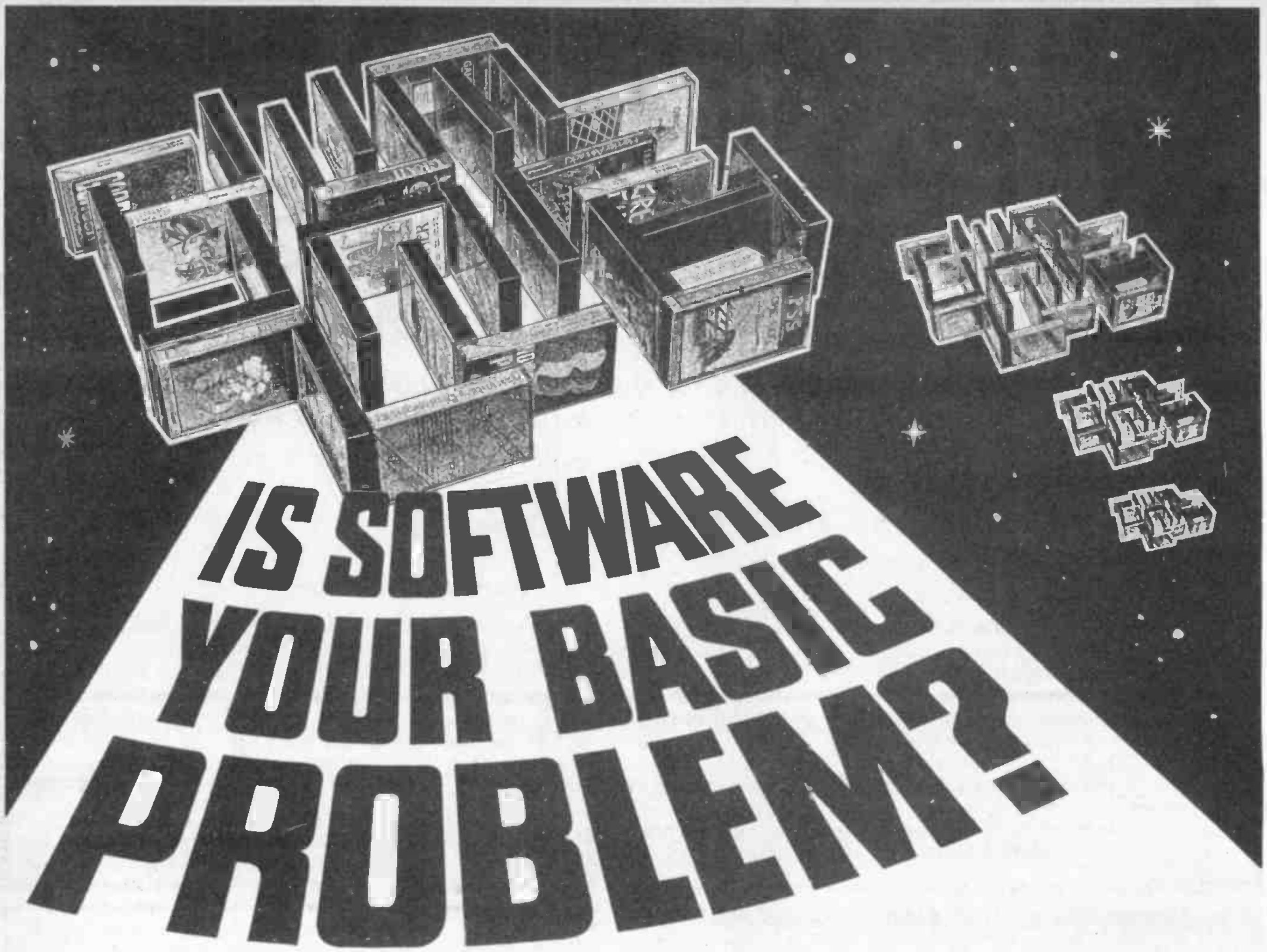
Since the circuit in its dormant state draws less than 1 milliamp, battery operation is perfectly acceptable, the 12V being derived from 'AA' 1·5V pen cells in two 4-cell plastic holders, although the unit will in many cases work quite successfully from a 9V PP3.

The alarm itself is largely a matter of choice and can range from a conveniently sited doorbell, to a mains-operated gong with, possibly, some of the house lights switching on at the same time. A 'test' circuit is a useful addition and Fig. 2 shows the switching arrangement with a mains bell and neon indicator. A 3-pole 3-way rotary switch is used providing 'Off', 'Test' and 'Alarm' positions. Section S1a is the On/Off, S1b switches off mains, or connects it to either the neon or bell and S1c joins the external loop to the transistor base in the 'Alarm' position. The Test setting shows that both battery and mains supplies are good and that the circuit is operating correctly (since the loop is open-circuit).



The basis of operation—or rather, *non*-operation—relies upon the transistor base being firmly grounded, so it is important to ensure that there are no poor connections in the loop. If the foil is damaged during installation, *replace it*. Magnetic switches, window foil and all accessories for making the loop are readily available from advertisers and in many cases, these days, from local shops. Special connectors for joining the foil to the wiring are on the market, but quite satisfactory use has been made of standard strip-connectors, although needing a little more patience. If a 4-pole switch wafer is used, the spare tags can be connected in parallel with those of S1b so as to increase the current capacity of the switch if heavier loads are going to be used in the alarm circuit.

P. E. Mackrell,
Lytham St Annes,
Lancashire.



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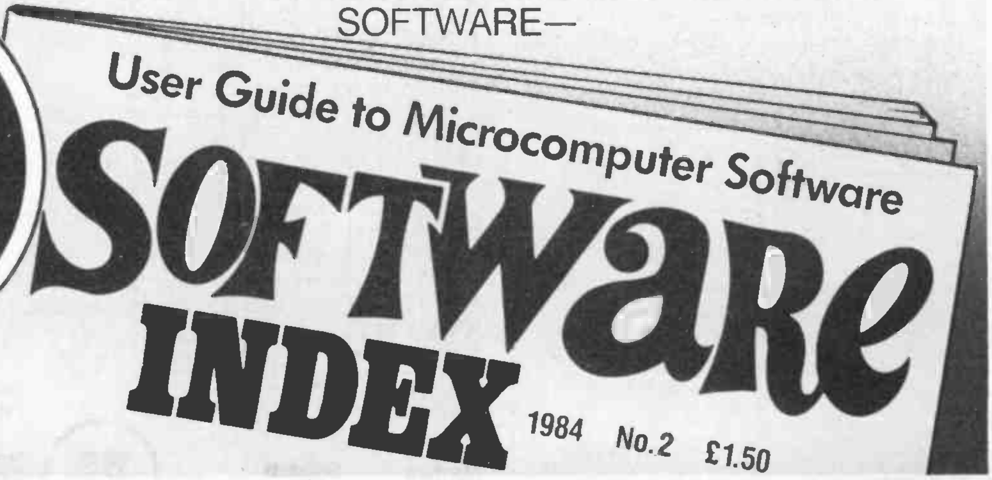

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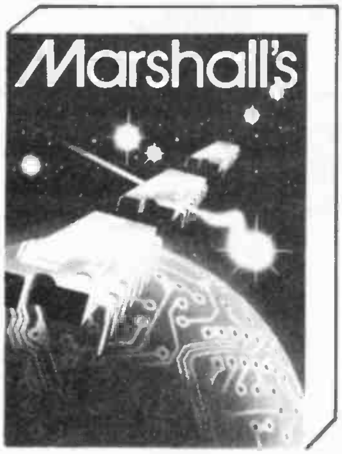

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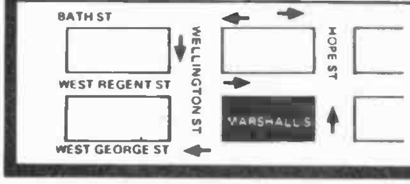

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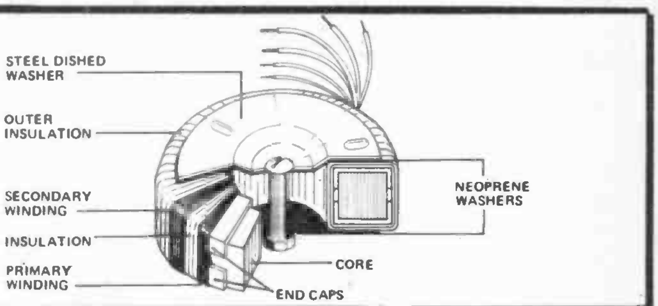

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0.50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4.16
2x011	9+9	2.77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1.38
2x015	22+22	1 13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6.64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2.66
3x014	18+18	2.22
3x015	22+22	1.81
3x016	25+25	1 60
3x017	30+30	1.33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10.00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4.00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0.50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3.63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1 45
5x029	220	0 72
5x030	240	0.66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2.81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6.82
7x016	25+25	6 00
7x017	30+30	5.00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3.33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4 54
8x029	220	2.27
8x030	240	2 08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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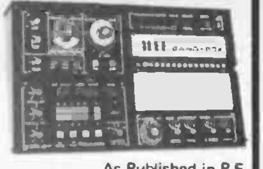

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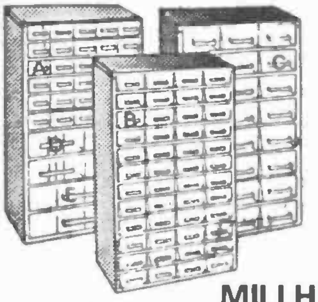

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32/350V	50p	32+32/350V	75p	32+32+16/350V	75p
32/500V	95p	20+20/350V	75p	32+32+32/325V	50p
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100V

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330nF to 390nF	20p
470nF to 560nF	26p
680nF	30p
1µF (10mm)	35p

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10nF 15nF 22nF 33nF 47nF 68nF 100nF	7p
150nF 200nF	10p
330nF 470nF	13p
680nF	18p
1µF	22p
1 5µF	39p
2 2µF	39p

FEEDTHROUGH
1nF 500V 7p

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Capacitors please enquire many types in stock

TANT BEADS

1 35V	14p
22 35V	14p
33 35V	14p
47 35V	14p
68 35V	14p
1 0 35V	14p
2 2 35V	14p
3 3 35V	18p
4 7 16V	18p
4 7 35V	20p
6 8 25V	20p
6 8 35V	21p
10 16V	18p
10 35V	27p
15 10V	22p
15 16V	30p
15 25V	32p
22 6 3V	26p
22 16V	29p
33 10V	30p
47 3V	14p
47 6 3V	34p
47 16V	39p
100 3V	32p

ELECTROLYTICS
Mainly Matsushita (Panasonic) &

Siemens AXIALS (Wires each end)

uFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2000	16	40p
2200	25	63p
2200	40	70p
2200	63	1 34p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end)
Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

74TTL

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PHONE FOR LATEST PRICES AND DELIVERY

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74LS540
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74LS640
74LS641

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CMOS

4000	16p
4001	16p
4002	16p
4006	49p
4007	19p
4008	32p
4009	24p
4010	24p
4011	16p
4012	19p
4013	19p
4014	46p
4015	39p
4016	19p
4017	32p
4018	45p
4019	24p
4020	42p
4021	39p
4022	39p
4023	19p
4024	32p
4025	19p
4026	79p
4027	28p
4028	39p
4029	43p
4030	19p
4031	1 19
4032	79p
4033	1 19
4034	1 29
4035	44p
4036	2 49
4037	1 13
4038	99p
4039	2 45
4040	39p
4041	39p
4042	39p
4043	39p
4044	39p
4045	99p
4046	44p
4047	69p
4048	39p
4049	22p
4050	23p
4051	44p
4052	58p
4053	49p
4054	79p
4055	83p
4056	83p
4059	4 35
4060	42p
4063	79p
4066	22p
4067	2 39
4068	19p
4069	19p
4070	19p
4071	19p
4072	19p
4073	19p
4075	19p
4076	45p
4077	19p
4078	19p
4081	19p
4082	19p
4085	49p
4086	60p
4089	1.23
4093	19p
4094	69p
4095	71p
4096	69p
4097	2.88
4098	74p
4099	89p
4502	55p
4503	39p
4507	33p
4508	1.26
4510	44p
4511	44p
4512	48p
4514	1.13
4515	1.13
4516	55p
4518	39p
4519	29p
4520	48p
4521	88p
4526	68p
4527	62p
4528	74p
4532	69p
4534	3.96
4536	2.59
4538	78p
4539	89p
4543	68p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.65
4584	39p
4585	59p

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CPUs
1802
2550A
6502
6800
6802
6809
8035
8080A
8085A
Z80A
Z80B

MEMORIES
2114(200ns)
2532
2564
2708
2716 (5v)
2764
4116(200ns
4118 3
5204
6116P3
6514
6810
7489
74189
74LS188
74LS287
74LS288
74LS289

MISC LOGIC IC's
ADC0804
ADC0816
ADC0817
INS1671
INS1771
RO2513LC
RO2513UC
SAA5000
SAA5010
SAA5012
SAA5020
SAA5030
SAA5040
SAA5041
SAA5050
SAA5052
SAA5070
8T26
8T28
8T95
8T97
81LS95
81LS96
81LS97
81LS98
6522
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8155
8212
8216
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8226
Z80ACTC
Z80ADART
Z80ADMA
Z80APIO
ZN425E8
ZN426E8
ZN427E8

PHONE FOR LATEST PRICES AND DELIVERY

V REGS

Positive 100mA

78L05A	29p
78L12A	29p
78L15A	29p
78L24A	29p

1 Amp TO202

7805T	45p
7812T	45p
7815T	45p
7824T	45p

Negative 100 mA TO92

79L05	49p
79L12	49p
79L15	49p

1 Amp TO220

7905T	57p
7912T	57p
7915T	57p
7924T	57p

TRANSISTORS

2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2368	25p
2N2369	19p
2N2369A	20p
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	9.25
2N2926	10p
2N3053	27p
2N3054	56p
2N3055	60p
2N3055H	1.20
2N3439	98p
2N3440	80p
2N3441	1 25
2N3442	1 35
2N3553	2 65
2N3638	55p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2 00
2N3713	1.38
2N3714	2 98
2N3715	3 31
2N3716	3 60
2N3773	1.99
2N3819	35p
2N3820	68p
2N3866	90p
2N3903	13p
2N3904	13p
2N3905	13p
2N3906	13p
2N4030	75p
2N4031	65p
2N4032	69p
2N4036	63p
2N4037	49p
2N4240	3 00
2N4400	15p
2N4401	27p
2N4402	30p
2N4902	1.85
2N4903	1.98
2N4904	2 15
2N4905	2 75
2N4906	2 99
2N4907	3 20
2N4908	3 15
2N4909	2 90
2N5089	37p
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2 88
2N5293	98p
2N5294	1 28
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2N5401	35p
2N5415	1 10
2N5416	1 54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5551	37p
2N5884	5 95
2N5886	5 95
2N6121	57p
2N6122	59p
2N6123	65p
2N6124	59p
2N6125	65p
2N6126	75p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1 14
2N6134	1 36
2N6253	1 4
2N6254	1 5
2SC1306	95p
2SC2078	1.70
2SJ49	3 95
2SJ50	4 50
2SJ82	4 75
2SK134	3 95
3SK135	4 50
2SK226	4 75
3N128	1 12
3N140	1 07
3N200	6 93
3N201	2 98
40360	60p
40361	67p
40362	67p
40363	2 95
40406	1 39
40407	75p
40408	1 59
40410	1 80
40411	3 95
40412	90p
40673	70p
40822	1.80
40871	1.00
40872	1.00
AC125	49p
AC126	32p
AC127	32p
AC128	35p
AC132	68p
AC141K	28p
AC142K	28p
AC151	51p
AC152	45p
AC153	55p
AC153K	84p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
AF239	55p
AF240	1.00
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p
BC140	29p
BC141	37p
BC142	29p
BC143	30p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC186	24p
BC187	24p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LA	13p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC516	40p
BC517	40p
BC546B	15p
BC547	13p
BC556B	15p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	15p
BC550C	25p
BC557	15p
BC557A	16p
BC557B	15p
BC558	14p
BC558A	15p
BC558B	16p
BC558C	17p
BC559	15p
BC559B	16p
BC559C	17p
BC560	25p
BC560C	25p
BC650	45p
BC651	46p
BCY70	16p
BCY71	16p
BCY72	19p
BD131	44p
BD132	44p
BD135	35p
BD136	35p
BD137	37p
BD138	37p
BD139	38p
BD140	38p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1 00
BD245A	1 14
BD245C	1 30
BD246A	1.20
BD246C	1 50
BC249A	2.00
BD249C	2 31
BD250A	2.11
BD250C	2 46
BD419	1.29p
BD420	1.37
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1 20
BD530	1 30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1 10
BD540	85p
BD540C	1 20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1 32
BD712	1 32
BDX32	3 47
BDX66B	5 95
BDX67B	5 95
BDY54	1 70
BDY55	1 75
BDY56	1 80
BDY57	5 25
BDY58	6 15
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	75p
BF224J	32p
BF225J	35p
BF244A	55p
BF244B	55p
BF245A	55p
BF245B	65p
BF246	70p
BF246A	70p
BF246B	70p
BF247A	75p
BF247B	75p
BF254	39p
BF255	42p
BF256A	58p
BF256B	58p
BF256C	65p
BF257	30p
BF258	32p
BF259	35p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2 11
BFS28	2 95
BFS61	1 00
BFS98	1 10
BFX29	36p
BFX30	36p
BFY50	[illegible]
BFY51	36p
BFY52	36p
BFY53	31p
BSX19	24p
BSX20	24p
BSX21	40p
BU104	2.22
BU105	1.70
BU108	3.95
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU226	3.95
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU500	2.95
BUY18S	3.95
E430	5.95
J300	70p
J310	70p
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ4502	3.99
MJ15003	4 85
MJ14004	5 55
MJ15015	2 45
MJ15016	3 34
MJE340	53p
MJE350	1.50
MJE2955	1.95
MJE3055	1.95
MJE2955T	99p
MJE3055T	69p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	85p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	46p
MPSL51	49p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1 20
NE5534A	1 66
TIP29A	29p
TIP29C	38p
TIP30A	35p
TIP30C	36p
TIP31A	33p
TIP31C	34p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1 09
TIP35C	1 28
TIP36A	1 29
TIP36C	1 39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	59p
TIP49	1 20
TIP50	1 40
TIP53	1 57
TIP54	1 59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	84p
TIP127	84p
TIP130	93p
TIP132	93p
TIP135	99p
TIP137	99p
TIP140	1 04
TIP142	1 04
TIP145	1 15
TIP147	1 15
TIP162	4 95
TIP2955	77p
TIP3055	70p
TIS43	50p
TIS88A	80p
VN10KM	60p
VN46AF	95p
VN66AF	99p
ZTX107	10p
ZTX108	10p
ZTX109	12p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX450	39p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	24p
ZTX530	24p
ZTX531	26p
ZTX650	46p

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	3p
1N4150	18p
1N4448	22p
1N5400	12p
1N5401	13p
1N5402	14p
1N5404	16p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1S44	10p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA155	15p
BA156	38p
BA157	25p
BA158	30p
BA150	32p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAX13	10p
BB109G	65p
BY126	11p
BY127	12p

SCR's TRIACS DIACS

THYRISTORS
4, 8 & 12 Amps
Texas TO220
Suffix A - 100V
B - 200V
C - 300V
D - 400V
M - 600V

TIC106A	46p
TIC106B	47p
TIC106C	48p

4A

TIC106D	49p
TIC106M	68p
TIC116A	66p
TIC116B	68p

8A

TIC116C	71p
TIC116D	73p
TIC116M	80p
TIC126A	72p
TIC126B	72p

12A

TIC126C	73p
TIC126D	77p
TIC126M	96p

TRIACS
Texas 400V
TO220 Case

TIC206D (4A)	66p
TIC225D (6A)	74p
TIC226D (8A)	88p
TIC236D (12A)	1 16
TIC246D (16A)	1 22
TIC253D (20A)	1.90
TIC263D (25A)	2 11

DIACS

BR100	29p
ST2	29p

ZENER'S

many inc specials see our CAT
400-500mW
E24 Series
2 4-47V 7p

1 3 Watt
E24 Series
3 3-82V 14p

BRIDGE

(PIV shown in brackets)
1½ amp type

W01 (100)	28p
W02 (200)	34p
W04 (200)	38p
W08 (800)	50p

2 amp type
Square with hole

S01 (100)	46p
S02 (200)	50p
S04 (400)	55p
S08 (800)	66p

6 amp type
Square with hole

PW01 (100)	95p
PW02 (200)	99p
PW04 (400)	1.30
PW06 (600)	1.39

25 amp type
Metal clad with hole

K01 (100)	2.62
K02 (200)	2.75
K04 (400)	3.25
K06 (600)	4.10
BYW64	
35A 400V	4.50

OPTO

many inc. specials see our CAT.

LED LAMPS
R = Red
G = Green
Y = Yellow

Large Diffused 1·

R5D	9p
G5D	15p
Y5D	15p

Small diffused

R3D	8p
G3D	12p
Y3D	12p

Micro 0.1"

R1M	25p
G1M	27p
Y1M	27p

Lage clear

R5C	12p
G5C	17p
Y5C	17p

Super bright high efficiency Large (100 times brighter)

R5U	38p
G5U	42p
Y5U	42p

Rectangular Stackable LEDs

R5R	17p
G5R	18p
Y5R	19p

LINICS

AY1 5050	95p
AY3 8910	3.99
AY3 8912	4.95
CA3048	2 15
CA3059	2 80
CA3090AQ	3 70
CA3130E	87p
CA3130T	2 35
CA3140E	39p
CA3140T	1 40
HA1366W	2 40
HA388	2 54
ICL7106	7 50
ICL7107	9 50
ICL7611	97p
ICL8038	2 99
ICM7555	80p
ICM7556	1 50
LC7120	3 20
LC7130	3 40
LC7137	3 95
LF347	1 50
LF351	47p
LF353	92p
LF355	83p
LF356	1.26
LF357	1 30
LF398	4 62
LM3352	1 60
LM348N	62p
LM349N	1 09
LM350K	4 60
LM379S	5 50
LM380N14	1.10
LM380N8	1 50
LM381AN	2 26
LM381N	1 40
LM382N	1 12
LM383T	3.40
LM384N	1.40
LM386	88p
LM388N	2 43
LM391N60	2 10
LM391N80	2 40
LM723CH	95p
LM723CN	35p
LM725CH	3 40
LM725CN	3 19
LM741CH	96p
LM741CN	22p
LM741CN14	80p
LM747CN	69p
LM748CH	1 00
LM748CN	35p
LM1871	3 25
LM1872	4 39
LM1877	5 95
LM1886	7 44
LM1889	3 77
LM2907N	2 76
LM2907N8	2 60
LM2917N	2 40
LM2917N8	2 40
LM3900	48p
LM3911	1 20
LM3914	3 25
LM3915	3 25
LM13600	1 15
MF10	3 50
NE531N	1 36
NE543N	2 50
NE544N	1 95
NE555	22p
NE556	65p
NE558	1 89
NE560	3 25
NE565	1 18
NE566	1 49
NE567	1 37
NE570	4 07
NE571	3 99
NE5534A	1 45
RC4194	3 95
RC4195	2 95
RC4558	44p
SL470	3 47
SL480	2.[illegible]
SL490	3.47
SN76003	2.96
SN76013	2.96
SN76023	2.96
SN76033	2.96
TA7204	1.99
TA7205	1.20
TA7222	1.76
TA7227	6.82
TBA500	2.97
TBA500Q	3.11
TBA510	2.96
TBA510Q	3.05
TBA520	2.67
TBA520Q	2.75
TBA530	2.66
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.26
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	2.25
TDA1022	4.95
TDA2002	3.25
TDA2003	3.25
TDA2020	2.99
TDA2030	2.85
TDA2611A	2.50
TDA7000	3.45
TL061	40p
TL062	60p
TL064	1.35
TL071	34p
TL072	45p
TL074	1.35
TL081	34p
TL082	45p
TL084	1.20
UAA170	2.49
UAA180	2.49
ULN2003	75p
UPC575C2	2.00
UPC1156	2.75
UPC1156H	2.75
UPC1182	3.75
UPC1185	1.95
UPC2002	2.95
XR2206	3.95
ZN409	2.25
ZN414	1,00
ZN1034	1.99

TRANSFORMERS

All 240V Primary
6 0 6V, 9 0 9V
12 0 12V,
15 0 15V

100mA	95p
1A	2.65

20 0 20V

0.125A	2.65

12 0 12V

50VA	5.25

12 0 12V

100VA	9.50

0-6-6-9-9

1 25A	4 25

These goods are heavy send extra p & p We will credit any difference

VERO

0.1" COPPER TRACKS

2 5 · 3 7	83p
2 5 · 5	99p
3 75 · 3 75	99p
3 75 · 5	1 14
2 5 · 17	2.99
3 75 · 17	3.85
4 79 · 17	4.93
VQ Board	1.92
Dip Board	3.90
Track Cutter	1.48
Pin Insertor	1 79
100Pins	55p
Verobloc	3.99

Vero Wiring

Pen + Spool	3 35
Spare Spool	75p
Combs	6[illegible]

PCB

FERRIC CHLORIDE
Quick dissolving Enough to make over 1 litre 1.69

ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots + holes
8 0 1 edge connectors
9 Mixture
Any sheet of above 35p

GRADE ONE GLASS PCB
SINGLE SIDED

178 · 240mm	150p
420 · 195mm	1 95
420 · 245mm	2 95

DALO ETCH RESIST PEN
+ spare nib 1 20

PHOTO SENSITIVE PCB
1st Class Epoxy Glass For better results than spraying Expose to UV

Single Sided

100 × 160	2.10
100 × 220	2.50
203 × 114	2.40
233 × 220	5.20

Double Sided

100 × 160	2.20
100 × 200	2.80
203 × 114	2.90
233 × 220	5.90

Developer for above (do not use Sodium Hydroxide)

500 ml	2.95

WIRE

PRICES PER METRE
Solid connecting wire

MAINS/SPEAKER

Twin 1 Amp	14p
Twin 2½ Amp	16p
3 Core 2½ Amp	18p
3 Core 6 Amp	31p
3 Core 13 Amp	56p

SCREENED

Single	14p
Stereo	27p
Mini Single	12p
Mini Stereo	15p
4 Core 4 Screens	44p
4 Core, Single Screen	54p
8 Core	61p
12 Core	80p
Heavy Duty Mike/Guitar Lead	25p

AERIAL

50Ω RG58A	25p
75Ω UHF	29p
75Ω VHF	28p
300Ω Flat	14p

RAINBOW RIBBON
Prices per foot

8 way	25p
10 way	25p
16 way	39p
20 way	48p
24 way	62p
30 way	75p
32 way	82p
40 way	88p
64 way	1.49

RECHARGE BATTERIES

Top quality Don't throw these batteroes away – they charge up to 1000 times!

HP2(1 2AH)	2.39
HP2(4AH)	4.75
HP7(½AH)	99p
HP11(1 2AH)	2.29
PP3(110mAH)	4 95

Chargers

TYPE H: Adjusted to 6 of any HP type Above	£15 59
TYPE M: As above but faster charge for 4AH	£25 95
TYPE P PP3	£5.50
TYPE A: HP7 (Up to 4 at a time)	£5.85

SOLDER

ANTEX SOLDERING IRONS

C240 (15W)	5.20
XS240 (25W)	5.40
Iron Stand	1 75

Elements

(State Iron)	2 05

C240 Bits

No 2 (Small)	85p
No 3 (Med)	85p
No 6 (Micro)	85p

XS240 X25 Bits

No 50 (Small)	85p
No 51 (Med)	85p
No 52 (Lge)	85p

SOLDER 125gms

18swg	2 95
22swg	3.10

PLUGS & SOCKETS

'D' Connectors
25 Way Solder

Male	1.60
Female	2.09

PCB Wire Wrap

Male	1 60
Female	2 09
Covers	1 00

Phono Plugs

Blk Red Grn Wt or Yell	15p
Line Skts	1.20
Chas Skt - 1	20p
Dual	30p
Quad	40p

ZIF SOCKET

24pin	4 35
28pin	5 00
40pin	5 35

SWITCHES

TOGGLE (MINI)

SPST	49p
SPDT	59p
DPDT	69p
DPDT C OFF	90p
4PDT	2 95

MAPLIN Massive range of components for your hobby....insist on Maplin quality!

MAPLIN'S TOP TWENTY KITS

THIS MONTH	LAST MONTH	DESCRIPTION OF KIT	ORDER CODE	KIT PRICE	DETAILS IN PROJECT BOOK
1.	(1)	✱ 75W Mosfet Amp Module	LW51F	£12.95	Best of E&MM
2.	(3)	♠ Modem	LW99H	£44.95	5 XA05F
		Case also available: YK62S Price £9.95.			
3.	(5)	♠ ZX81 I/O Port	LW76H	£9.25	4 XA04E
4.	(4)	✱ Car Burglar Alarm	LW78K	£6.95	4 XA04E
5.	(8)	♠ Partylite	LW93B	£9.45	Best of E&MM
6.	(2)	♠ Keyboard for ZX81	LW72P	£23.95	3 XA03D
		Case also available: XG17T £4.95. Complete ready-built: XG22Y £32.50			
7.	(10)	♠ 8W Amp Module	LW36P	£4.45	Catalogue
8.	(14)	♠ VIC20/64 RS232 Interface	LK11M	£9.45	7 XA07H
9.	(7)	♠ Syntom Drum Synthesiser	LW86T	£11.95	Best of E&MM
10.	(12)	♠ Harmony Generator	LW91Y	£17.95	Best of E&MM
11.	(17)	♠ Spectrum RS232 Interface	LK21X	£17.95	8 XA08J
12.	(6)	♠ VIC20 Speech Synthesiser	LK00A	£22.95	6 XA06G
13.	(13)	✱ ZX81 Sounds Generator	LW96E	£10.95	5 XA05F
14.	(11)	♠ Ultrasonic Intruder Detctor	LW83E	£10.95	4 XA04E
15.	(15)	✱ Logic Probe	LK13P	£9.95	8 XA08J
16.	(26)	♠ Car Battery Monitor	LK42V	£6.25	Best of E&MM
17.	(18)	♠ Hexadrum	LW85G	£19.95	Best of E&MM
18.	(21)	♠ Synwave Sounds Synth	LW87U	£10.95	Best of E&MM
19.	(25)	♠ Spectrum Keyboard	LK29G	£28.50	9 XA09K
		Also required: LK30H £6.50; Case: XG35Q £4.95 — Total £39.95.			
		Also available complete ready-built: XG36P £44.95.			
20.	(9)	♠ ZX81 Speech Synthesiser	LK01B	£16.95	6 XA06G

Over 80 other kits also available. All kits supplied with instructions.

The descriptions above are necessarily short. Please ensure you know exactly what the kit is and what it comprises before ordering, by checking the appropriate Project Book mentioned in the list above.

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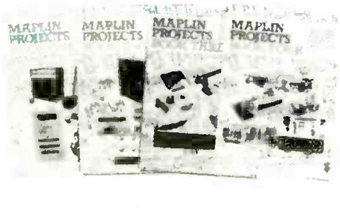

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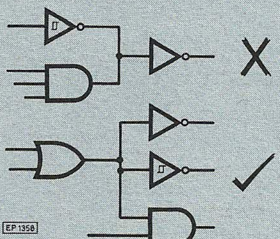
CONNECTING GATES

A standard ('totem-pole') TTL gate output to be connected to the input of any other TTL gate. The use of standard logic levels and common power supplies ensures that such signals will be compatible. There are many cases, however, where more than just two gates are involved in processing a signal. The rule then for connecting multiple standard gates (illustrated below) is that a single TTL output may be connected to more than one input, but not vice versa.



FAN-IN AND FAN-OUT

The output of a TTL gate may be connected to the input of one or more gates. The drive capability of a gate is known as its fan-out, and is usually expressed as the number of standard loads (usually ten) which can be driven by the gate. The fan-in of a gate indicates its loading effect on a gate output, and is usually expressed as the number of standard loads (usually one) that it represents. It is unusual for more than ten loads to be connected to a single output, but if the fan-out is exceeded, the voltage and current swings may become too small to drive all of the loads reliably.

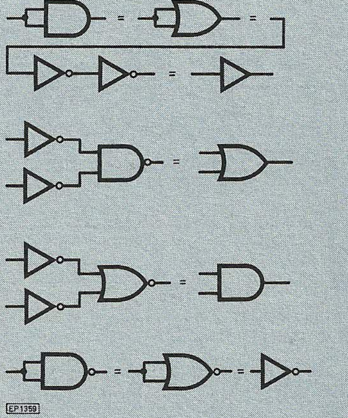
As a general rule, the fan-out within a TTL sub-family is 10 (20 for LS), and the majority of inputs have a fan-in of one. The general rules for fan-in and fan-out for the commonly encountered TTL sub-families are summarised in Table 1.

INPUT AND OUTPUT CURRENT

The limits on fan-out are caused by the currents which must flow to hold the input of a gate at logic 0 and at logic 1. In TTL, the logic 0 currents usually predominate in determining fan-out. A standard gate input requires 1·6mA to flow between the input and 0 volts to establish a logic 0. Thus, to support a fan-out of 10, the corresponding gate output must be capable of 'sinking' 16mA. In the logic 1 state, the current flow is in the opposite direction, and is substantially smaller. Standard TTL inputs are typically able to 'source' 800μA, while typical inputs only require 40μA each in the logic 1 state. The source and sink currents for standard gates are shown in Table 2.

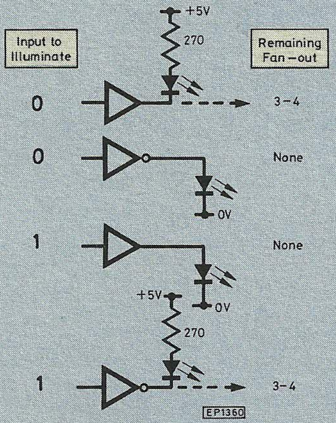
CIRCUIT EQUIVALENTS

There are a number of arrangements of logic gates which are very useful in building real logic circuits. These are particularly useful when trying to use the minimum number of i.c.s in the circuit. Some useful equivalents are shown below.



DRIVING LEDs

A typical red l.e.d. requires a current of around 10mA to flow through it in order to provide a reasonably bright display. There are a number of ways to drive an l.e.d. from a TTL gate output. The actual method chosen depends on whether the diode is to be illuminated for a gate output of 0 or 1, and whether the gate is required to drive any other logic gates in addition to the diode. The various techniques are shown below, together with the logic input/output states required to illuminate the l.e.d., and the fan-out remaining to drive other gates. Although specific gates are shown, any logical equivalent may also be used.

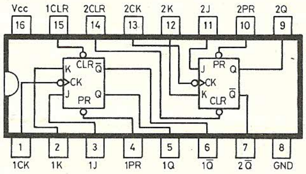


Driving Gate	Max. Number of Inputs Driven				
	74	74L	74H	74S	74LS
Standard TTL (74)	10	40	8	8	20
Low-Power (74L)	2	10	1	1	5
High-Power (74H)	12	40	10	10	25
Schottky (74S)	12	40	10	10	50
L-P Schottky (74LS)	5	20	4	4	20

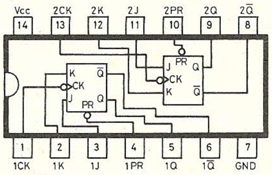
Table 1

Gate Type	High I/P (μA)	Low I/P (mA)	High O/P (μA)	Low O/P (mA)
74	40	−1·6	400	−16
74L	10	−0·18	100	− 3·6
74H	50	−2	500	−20
74S	50	−2	1000	−20
74LS	20	−0·4	400	− 8

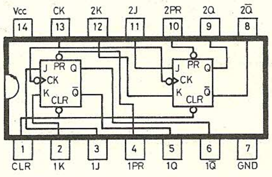
Table 2



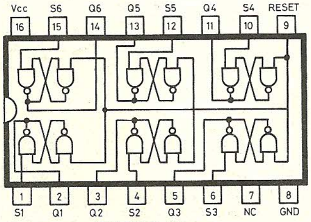
74112 Dual J–K preset and clear



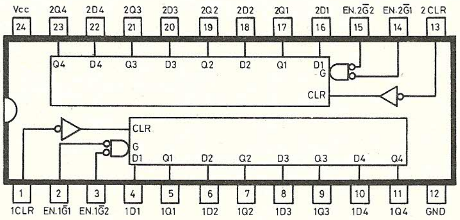
74113 Dual J–K with preset LS



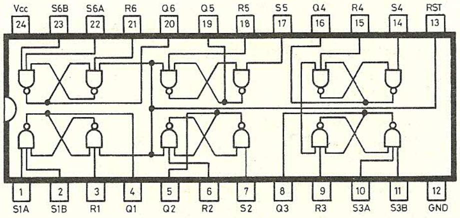
74114 Dual J–K preset and clear LS



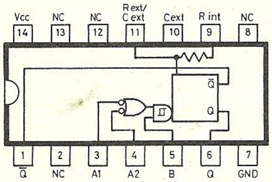
74118 Hex S–R latch with single reset



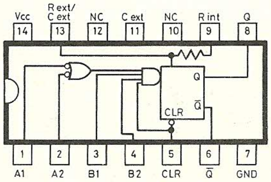
74116 Dual 4-bit latch with enable and clear



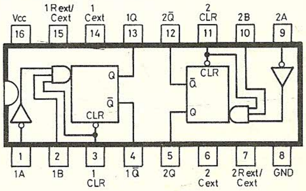
74119 Hex S–R latch



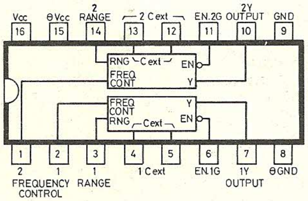
74121 Monostable



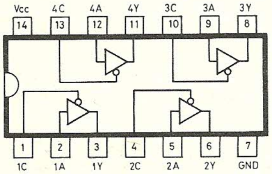
74122 Retriggerable mono with clear



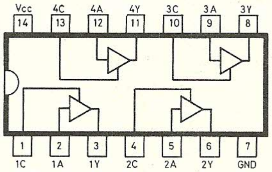
74123 Dual Retriggerable mono with clear



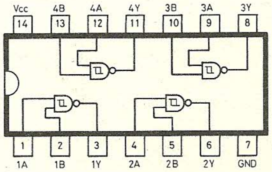
74124 Dual Voltage-controlled osc LS



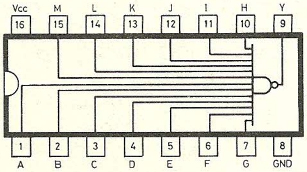
74125 Quad buffer tri-state



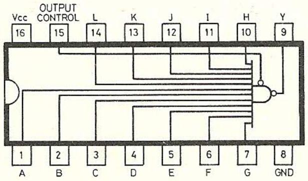
74126 Quad 3 state buffer



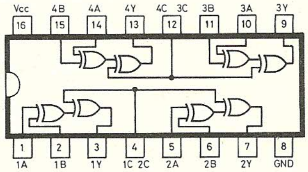
74132 Quad 2-input NAND Schmitt



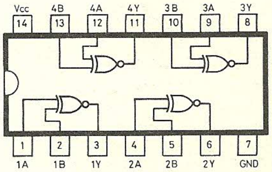
74133 13-input NAND LS



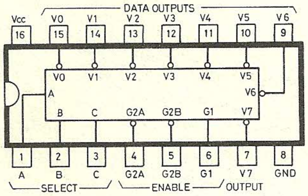
74134 12-input 3 state NAND



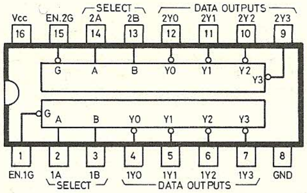
74135 Quad exclusive OR/NOR



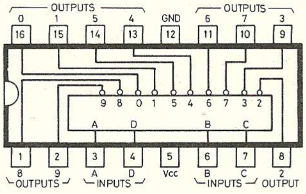
74136 Quad 2-input Ex-OR



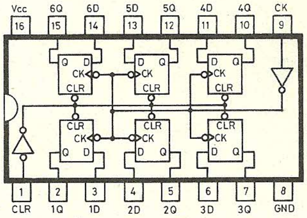
74138 3-line to 8-line decoder/demultiplexer



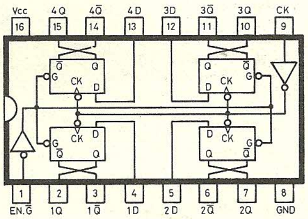
74139 Dual 2-line to 4-line decoder/demultiplexer



74141 BCD decimal decoder/driver



74174 Hex D-type



74175 Quad D-type