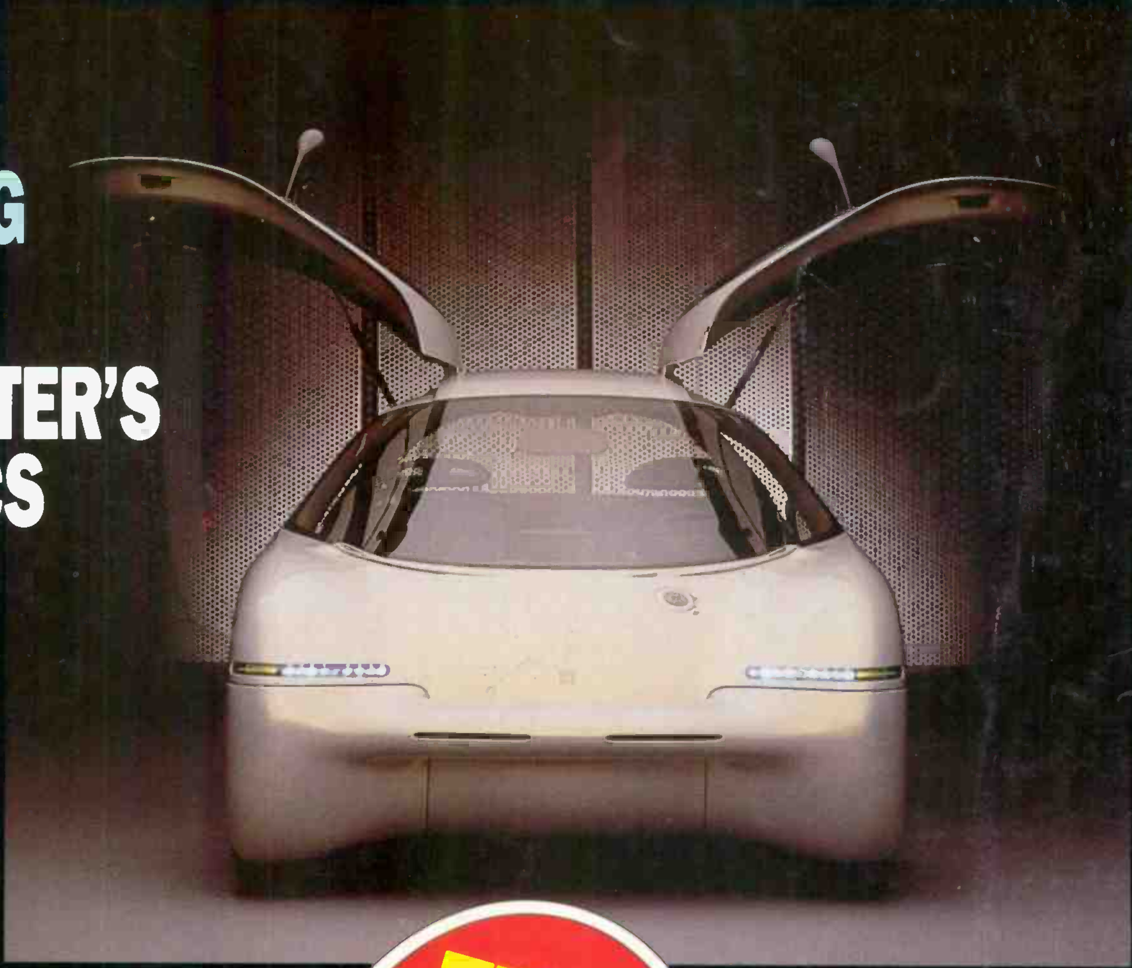
ETI
ELECTRONICS TODAY INTERNATIONAL

TOMORROW'S TECHNOLOGY TODAY

SIX SUPER PROJECTS!

ELECTRIC VEHICLE REVOLUTION



COMPUTER INTERFACING

EXPERIMENTER'S ELECTRONICS

AUTO ALARM PROJECT

Build a RF Detector with this PCB

NO FREE PCB?
PLEASE ASK YOUR NEWSAGENT

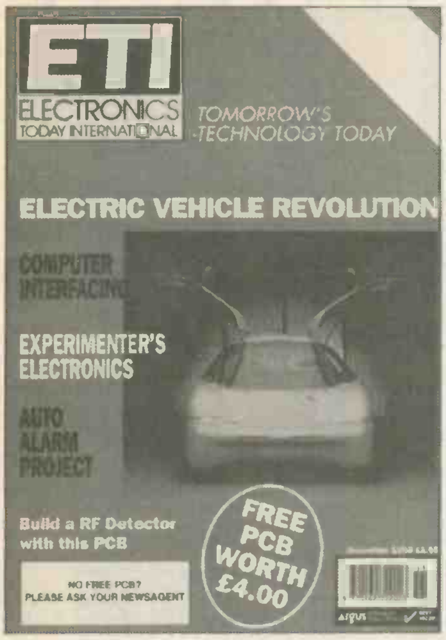
FREE PCB WORTH £4.00

November 1993 £1.95

9 770142 722023 11

Argus SPECIALIST PUBLICATION

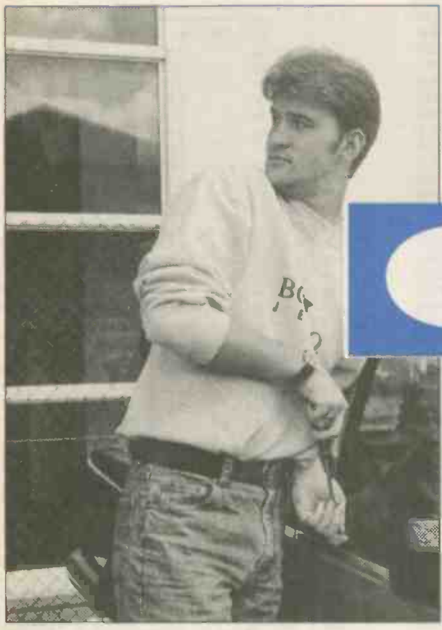
BEST VALUE



Volume 22 No.11
November 1993

Features & Projects

Contents



Protect your car - page 42

Regulars

Next Month...

In the next issue of ETI, we will be looking at the new generations of super processor chips - chips like the Pentium, the Alpha 21064 and the R4400. We will be examining what they can do and how they will be used. There will be a full range of new projects, including a computer aided typing system for the disabled. We will also be continuing the series on computer interfacing and introducing the new ETI computer conferencing system, that will put readers in touch with each other.

SUBSCRIPTION & BACK ISSUES HOTLINE 0737 768611

EXPRESS COMPONENTS

74LS SERIES

74LS00	0.10
74LS01	0.10
74LS02	0.10
74LS03	0.10
74LS04	0.10
74LS05	0.10
74LS06	0.39
74LS07	0.39
74LS08	0.10
74LS09	0.12
74LS10	0.10
74LS11	0.10
74LS12	0.10
74LS13	0.18
74LS14	0.22
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS24	0.33
74LS26	0.12
74LS27	0.12
74LS28	0.12
74LS30	0.12
74LS32	0.13
74LS33	0.13
74LS37	0.14
74LS38	0.13
74LS40	0.13
74LS42	0.23
74LS44	1.62
74LS47	0.50
74LS48	0.46
74LS49	0.62
74LS51	0.11
74LS54	0.11
74LS55	0.13
74LS73	0.20
74LS73A	0.26
74LS74	0.16
74LS74A	0.18
74LS75	0.21
74LS76	0.22
74LS76A	0.24
74LS77	0.42
74LS83	0.34
74LS85	0.34
74LS86	0.22
74LS90	0.24
74LS91	0.50
74LS92	0.29
74LS93	0.24
74LS95	0.38
74LS96	0.46
74LS107	0.25
74LS109	0.25
74LS112	0.25
74LS113	0.25
74LS114	0.25
74LS122	0.33
74LS123	0.33
74LS125	0.28
74LS126	0.21
74LS132	0.28
74LS133	0.25
74LS136	0.21
74LS137	0.62
74LS138	0.24
74LS139	0.26
74LS145	0.58
74LS147	0.86
74LS148	0.70
74LS151	0.25
74LS153	0.28
74LS154	0.70
74LS155	0.25
74LS156	0.25
74LS157	0.20
74LS158	0.25
74LS160	0.32
74LS161	0.32
74LS162	0.32
74LS163	0.32
74LS164	0.30
74LS165	0.48
74LS166	0.53
74LS168	0.58
74LS169	0.53
74LS170	0.66
74LS173	0.56
74LS174	0.24
74LS175	0.24
74LS181	1.48
74LS182	1.58
74LS183	1.58
74LS190	0.25
74LS191	0.24
74LS192	0.29
74LS193	0.39
74LS194	0.39
74LS195	0.24
74LS196	0.24
74LS197	0.24
74LS221	0.36
74LS240	0.32
74LS241	0.32
74LS242	0.32
74LS243	0.32
74LS244	0.32
74LS245	0.33
74LS247	0.32
74LS248	0.38
74LS249	0.68
74LS251	0.24
74LS253	0.34
74LS256	0.50
74LS257	0.24
74LS258	0.24
74LS259	0.48
74LS260	0.28
74LS266	0.14
74LS273	0.32
74LS279	0.25
74LS280	0.86
74LS283	0.49
74LS290	0.24
74LS293	0.24
74LS295	0.58
74LS298	0.63
74LS299	1.18
74LS322	1.58
74LS323	1.78
74LS347	0.90
74LS348	1.18
74LS352	0.78
74LS353	0.88
74LS363	1.38
74LS364	1.38
74LS365	0.24
74LS366	0.28
74LS367	0.26
74LS368	0.28
74LS373	0.32
74LS374	0.32
74LS375	0.34
74LS377	0.32
74LS378	0.62
74LS379	0.86
74LS385	2.22
74LS386	0.46
74LS390	0.25
74LS393	0.24
74LS395	0.32
74LS396	1.68
74LS398	1.22
74LS399	0.62
74LS445	1.50
74LS490	0.90

D CONNECTORS
SOLDER BUCKET

9 PIN SOCKET	0.27
9 PIN PLUG	0.26
15 PIN SOCKET	0.34
15 PIN PLUG	0.34
25 PIN SOCKET	0.42
25 PIN PLUG	0.40

4000 SERIES

4000	0.16
4001	0.16
4002	0.16
4006	0.31
4007	0.16
4008	0.30
4010	0.22
4011	0.15
4012	0.15
4013	0.16
4014	0.29
4015	0.30
4016	0.17
4017	0.24
4018	0.26
4019	0.18
4020	0.30
4021	0.30
4022	0.32
4023	0.16
4024	0.21
4025	0.15
4026	0.40
4027	0.18
4028	0.28
4029	0.27
4030	0.17
4031	0.70
4033	0.55
4034	1.23
4035	0.30
4040	0.28
4041	0.30
4042	0.21
4043	0.27
4044	0.30
4046	0.30
4047	0.24
4048	0.30
4049	0.19
4050	0.19
4051	0.24
4052	0.24
4053	0.24
4054	0.55
4055	0.29
4060	0.30
4063	0.28
4066	0.18
4067	1.90
4068	0.15
4069	0.19
4070	0.16
4071	0.20
4072	0.17
4073	0.17
4075	0.17
4076	0.30
4077	0.17
4081	0.14
4082	0.17
4085	0.27
4086	0.26
4089	0.55
4093	0.15
4094	0.30
4095	0.55
4097	1.19
4098	0.31
4099	0.37
4502	0.37
4503	0.31
4508	0.89
4510	0.25
4511	0.28
4512	0.30
4514	0.72
4515	0.77
4516	0.30
4518	0.26
4520	0.25
4521	0.62
4526	0.39
4527	0.38
4528	0.39
4529	0.43
4532	0.31
4534	2.20
4536	0.99
4538	0.36
4541	0.30
4543	0.45
4555	0.34
4556	0.33
4560	1.17
4566	1.95
4572	0.24
4584	0.23
4585	0.32
4724	0.69
40106	0.30
40109	0.49
40163	0.45
40174	0.33
40175	0.35
40193	0.59

VOLTAGE REGS

78L05	0.23
78L12	0.23
78L15	0.23
79L05	0.27
79L12	0.27
79L15	0.27
7805	0.27
7812	0.27
7815	0.27
7905	0.37
7912	0.37
7915	0.37
78S05	0.48
78S12	0.48
LM317T	0.43
LM323K	2.49
LM338K	4.95

IC SOCKETS

8 PIN	0.06
14 PIN	0.10
16 PIN	0.14
18 PIN	0.14
20 PIN	0.15
24 PIN	0.18
28 PIN	0.20
40 PIN	0.24

RESISTORS

ALL 1/4 WATT MF 1%10 FOR £0.15 (1 VALUE). INDIVIDUAL RESISTORS £0.03 EA. SKELETON PRESETS £0.10 ANY VALUE. STANDARD POTS 1/4" SHAFT, LOG OR LIN £0.35 EACH. SWITCHED POTS £0.45 EACH.

LEDS

3MM RED	0.05
3MM GREEN	0.10
3MM YELLOW	0.12
5MM RED	0.05
5MM GREEN	0.07
5MM YELLOW	0.07
5MM FLASH RED	0.48
5MM FLASH G'RN	0.51
8MM FLASH RED	0.99
3MM CLIPS	0.04
5MM CLIPS	0.04
8MM CLIPS	0.18
COMMON CATHODES	
.3" 7 SEG RED	0.70
.5" 7 SEG RED	0.75
.56" 7 SEG RED	0.85
COMMON ANODES	
.3" 7 SEG RED	0.70
.5" 7 SEG RED	0.75
.56" 7 SEG RED	0.85
10 BAR DIL RED	1.39
ORP12 (LDR)	0.65

LINEAR

TL061	0.33
TL062	0.39
TL064	0.43
TL071	0.30
TL072	0.33
TL074	0.45
TL081	0.32
TL082	0.32
TL084	0.45
TBA120S	0.62
L165V	1.85
TLC271	0.55
TLC272	0.96
L272M	1.65
L293E	3.20
L297	4.90
L298	4.90
LM301A	0.30
LM311	0.32
LM318	0.80
LM324	0.22
LM334Z	0.80
LM335Z	0.90
LM339	0.34
LM348	0.32
LF351	0.35
LF353	0.35
LF356	0.79
LM358	0.26
LM380	1.10
LM381	2.60
LM386	0.46
LM393	0.27
ZN414Z	0.99
ZN416E	1.59
ZN423	1.45
ZN424P	1.20
ZN425E	4.90
ZN426E	2.90
ZN427E	9.40
ZN428E	7.90
ZN435E	6.25
ZN448E	9.20
SL486	2.70
SL490	2.35
NE531	1.54
NE544	2.75
NE555	0.19
7555	0.41
NE556	0.34
NE565	1.49
NE566	1.10
NE567	0.35
NE570	2.35
NE571	1.98
LM710	0.80
LM711	0.80
LM725	4.80
741	0.17
LM747	0.38
LM748	0.30
TBA810	0.67
TBA820	0.38
ML924	4.65
ML926	4.25
ML927	4.25
TDA1024	1.80
SAA1027	3.20
ZN1034E	3.20
LM1458	0.30
ULN2003	0.39
ULN2004	0.42
TDA2004	1.75
TDA2030	1.18
ULN2064	1.20
ULN2065	1.20
ULN2068	1.20
XR2206	4.20
UA2240	2.60
ULN2803	0.64
LM2917N8	2.60
CA3046	0.35
CA3080E	0.71
CA3130E	0.97
CA3140E	0.55
CA3240E	1.20
MC3302	0.60
MC3340	1.75
LM3900	0.70
LM3909	1.45
LM3911	2.20
LM3914	2.65
LM3915	2.65
RC4558	0.36
NE5532	0.79
NE5534	0.80
ICL7106	5.80
ICM7555	0.45
ICM7556	1.20
ICL8038	4.90
LM13600	1.10

ELECTROLYTICS AXIAL

47UF 16V	0.09
100UF 16V	0.09
220UF 16V	0.10
470UF 16V	0.19
1,000UF 16V	0.28
2,200UF 16V	0.45
4,700UF 16V	0.75
10UF 25V	0.05
22UF 25V	0.05
47UF 25V	0.06
100UF 25V	0.09
220UF 25V	0.11
470UF 25V	0.22
1,000UF 25V	0.35
2,200UF 25V	0.52
4,700 25V	1.35

ELECTROLYTIC RADIAL

47UF 16V	0.05
100UF 16V	0.06
220UF 16V	0.08
470UF 16V	0.12
1,000UF 16V	0.19
2,200 16V	0.35
10UF 25V	0.05
22UF 25V	0.05
47UF 25V	0.05
100UF 25V	0.08
220UF 25V	0.11
470UF 25V	0.17
1,000UF 25V	0.25
2,200UF 25V	0.49

TANTALUM CAPACITORS

0.1UF 35V	0.10
0.22UF 35V	0.10
0.33UF 35V	0.10
0.47UF 35V	0.10
1UF 35V	0.12
2.2UF 25V	0.14
3.3UF 25V	0.16
4.7UF 25V	0.18
6.8UF 25V	0.20
10UF 25V	0.22
15UF 16V	0.28
22UF 16V	0.28
33UF 16V	0.50
47UF 16V	0.62
68UF 6V	0.72
100UF 10V	1.40
100UF 16V	1.70

CERAMIC CAPACITORS

1.8PF	0.05
2.2PF	0.05
3.3PF	0.05
4.7PF	0.05
6.8PF	0.05
10PF	0.05
15PF	0.05
22PF	0.05
33PF	0.05
47PF	0.05
56PF	0.05
68PF	0.05
82PF	0.05
100PF	0.05
120PF	0.07
150PF	0.07
180PF	0.07
220PF	0.07
270PF	0.07
330PF	0.07
390PF	0.07
470PF	0.07
560PF	0.07
680PF	0.07
820PF	0.07
1NF	0.07
1N5F	0.07
2N2F	0.07
3N3F	0.07
4N7F	0.07
6N8F	0.07
10NF	0.07
100NF	0.07

POLYESTER/MICA CAPACITORS 15V

1NF	0.05
2N2	0.05
4N7	0.05
10N	0.05
22N	0.05
47N	0.05
100N	0.05
220N	0.05
470N	0.05
680N	0.05

POLYSTYRENE CAPACITORS 120V

47PF	0.09
68PF	0.09
82PF	0.09
100PF	0.09
120PF	0.09
150PF	0.09
180PF	0.09
220PF	0.09
270PF	0.09
330PF	0.09
390PF	0.09
470PF	0.09
560PF	0.09
680PF	0.09
820PF	0.09
1NF	0.09
1N5F	0.09
2N2F	0.09
3N3F	0.09
4N7F	0.09
6N8F	0.09
10NF	0.09

TRIMMER CAPACITORS

2-10PF	0.38
2-22PF	0.38
5.5-65PF	0.38

BRIDGE RECTIFIERS

W005 50V 1.5A	0.18
W02 200V 1.5A	0.19
W04 400V 1.5A	0.22
BR32 200V 3A	0.34
BR34 400V 3A	0.38
DB602 200V 6A	0.59
DB608 800V 6A	0.78
DB2502 200V 25A	1.40
DB2506 600V 25A	1.90

TRIACS/DIACS THYRISTORS

Z0105DA	0.40
Z0102MA	0.42
TIC206D	0.62
TIC226D	0.69
TIC246D	0.99
BR100 DIAC	0.19
TIC106D	0.40
TIC116D	0.69
TIC126D	0.79

CONNECTORS

BNC 50R PLUG	0.69
BNC 75R PLUG	0.69
BNC CH'IS SOC	0.59
TNC 50R PLUG	0.89
TNC CH'IS SOC	0.65
PL259 PLUG	0.55
REDUCER (PL259)	0.16
PL259 SOCKET	0.55
COAX PLUG	0.18
COAX LINE SOC	0.38
SCART PLUG	0.65
IEC CH'IS PLUG	0.49
IEC LINE SOCKET	1.70
IEC 2M LEAD	1.80
IEC RA 2M LEAD	2.40
1/4" MONO PLUG	0.18
1/4" STEREO PLUG	0.29
2.5 MONO PLUG	0.12
3.5 MONO PLUG	0.12
3.5 STEREO PLUG	0.20

TOGGLE SWITCHES

SPDT 3A 250V	0.57
SPDTC/O 3A 250V	0.62
DPDT 3A 250V	0.67
DPDTC/O 3A 250V	0.79

MINATURE PUSH TO MAKE SWITCHES

RED	0.19
BLACK	0.19
GREEN	0.19
BLUE	0.19
YELLOW	0.19
WHITE	0.19

ROTARY SWITCHES

1 POLE 12 WAY	0.75
2 POLE 6 WAY	0.75
3 POLE 4 WAY	0.75
4 POLE 3 WAY	0.75

DIL SWITCHES

4 WAY 8 PIN	0.49
6 WAY 12 PIN	0.69
8 WAY 16 PIN	0.79

TRANSISTORS

AC125	0.30
AC126	0.29
AC127	0.29
AC128	0.28
AC176	0.34
AC187	0.35
AC188	0.36
AD142	1.90
AD161	0.78
AD162	0.85
AF124	0.78
AF126	0.46
BC107	0.12
BC107B	0.13
BC108	0.11
BC108B	0.13
BC108C	0.14
BC109	0.13
BC109C	0.14
BC140	0.24
BC141	0.26
BC142	0.30
BC143	0.33
BC147	0.33
BC148	0.33
BC149	0.11
BC157	0.11
BC158	0.11
BC159	0.11
BC160	0.27
BC168C	0.16
BC169C	0.16
BC171	0.11
BC177	0.17
BC178	0.17
BC179	0.17
BC182	0.07
BC182L	0.07
BC183	0.07
BC183L	0.07
BC184	0.07
BC184L	0.07
BC212	0.07
BC212L	0.07
BC213	0.07
BC213L	0.07
BC214	0.07
BC214L	0.07
BC237B	0.08
BC238B	0.08
BC308	0.09
BC327	0.09
BC328	0.09
BC337	0.09
BC338	0.09
BC477	0.33
BC478	0.33
BC479	0.33
BC517	0.19
BC547	0.07
BC548	0.07
BC549	0.07
BC557	0.07
BC558	0.07
BCY70	0.20
BCY71	0.19
BCY72	0.19
BD115	0.48
BD131	0.36
BD132	0.36
BD135	0.19
BD136	0.19
BD137	0.19
BD138	0.19
BD139	0.22
BD140	0.23
BF180	0.30
BF182	0.30
BF185	0.30
BF194	0.18
BF195	0.18
BF196	0.19
BF197	0.19
BF198	0.19
BF199	0.19
BF257	0.32
BF258	0.35
BF259	0.32
BF337	0.35
BFR40	0.38
BFR80	0.38
BFR81	0.38
BFX29	0.28
BFX84	0.30
BFX85	0.30
BFX87	0.43
BFX88	0.43
BFY50	0.28
BFY51	0.25
BFY52	0.27
BFY53	0.46
BFY55	0.46
BSX20	0.26
BSX29	0.55
BSY95A	0.48
BU205	1.39
BU206	1.40
BU208	1.65
MJ2955	0.75
MJE340	0.35
MJE520	0.44
MJE521	0.60
MJE3055	0.85
MPSA05	0.27
MPSA06	0.27
MPSA12	0.27
MPSA56	0.17
MPSU05	0.56
MPSU06	0.56
TIP29A	0.30
TIP29B	0.30
TIP29C	0.31
TIP30	0.31
TIP30A	0.31
TIP30B	0.30
TIP30C	0.30
TIP31A	0.30
TIP31B	0.30
TIP31C	0.31
TIP32A	0.30
TIP32B	0.30
TIP32C	0.31
TIP33A	0.66
TIP33C	0.71
TIP34A	0.69
TIP34C	0.74
TIP35A	1.05
TIP35C	1.15
TIP36A	1.15
TIP36C	1.25
TIP41A	0.35
TIP42A	0.35
TIP120	0.37
TIP121	0.34
TIP122	0.36
TIP141	1.20
TIP142	1.05
TIP147	1.10
TIP2955	0.62
TIP3055	0.62
ZTX107	0.17
ZTX108	0.17
ZTX109	0.17
ZTX300	0.16
ZTX302	0.20
ZTX341	0.24
ZTX500	0.15
ZTX501	0.24
ZTX502	0.24
ZTX504	0.24
2N2219A	0.27
2N2222A	0.15
2N2369	0.24
2N2484	0.24
2N2904	0.24
2N2904A	0.24
2N2905	0.20
2N2905A	0.20
2N2906A	0.20
2N2907	0.19
2N2907A	0.19
2N2926	0.14
2N3053	0.26
2N3054	0.85
2N3055	0.56
2N3442	1.34
2N3702	0.09
2N3703	0.09
2N3704	0.09
2N3705	0.09
2N3706	0.09
2N3773	1.78
2N3866	1.18
2N3903	0.09
2N3904	0.09
2N3905	0.09
2N3906	0.09
2N4062	0.16

FETS

BF244B	0.34
BF256B	0.36
2N3819	0.39
2N3820	0.58
2N5457	0.49
2N5458	0.49
2N5485	0.42

DIODES

1N4001 (10 PACK)	0.24
1N4002 (10 PACK)	0.25
1N4003 (10 PACK)	0.26
1N4004 (10 PACK)	0.27
1N4006 (10 PACK)	0.28
1N4007)10 PACK)	0.29
1N5401 (5 PACK)	0.30
1N5402 (5 PACK)	0.31
1N5404 (5 PACK)	0.33
1N5406 (5 PACK)	0.34
1N5408 (5 PACK)	0.37
OA47 (5 PACK)	0.95
OA90 (5 PACK)	0.40
OA91 (5 PACK)	0.50
1N914 (5 PACK)	0.20
1N4148 (10 PACK)	0.22

74HC SERIES

74HC00	0.14
74HC02	0.14
74HC03	0.14
74HC04	0.14
74HC08	0.14
74HC10	0.14
74HC11	0.14
74HC14	0.18
74HC20	0.14
74HC27	0.14
74HC30	0.14
74HC32	0.14
74HC42	0.26
74HC73	0.26
74HC74	0.19
74HC75	0.19
74HC76	0.19
74HC85	0.25
74HC86	0.19
74HC107	0.19
74HC123	0.32
74HC125	0.23
74HC126	0.22
74HC132	0.25
74HC133	0.26
74HC138	0.25
74HC139	0.25
74HC151	0.25
74HC153	0.25
74HC154	0.38
74HC157	0.28
74HC158	0.26
74HC160	0.32
74HC161	0.25
74HC162	0.25
74HC163	0.25
74HC164	0.25
74HC165	0.40
74HC173	0.32
74HC174	0.25
74HC175	0.25
74HC192	0.47
74HC193	0.40
74HC194	0.36
74HC195	0.32
74HC240	0.35
74HC241	0.36
74HC242	0.36
74HC243	0.46
74HC244	0.34
74HC245	0.49
74HC251	0.28
74HC253	0.28
74HC257	0.28
74HC259	0.34
74HC266	0.25
74HC273	0.34
74HC280	0.36
74HC299	0.59
74HC354	0.42
74HC356	0.44
74HC365	0.32
74HC366	0.32
74HC367	0.25
74HC368	0.25
74HC373	0.34
74HC374	0.34
74HC390	0.44
74HC393	0.32
74HC423	0.36
74HC533	0.42
74HC534	0.42
74HC563	0.46
74HC564	0.46
74HC573	0.42
74HC574	0.42
74HC640	0.60
74HC643	0.72
74HC646	1.10
74HC648	1.10
74HC688	0.48
74HC4002	0.34
74HC4017	0.32
74HC4020	0.38
74HC4040	0.39
74HC4049	0.26
74HC4050	0.26
74HC4060	0.40
74HC4075	0.16
74HC4078	0.16
74HC4511	0.40
74HC4514	0.80
74HC4538	0.40
74HC4543	0.66
74HC7266	0.26

CRYSTALS

1MHZ	1.10
1.8432MHZ	1.78
2MHZ	1.66
2.097MHZ	0.76
2.4576MHZ	0.98
3.276MHZ	0.76
3.579MHZ	0.76
4MHZ	0.76
4.194MHZ	0.76
4.43MHZ	1.78
4.915MHZ	0.76
5.008MHZ	0.76
5.06MHZ	0.76
6MHZ	0.76
6.144MHZ	0.76
8MHZ	0.76
10MHZ	0.76
11.05MHZ	0.76
12MHZ	0.76
16MHZ	0.76
18MHZ	0.76
39.925MHZ	0.76

MEMORIES

2114	1.25
4164-10	1.16
4164-12	1.08
4164-15	0.98
41256-8	1.60
41256-10	1.46
41464-10	4.24
41464-12	4.20

WIRE AND CABLE

SPEAKER WIRE 7P A METRE ANY LENGTH.
STEREO SCREENED CABLE 16P A METRE ANY LENGTH.
4 CORE SCREENED ANY LENGTH 28P A METRE.
STANDARD TV COAX CABLE 20P A METRE ANY LENGTH

EXPRESS COMPONENTS

SALES 0273 771156

FAX 0273 206875

ALL PRICES ARE SUBJECT TO VAT (17.5%).
POSTAGE AND PACKING IS 99P + VAT PER ORDER.
AUTOMATIC ACCOUNT FACILITIES FOR SCHOOLS ETC.
NO MINIMUM ORDER.
NO COUNTER FACILITIES.

PO BOX 517 HOVE, E SUSSEX BN3 5QZ

ETI NEWS

FLAT SPEAKERS

Ever fancied having a super efficient high fidelity speaker that was just a centimetre thick and could be hung on the wall or the ceiling? Great for surround sound! Well now, thanks to a bit of lateral thinking by scientists at the UK's Defence Research Agency, such speakers should be on the market within the next few years.

The scientists at the DRA were developing a sound absorbing system for use on helicopters and out of curiosity decided to see if it could produce sound as well as it absorbed it. They were amazed to discover that it was able to produce high quality sound with 100% efficiency in energy conversion, which compares with 1% efficiency in a conventional loudspeaker.

The system is made from a sandwich of two 0.06mm aluminium sheets with a precision machined air filled honeycomb in between. The result is a flat metal board about 1cm thick. It is driven by a conventional mechanical coil attached to the back, which in turn is powered by a standard power amplifier. There is only one drawback - at the moment they are hand made and a 1m square flat speaker will set you back a cool £1000.

PCB DESIGN FOR WINDOWS

The latest release of TangoPro, electronic design and automation software, offers users many new features and is based on the widely used Windows operating environment.

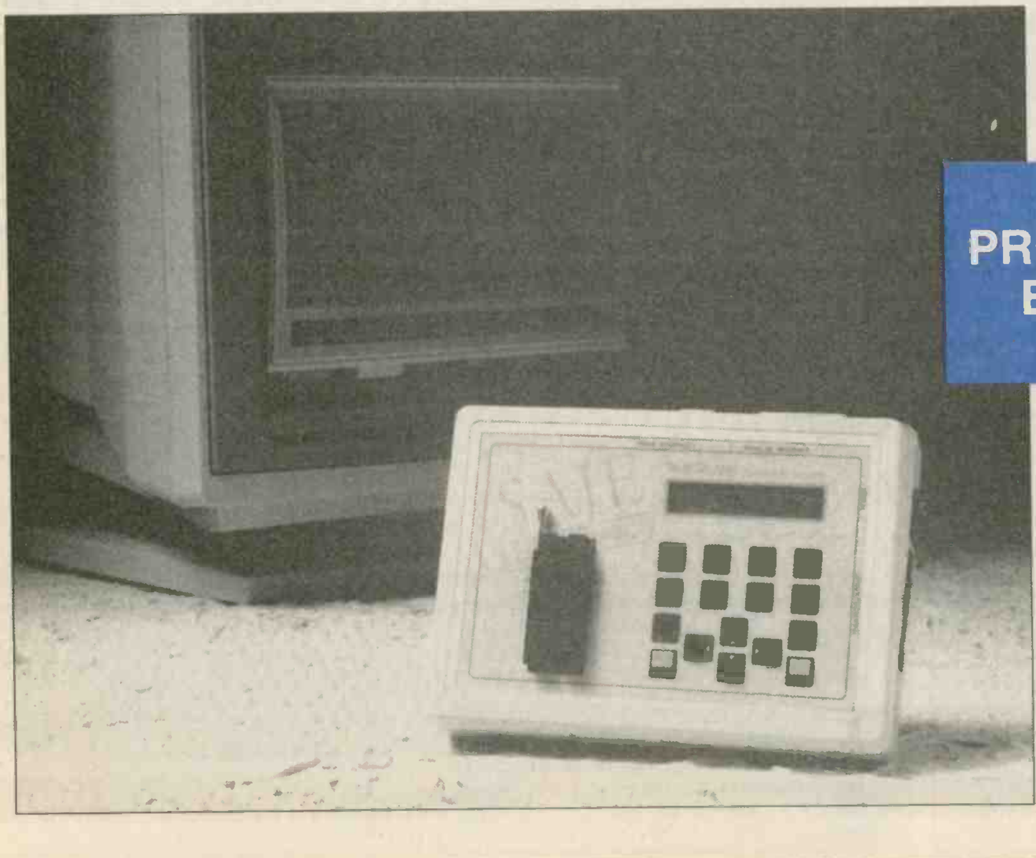
TangoPro is a full PCB layout system with fast auto-routing and multilayer capability. The mouse is used for clicking and dragging lines, etc..

TangoPro is available in the UK from Pentica Systems Ltd. which can be contacted on 0734 792101.

SUPER CCDS WILL REPLACE FILM

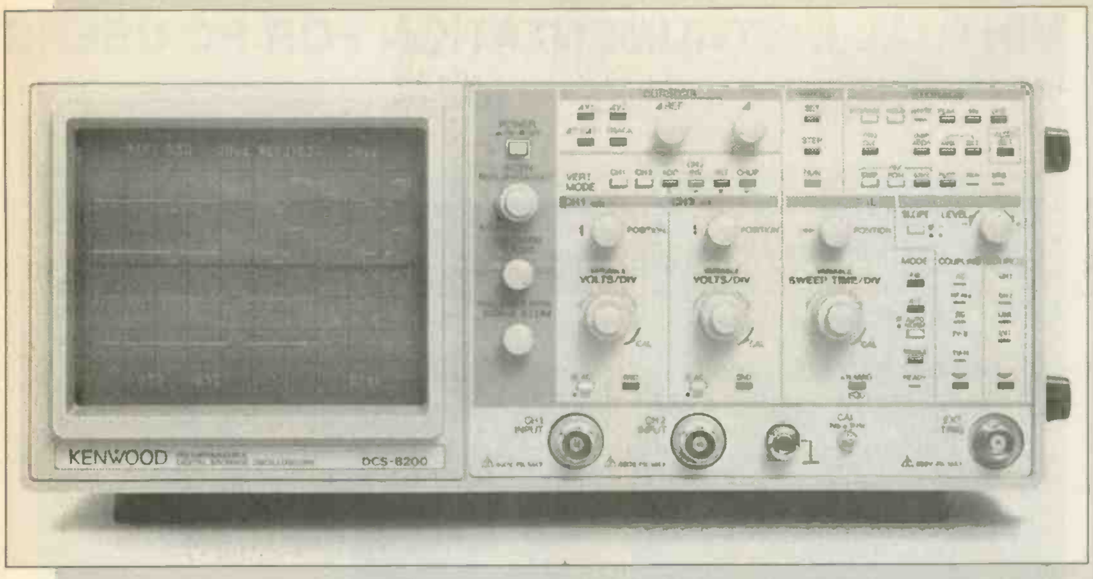
The development of super-large high resolution CCD imaging chips by the Canadian company Dalsa Inc., of Waterloo, Ontario, looks set to sound the death knell for conventional film based photography.

These giant 2.5in square chips, called Megasensors, are packed with 26.2 million pixels. An image resolution that is one third better than that of conventional film with an equivalent of about 18 million pixels in the same area. But at $20,000 per chip, do not expect to see them in commercial electronic cameras just yet!



EPROM PROGRAMMER/ EMULATOR FOR PCs

From Saje Electronics comes a new low cost EPROM programmer/emulator, the SP1000. This device works in stand alone mode or interfaces directly with a PC via a special software package. It will program and emulate most EPROMs, OTP and FLASH devices, and ease of use of both software and hardware has been a key design feature. Priced at just £299, plus £29 for the software package, it offers good value for money. Saje can be contacted on 0223 425440.



NEW DIGITAL STORAGE SCOPE FROM KENWOOD

From Trio Kenwood comes a new programmable digital storage oscilloscope, the DCS8200. It combines a 20ms/s oscilloscope with 32K words of memory per channel and 50Hz real-time capability. It features both GPIB and RS232 interfaces for computer data acquisition.

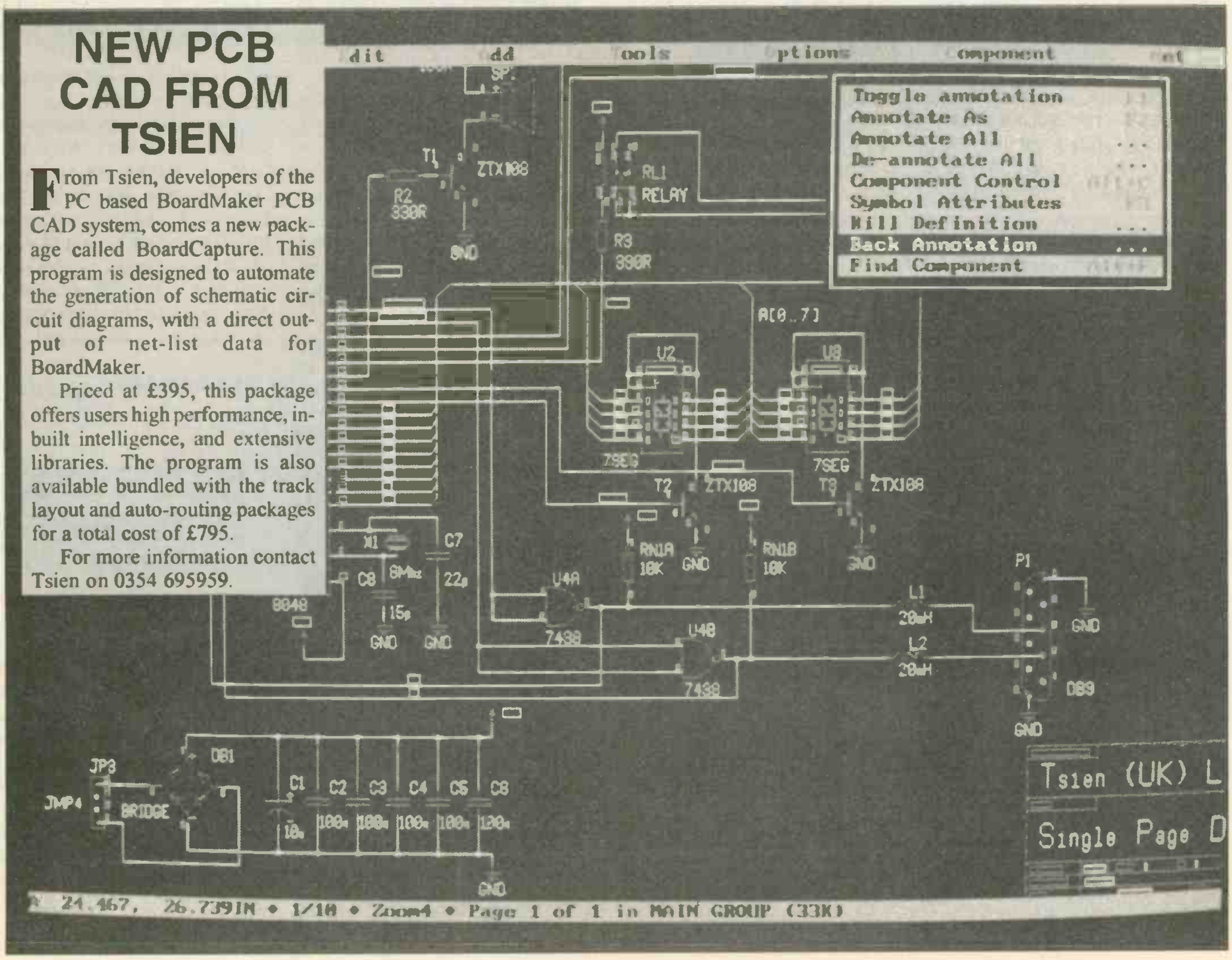
Complete with probes, the DCS8200 costs £2455 and further information can be obtained from Kenwood on 0923 816444.

CHIPS AT ATOMIC LEVEL

Scientists at AT&T's Bell Research Labs and Harvard University are developing ways of building electronic circuits from single atoms that are positioned using beams of light. The individual atoms are moved as they are deposited onto the surface of a semiconductor such as silicon, with very precise amounts of energy provided by photons.

The technique actually involves creation of a form of lens for precisely focusing the atoms to be deposited. A lens which is created from a large number of photons forming what is known as a standing wave. Such positional accuracy should allow the construction of electronic circuits with dimensions of less than one tenth of a micron.

Integrated circuits might get a lot smaller, more powerful and a lot faster than we ever thought.



NEW PCB CAD FROM TSIEN

From Tsien, developers of the PC based BoardMaker PCB CAD system, comes a new package called BoardCapture. This program is designed to automate the generation of schematic circuit diagrams, with a direct output of net-list data for BoardMaker.

Priced at £395, this package offers users high performance, inbuilt intelligence, and extensive libraries. The program is also available bundled with the track layout and auto-routing packages for a total cost of £795.

For more information contact Tsien on 0354 695959.

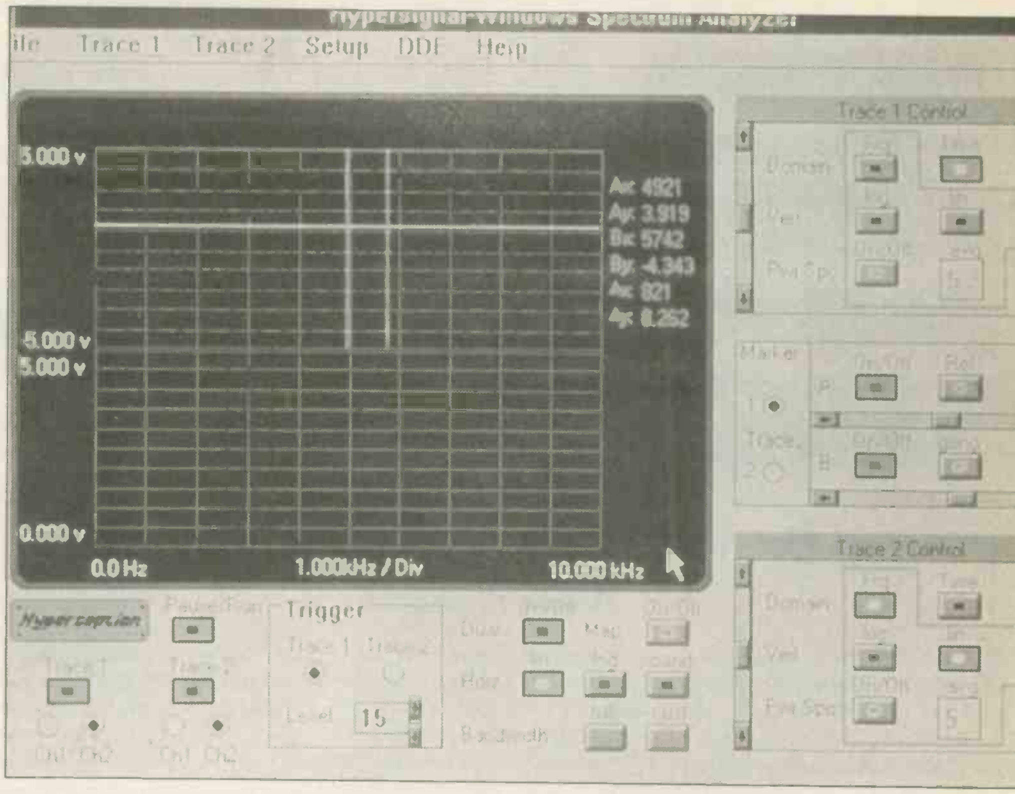
With ever more powerful personal computers on the market at low cost, it is not surprising that an increasing number of people are using a PC to replace traditional laboratory instruments.

Special plug in boards are used to acquire the data to be measured, and computer software then interprets the data and displays it in a way that resembles a conventional instrument. These screen based instruments are referred to as virtual instruments and can range from simple voltmeters to high frequency oscilloscopes.

A range of virtual instrumentation hardware and software is available from Loughborough Sound Images. These are Windows based systems and utilise LSI's DSP based data acquisition boards. Virtual instruments include a multi-channel real-time digital oscilloscope and spectrum analyser. The software also supports data logging, data manipulation and non-real time simulation.

For more information contact LSI on 0509 231843.

VIRTUAL INSTRUMENTATION FOR PC USERS



MERCURIAL SUPERCONDUCTOR

Last March, a team of Russian scientists announced the development of a new high temperature superconductor based upon mercury. Most high temperature superconductors are based upon either of the two elements, yttrium or bismuth, plus an assortment of other elements.

The properties of these superconductors depend upon the way in which the particles are aligned, a fact which makes fabrication of superconducting wires, etc., very difficult and expensive. According to scientists from the Argonne National Laboratory in the USA this is not the case with the Russian mercury based superconductor, which should therefore be cheaper to manufacture.

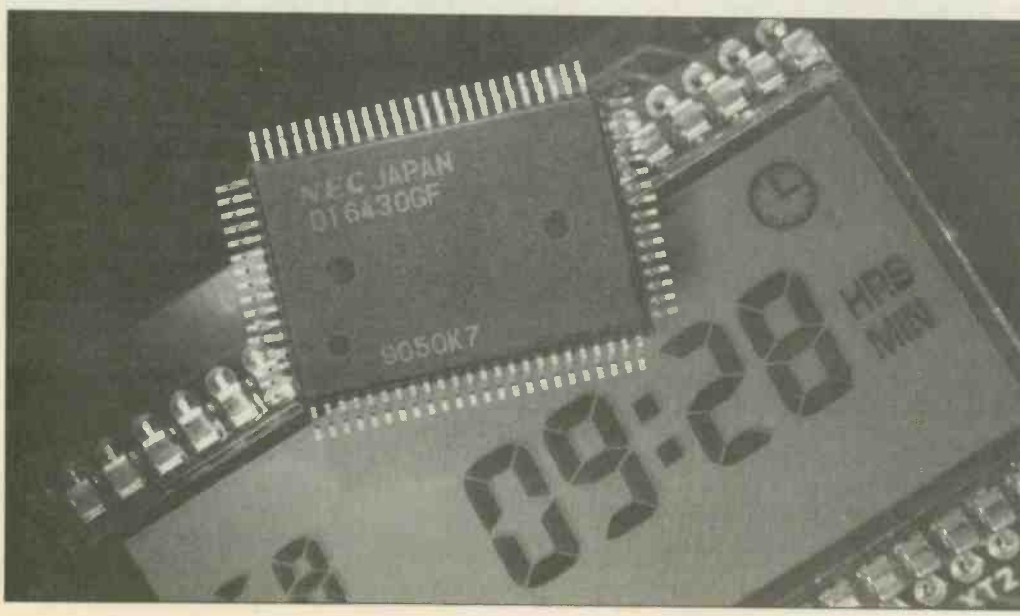
But there is one problem - the high mercury content makes it rather dangerous to use!

SUPERSONIC MAGNETS

At a remote firing range in the Scottish coastal area of Kirkudbright, scientists at the Electro-Magnetic Launcher Facility are using electromagnetic pulses to fire projectiles at over ten times the speed of sound.

This technology is seen by many in the military as superseding the use of explosives as the projectile force for big guns. It is also a technology which some space scientists see as having the potential to launch small objects and raw materials, into space at a very low cost.

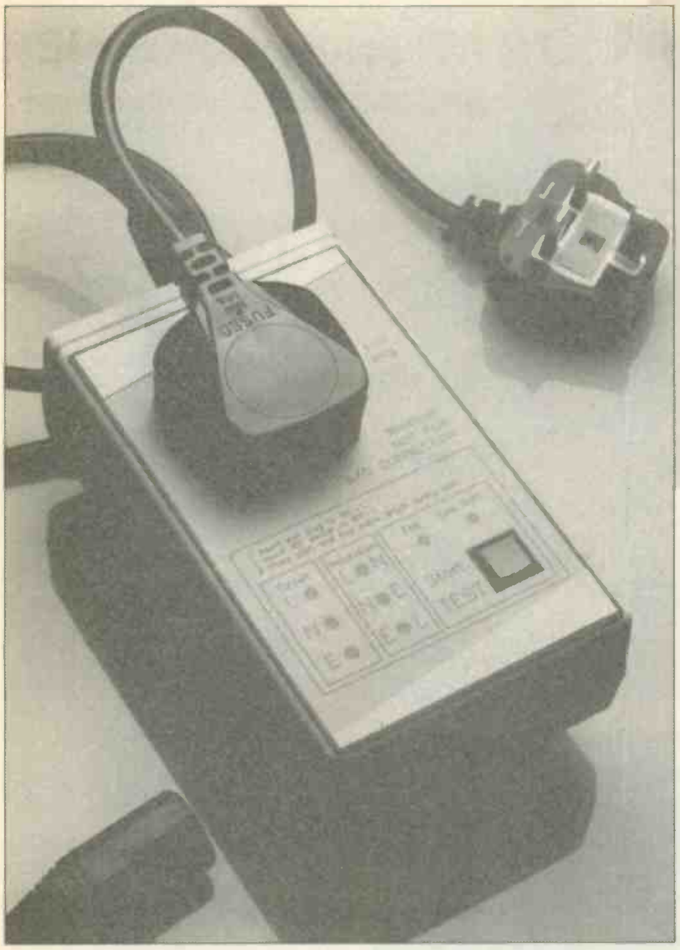
It is an Anglo-American research project and involves using a tungsten projectile that sits between two conducting rails (the reason why this system is known as a rail gun). An electrical pulse of about 3 million amps passes between the rails through an armature behind the projectile. The result is an enormous magnetic force which accelerates the projectile to a speed of up to 4000m per second.



NEC'S 240 SEGMENT LCD DRIVERS

From NEC comes a new range of LCD driver ICs which can handle up to 240 segments, almost twice as many as the current standard chip. An 80 pin device, it can be used directly with microprocessors and microcontrollers, without need for additional logic.

For further information contact NEC on 0908 691133



CABLE TESTING FOR SAFETY

Defective power leads and plugs can pose a major risk to users, giving rise to electric shocks, or starting fires. With the proliferation of electronic equipment, in particular computers and computer peripherals, a company may be using literally thousands of mains power leads.

If such a company is to comply with the Electricity at Work Regulations 1989, then these leads will need to be checked regularly. To do this, Rendar has launched a new hand held instrument which quickly checks continuity, insulation and polarity on any IEC mains power lead, with a simple display showing whether it is OK or defective.

This portable cable tester costs £99. For more information contact Rendar Ltd on 0243 866741.

CALLING ALL MICROENGINEERS

Microengineering is all about building machines using integrated circuit manufacturing techniques, machines which contain moving parts that are smaller than a human hair and which combine electronics and mechanics to produce accelerometers, pressure sensors, chemical analysers, even microscopic electric motors, and in the future perhaps robots that are no larger than a grain of wheat.

Microengineering is a very new science and one that has enormous industrial potential. It is not surprising that the Japanese are spending $200 million on research, the Germans over £60 million and even the Danes are spending over £6 million. It is therefore a relief to hear that the UK government has just put up £11.8 million to fund research through the Link Nanotechnology programme.

This funding should ensure that UK industry has a stake in this new technology. Let's hope that the government does not pull the plug on funding before viable research has been completed.

SPEECH SYNTHESIS AND RECOGNITION FROM APPLE

The personal computer company Apple has just announced two new systems, the Cyclone and Tempest, which feature speech recognition and synthesis.

The speech synthesis used in these computers is based upon phonemes, tiny fragments of speech sound. These phonemes are used to reconstruct the sound of spoken words and phrases in a very natural manner. In-built intelligence allows the system to alter the sound and intonation in, for example, a question.

The speech recognition system is capable of recognising several hundred key words with a high degree of accuracy. It does this without any previous training and regardless of any accent or dialect. It is intended as a voice input command system, as opposed to a voice input typing system. Apple can be contacted on 081 569 1199.

KEYBOARDS WITHOUT KEYS

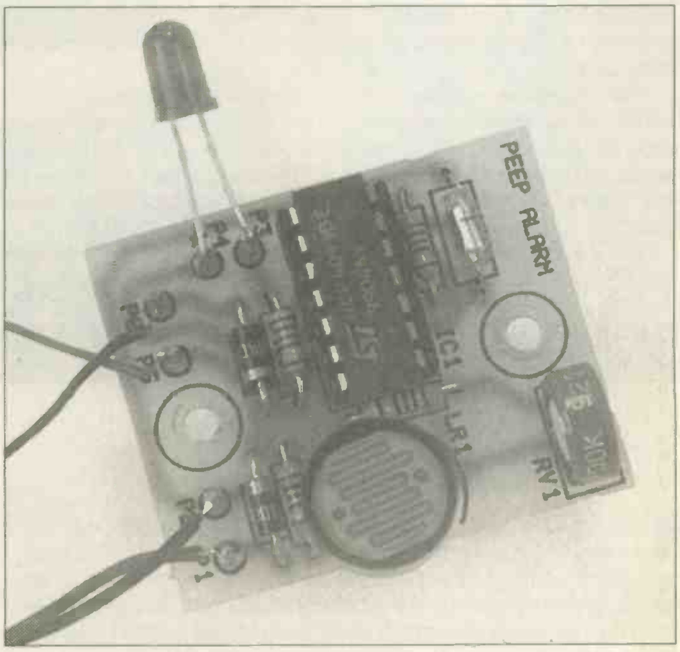
From IBM's researchers in Germany comes the idea of what they refer to as virtual keyboards, in other words keyboards without any physical keys.

With this technique the keyboard simply consists of a flat surface, a template and a video camera which watches the movement of the user's fingers. The computer analyses the data from this camera and then decides which keys have been pressed.

The great advantage of this system is that it allows the creation of small and very light keyboards which can be instantly reconfigured by using a display as the template. Such keyboards would also be free of all the mechanical problems which plague current keyboard technologies.

The virtual keyboard could also be used in environments which are currently difficult or impossible. Vandal proof keyboards in public places, or fully sterilised keyboards for use in operating theatres.

Expect to see systems in production in 1995.



NEW MAPLIN ALARM PROJECT

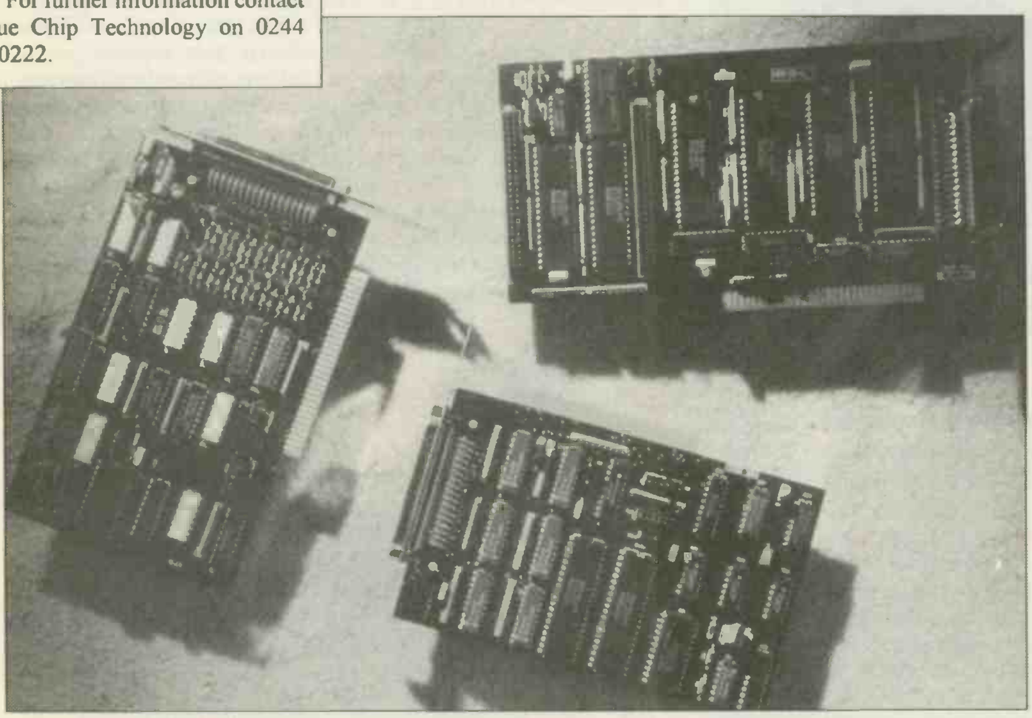
From Maplin Electronics comes a new low cost, light operated alarm kit. Called the 'Peep Alarm', it is designed to detect the presence of light. In the dark it is effectively switched off, but when light falls on it, its inbuilt photosensor triggers the alarm which then emits a loud 4.6KHz shrill tone. At £8.95 it is available from all Maplin stores, or ring 0702 554161.

BLUE CHIP I/O CARDS

A range of high quality PC I/O cards are now available from Blue Chip Technology. The cards are all high performance data acquisition products, available off the shelf and built to BS5750 standards using the latest surface mount technology. They come with a three year warranty.

The first boards to be offered include digital, analogue and serial cards, all of which feature 50 way D Type connectors and onboard timers. The range includes a 44 channel combination card which features sixteen analogue input channels, 4 channels of analogue output, DMA and 24 channels of programmable digital I/O. There is also a 144 channel digital I/O card.

For further information contact Blue Chip Technology on 0244 520222.



SHACK ALARM FROM CIRKIT

Cirkit has just introduced a simple to install, but apparently very effective intruder alarm kit, which is ideal for club houses, sheds, garages, shacks, or single room installations.

The alarm is based upon a PIR (Passive Infra Red) detector for general coverage, with magnetic switches for additional door and window protection. It is easy to use with a single key for set or reset. The system provides the user with a 2 1/2 minute exit time and a 15 second entry delay. It is mains powered but there is an optional battery back-up.

The kit is easy to build and comes complete with detector, control box, high power siren, three magnetic switches, mains power supply and full instructions for assembly, installation, and use. The kit costs £45.95 plus £1.40 p&p. For more information contact Cirkit Distribution Ltd. on 0992 444111.

TWO NEW 1994 CATALOGUES

Henry's Audio Electronics has just published its new 300 page full colour catalogue for 1994. Packed with a wide range of components and equipment, this catalogue is available by post, or at the company's shop, priced at £2 for callers or £4 by post. It also contains four money off vouchers worth £5 each. Henry's shop is at 404 Edgware Road, London W2, or contact their sales office on 071 258 1831.

The other new catalogue comes from Maplin. In fact, there are two new catalogues from the company, the familiar 800 pager and a new 24 page showcase brochure. The main catalogue is larger and features a new look user friendly index, enhanced colour and better quality paper. It includes over £50 worth of money saving vouchers costs £2.95, available from most newsagents or directly from Maplin. The small 'Showcase' brochure features a host of special offers on kits, components, tools, and test equipment.

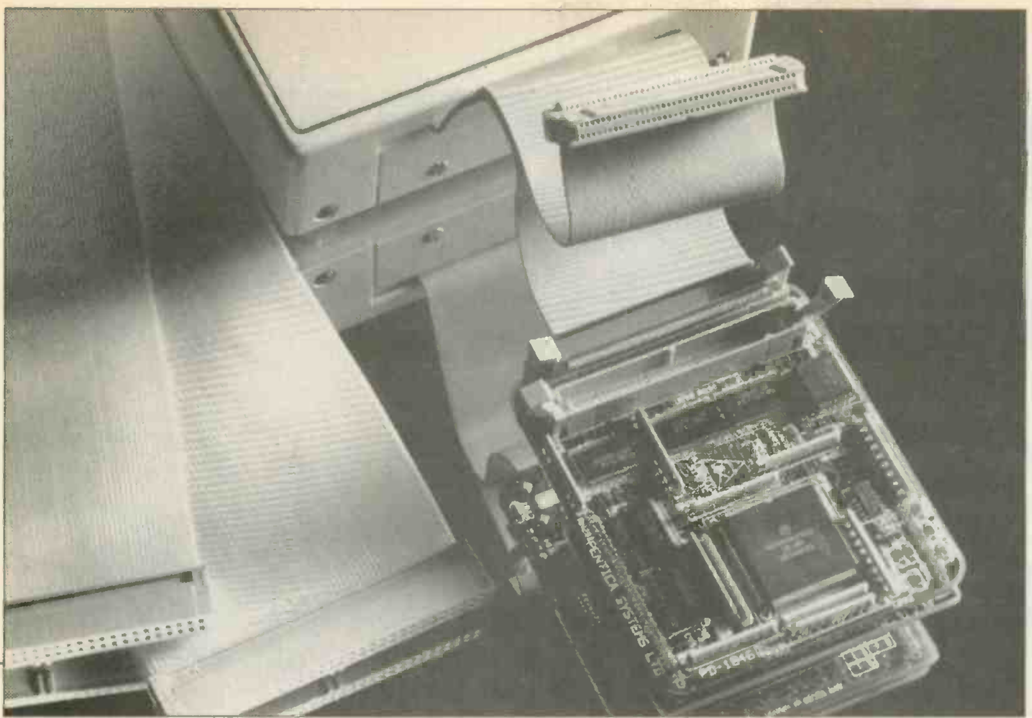
For more details contact Maplin on 0702 552911.

VERTICAL LASERS

At the US Sandia National Laboratories, scientists have developed a revolutionary new form of solid state laser, a development which looks set to change the way in which such lasers are used and could even mean the end of the cumbersome helium neon laser.

The new laser is a type known as a vertical cavity surface emitting laser, or VCSEL. Unlike conventional solid state lasers, it is capable of producing laser light within the visible spectrum, the red part of the spectrum between 639nm and 699nm wavelength.

This development should open up commercial applications such as displays, holographic memories, bar-code scanners, etc., to solid state lasers, applications which are currently confined to using gas or dye lasers.



ULTRA MINI SOCKET AND HEADER SYSTEM

From 3M comes a new mini socket and header IDC system which doubles the density of traditional connectors. This system uses 0.05in contact spacing as opposed to the familiar 0.1in spacing.

This high contact density has been made possible by the development of a proprietary termination technique. Called 'Hill-n-Dale', this 3M system vertically displaces every other wire, thus creating the separation necessary to use 0.025in pitch ribbon cable, without having to reduce the size and strength of the IDC.

This system should give designers a space saving of around 60%, thus increasing flexibility and enabling the design of more compact electronic packaging. For further information contact 3M on 0344 858509.

COMBINED EPROM EMULATOR/ PROGRAMMER

From White House Systems comes a combined EPROM programmer and emulator called the Progulator. It has been designed with the serious amateur or professional user in mind and will emulate all commonly used EPROMs for 8 bit work, that is the 27(C)64 through to the 27(C)512.

The system features seven different programming algorithms which allow one to program most commonly used EPROMs. The data to be programmed onto the EPROM is downloaded from a host PC via the serial port.

The programmer/emulator hardware comes with a sophisticated PC based software package which controls the programming and emulation functions.

The Progulator system costs £180. Contact White House Systems on 091 373 4605.

PROGRAM DSPs IN C

Writing optimised programs for digital signal processor chips has never been very easy. But now, thanks to a special software library from Loughborough Sound Images, it should be possible for any engineer to attain close to theoretical peak performance from the Texas Instrument TMS320C40 and TMS320C3x DSP chips, with code written in C.

For example, using LSI's library of routines one can implement a 100-coefficient finite impulse response (FIR) filter in just 548us on a 40MHz C40. That is about one sixth of the execution time of a compiled C routine. Other high performance routines in the library include fast Fourier transforms, infinite impulse response filters, convolution, correlation and windowing functions. In addition, there are other optimised useful routines such as a Gaussian white noise generator and matrix multiplication.

This software package is called DSPlib and comes with full and comprehensive documentation. The routines are supplied as both source and executable code, no run-time licence is necessary. Also provided are high level utilities which allow code to be developed in C on a PC and downloaded to any of LSI's compatible hardware for PCbus, VMEbus or Sbus. Code can then be run on the DSP with results displayed in real time on the screen.

DSP hardware available from LSI includes a variety of TMS320C40 and TMS320C3x boards for PC, VME systems. They also produce a range of software including debuggers, assemblers and linkers, C compilers, etc.

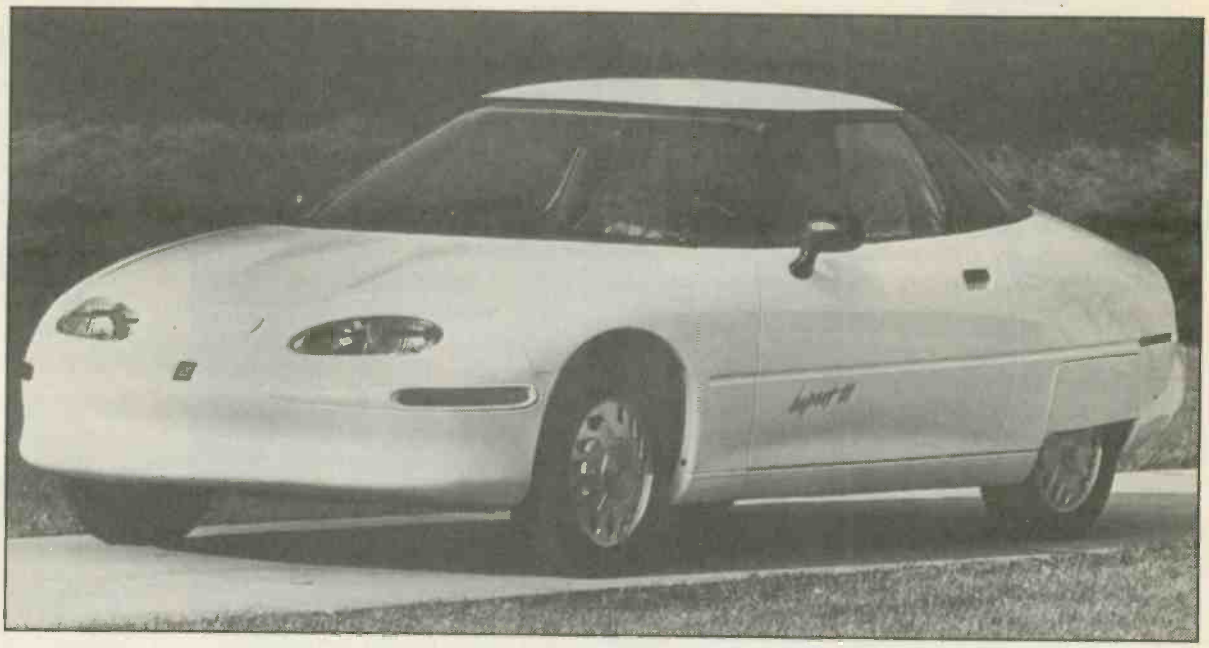
For further information contact Loughborough Sound Images Ltd. on 0509 231843.

NEW HANDHELD FREQUENCY COUNTERS

Now available in the UK is a range of handheld frequency counters from the US company, Startek. These low price units are specially designed for the hobby communications market and offer the user a wide range of features not previously obtainable at such a low price.

There are four units in the range and they cover frequency ranges from 1-1300MHz, rising to 1-2800MHz. All units run on rechargeable NiCads which give 3 to 5 hours of continuous operation. They feature a very high sensitivity, less than 1mv (typical), and an ultra fast, less than 80ms, response time. There is a large bright LED counter display and a 4GHz signal strength bar graph display.

The units cost between £129 and £289 each. For further information contact the distributors, Nevada, on 0705 662145.



Electronics and the vehicles of the future

The motor vehicles on the roads today are classic examples of a technology which has been refined and honed to near perfection, but nevertheless, has remained fundamentally unchanged over the last fifty years

A motor mechanic of 1943 could look under the bonnet of a 1993 model car and find most of it familiar. A reciprocating piston internal combustion engine, with spark plug ignition, a gear box and power transmission system, axles, brakes, steering system and fuel tank. Of course the design of most of the components has changed and they are now infinitely better then their equivalents of half a century ago, but this does not alter the fact that the technology is still the same - it is a technology which is now faced with the changing needs of society, and an increasing popular awareness of threats to the environment.

The environmental challenge

The public and politicians are faced with smog bound cities and ozone depleted skies, and they clamour for a cut in pollution levels. There is the ever present threat that fuel supplies will be outpaced by demand, that prices will skyrocket, that we will be held to ransom by the oil producing nations.

Vehicle manufacturers around the world are taking these impending changes seriously, so are the oil companies and even the politicians. From the politicians we have schemes for zero pollution emission zones in our cities, such as the scheme in operation in La Rochelle in France. In the USA, a 10% tax credit for driving an electric vehicle is the most ambitious political proposal. The response from the corporate sector has been an annual world-wide expenditure of over £5 billion on new low pollution vehicle technologies, such as electric cars.

So far, most of the results have been grandiose schemes and a handful of ingenious one-off concept cars. These concept vehicles have been based on a variety of different drive and power technologies, battery electric, regenerative flywheels and light-weight aerodynamic bodies. They have had a lot of publicity and yet they have remained nothing more than concepts.

Into the Future...

The pioneers

Of course, there are brave pioneering inventors like Britain's Sir Clive Sinclair who have attempted to open up a market for electric vehicles, but without a great deal of success. It seems that, although the public may demand a greener future, they are also very conservative when it comes to accepting changes in vehicle technology.

Perhaps they are right to be sceptical about electric vehicles. After all, there are still a lot of fundamental technological and infrastructural problems remaining to be solved. Battery technology has a long way to go before it can begin to compete with a tank of petrol in terms of energy capacity. There is a need for fast battery chargers and as far as infrastructure is concerned, there is a need for the electric car equivalent of the petrol station, the curb side charger.

But are these such major problems or is it simply that both the general public and the manufacturers are so intractably set in their preconceptions of what a motor vehicle should be, that they fail to even see the alternatives? They want an electric car to look and behave like a conventional car. It is an exact replay of the days when the early motor manufacturers had to produce cars which looked like horse drawn carriages.

The design challenge

Maybe if the consumer, the designer and the manufacturer are prepared to be more imaginative, they will discover that many of the technological problems facing electric vehicles are not so great. In particular the problem of battery capacity versus the power capacity of a tank of petrol.

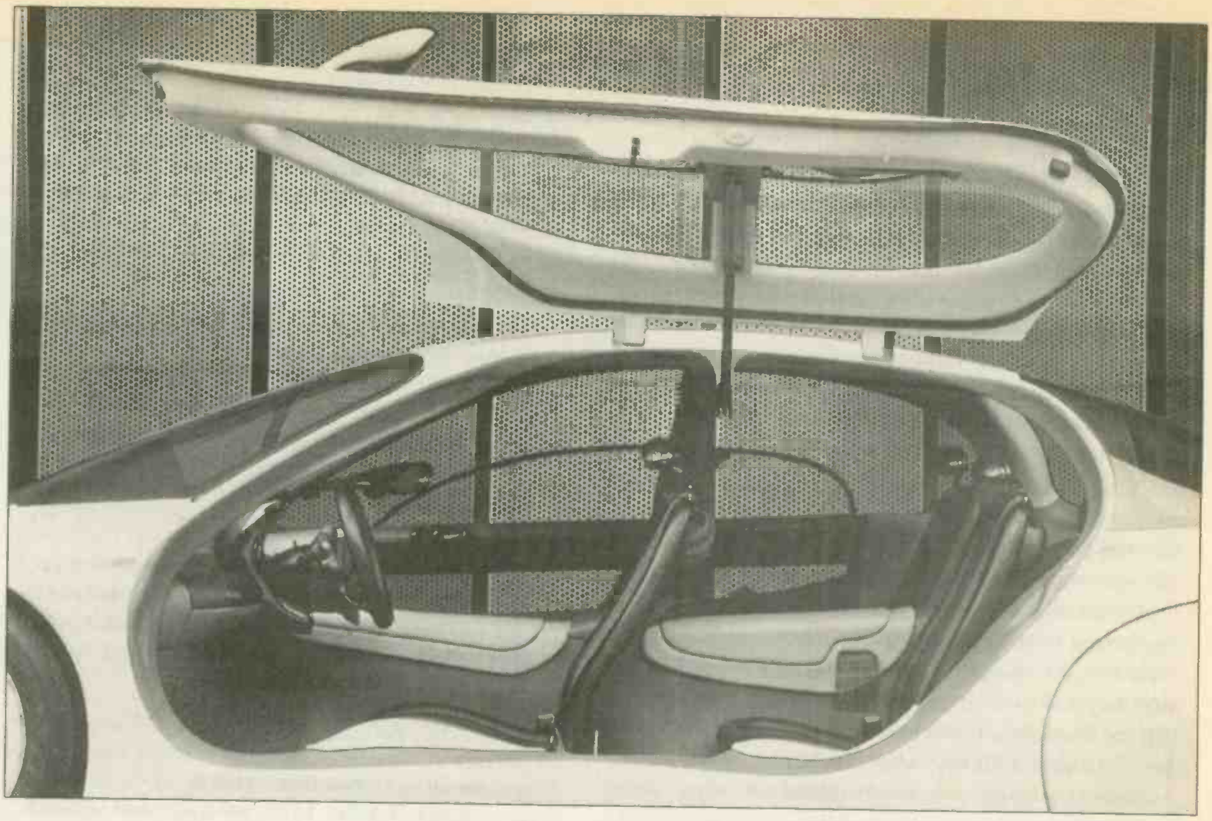
There are a great many well respected scientists and engineers who quite correctly point out that it takes 100Kg of lead acid battery to store the same amount of power as a single litre of petrol. They argue that even with the most advanced battery technology, such as sodium sulphur, or lithium aluminium iron disulphide, battery power density will never equal, or even get close to, that of petrol on a weight for weight basis. But what such critics ignore is the fact that, on average, a modern car only uses a little over 15% of the energy content of petrol. The rest is wasted in exhaust gasses, pollution and heat before it even drives the vehicle. In contrast, an electric vehicle can make 100% use of the energy stored in its batteries.

This observation has been the key to exciting new proposals being put forward by one of the world's leading think tanks, the Rocky Mountain Institute of Colorado. Their director, Amory Lovens, has in a recent series of talks given to politicians and industry leaders around the world, pointed out that the inefficiency in petrol energy usage results in a leverage factor in favour of electric propulsion.

Hybrid systems

However, he is not actually proposing the development of purely electric vehicles. Instead, he is considering hybrid systems. With a hybrid system, fuel would be used to power a small very high efficiency turbine engine which would in turn drive a generator for recharging batteries.

In a conventional internal combustion engined car the maximum engine output power is only rarely used, in overtaking or climbing hills, for the rest of the time the engine idles at low power and low efficiency. With a hybrid system the fuel burning engine need have no more power than the average power needs of the vehicle. In other words the equivalent of perhaps a 200cc engine. Peak power requirements would then be drawn from



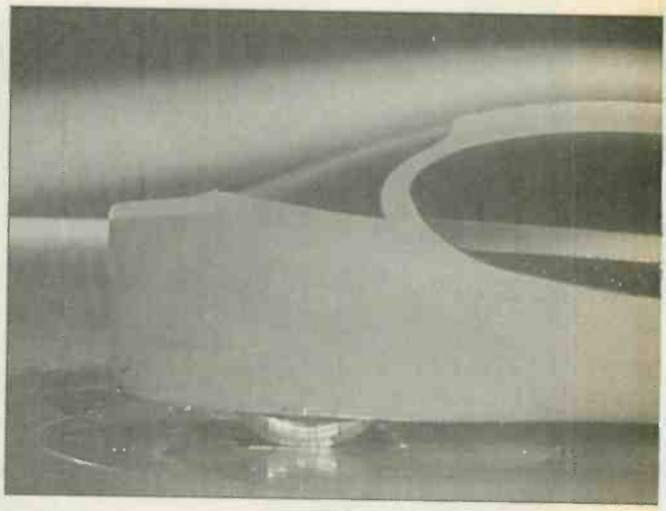
energy stored in the battery. In this way the engine can be designed for running at maximum efficiency and thus best fuel usage and minimum pollution. When the batteries are topped up, the engine is simply switched off.

Lovens expands on the concept of energy reduction by use of a hybrid system, pointing out that if we reduce the energy required to drive the wheels, then for every unit of energy saved there is with an IC engine a seven fold saving in fuel usage. This means that if we reduce the energy requirements sufficiently, the amount of energy stored in a reasonable size and weight battery can provide the user with the kind of vehicle performance which he requires.

Ultralights

For examples of this approach we only have to look at experimental vehicles such as the solar powered cars that take part in the World Solar Challenge in Australia (next one to be held in November). These vehicles which run on minute amounts of solar derived electric power but which can achieve speeds of up to 75mph. Other examples are the Voyager ultralight aircraft which circumnavigated the globe in 1991 on a single tankful of petrol or, more practically, the recently launched GM Ultralight concept vehicle.

The way to achieve such reductions in power requirement according to Lovens, and he is talking about the equivalent



of 300 miles per gallon in a car the size of a Ford Escort, is first of all to look at the main areas where energy is lost rather than used for locomotion. These his institute has identified as being energy lost through aerodynamic inefficiency, energy lost in heating up tyres and road and energy lost in braking systems.

Of these, air resistance accounts for about 70% of the lost energy. At the moment, a standard car's effective frontal

Motor Technology

The development of a compact, light, high power and efficient electric motor has been one of the key components in the development of electric vehicles. At the forefront of such developments is a revolutionary design developed over the last seven years by Devon based inventor Cedric Lynch.

It is a permanent magnet motor which has been specifically designed for use in electric vehicles. It is pancake shaped with a disk-shaped armature that is ideal for use as a hub mounted motor. The design is a low-speed high-torque system with an energy efficiency of well over 90%.

This motor has attracted a lot of interest from electric vehicle manufacturers and is currently being evaluated by several European electric car and scooter producers. One impressive achievement of the Lynch motor was its use as the power source for a hydroplane which in 1989 set the world speed record for electrically power boats.

The development of the Lynch motor has so far been through the Lynch Motor Company, with the backing of London Innovation, but the company has recently formed a joint venture with electricity generating giant Powergen to set up a manufacturing unit in Honiton, Devon. This plant will initially be able to produce 5000 motors a year, while a manufacturing plant serving the North American market is likely to be set up in Mexico in the near future.

The initial production will be concentrated upon a 200mm diameter, 48V version weighing 11kg and producing a power output of 8kW at 3,250rpm. Initially such motors will cost about £750 each, but prices will fall as manufacturing gets under way.

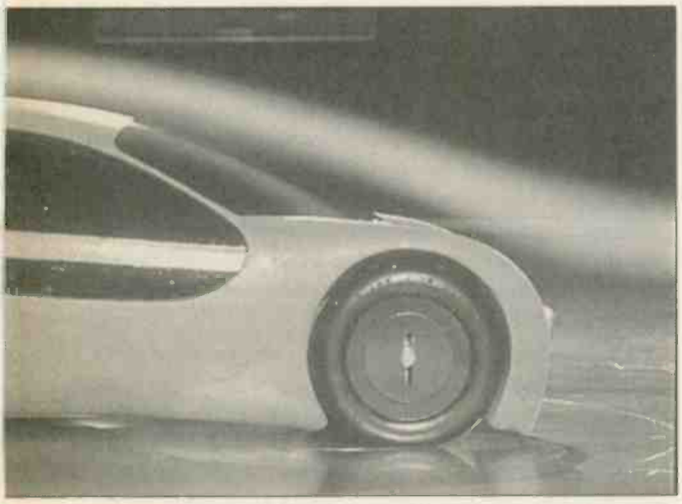
area, in other words the area which has to be pushed through the air, is about 0.75 square metres. But with computer aided design techniques it should be possible to reduce this to about 0.2 square metres, without affecting the size or seating capacity of the car. Indeed, General Motors has already demonstrated a car with a frontal area of 0.33 square metres.

Reduced aerodynamic drag can also be achieved by using new materials such as carbon fibre composites, which have much smoother surfaces and which can be manufactured to a high tolerance in shapes which would be impossible using conventional pressed steel technology.

At the moment, the energy lost in braking systems is simply dissipated as heat in the brake shoes. The use of regenerative braking systems would allow this energy, about 70%, to be largely recovered as electricity and used for locomotion at a later period.

Braking losses can also be reduced by cutting down the weight of the car, the less weight the less kinetic energy. Halving the current average car weight of 1440 kilograms by two thirds should be possible and prototype light weights have been demonstrated by General Motors.

However, the main key to reducing vehicle weight lies not



in the materials used in the body shell, but in getting rid of many of the heavy components found in a conventional car and replacing them with light weight electronics. Thus we can get rid of steering mechanisms, power transmission and gearbox systems, braking systems and environmental control systems.

The challenge for auto electronics

Electronics and computer control are the key to the further development of both electric vehicles and hybrid electric/fuel driven engine vehicles. Electronics will not only be used to replace many existing mechanical systems but will also be used to enhance the performance of both new and existing components.

Electronics will allow the power stored in a battery to be better utilised by allowing power regeneration and short period power boosting for rapid acceleration and hill climbing. Electronics will also be applied to keep battery performance at a constant level, eliminating the current situation, where there is high performance on a full charge, and a subsequent decay in performance as the charge level drops.

These two factors alone have been responsible for designers putting more batteries into a vehicle than were actually needed. Coupled with new fast charging techniques such electronic systems will enable existing battery technology to be more fully utilised. This will allow practical commercial electric vehicles to be produced without having to wait for better, and much more expensive, battery technologies to be developed.

Battery Technology

Conventional electric vehicles, such as the familiar milk float, have for over ninety years (yes electric vehicles have been around that long!) relied upon the standard lead acid battery for electric power storage, but the trouble with such batteries is that the amount of power stored in a kilogram of battery is very low. The best performing electric car using lead acid batteries has a maximum range of 100 miles per charge.

Increasing the amount of power stored means increasing vehicle weight, which in turn increases the need for more power, a vicious circle from which engineers can only produce a compromise solution.

One way out is to increase the amount of electric power stored by a kilogram of batteries - in other words improving battery technology. To date it is estimated that over $5 billion has been spent around the world in developing the super battery, research which has resulted in a whole range of new technologies looming on the horizon.

These new technologies start with improvements to existing lead acid batteries - the US company Electrosource claims it can produce a four fold increase in performance of lead acid batteries. Then there are solutions based upon more exotic battery technologies, including the widely used NiCAD and Lithium batteries found in rechargeable consumer goods. These deliver greater power densities but suffer from problems associated with recycling the old batteries. The lithium polymer cell is the long term solution preferred by US car giant General Motors.

Actually in production are two technologies which offer much better prospects as electric vehicle power sources. These are sodium sulphur batteries and nickel-metal-hydride.

The nickel-metal-hydride battery has been backed by Ford and largely developed by the US company Ovionics. It is a battery technology which has been widely applied over the last few years in making small batteries for use in consumer applications. Initial research focusing on scaling up the technology indicates that they should be capable of offering between 250 and 400 miles per charge

The sodium sulphur battery has been the subject of considerable development work in the UK by battery manufacturers Chloride and Silent Power and both companies are now embarking on commercial sodium sulphur battery production. It is the battery technology which has been picked as first choice by BMW, Ford and VW and should provide a performance even better than that of nickel-metal-hydride on a weight for weight basis.

However, they do have one drawback, they operate at a temperature of 425C. It has been claimed that this could pose a safety problem although the manufacturers have shown in drop tests that it is a problem which can be overcome. Overall, the UK developed sodium-sulphur batteries look like offering electric vehicle manufacturers the best battery technology for at least the next decade.

Power systems

The use of computer controlled motors built into the hub of each wheel will eliminate the need for power transmission systems and gearboxes, and allow power regeneration as well as accurate speed control. In advanced electric vehicles the motor and the wheel will become one and the same thing, with sensors built into the wheel to measure rotational speed and position. Sensors will also measure the power requirements, allowing the motor to be switched by the controlling computer from a motive power unit to a generator.

When a vehicle with power regeneration is going down

Electric Racing Cars

If you pass a milk float crawling along at ten miles per hour you may be surprised to learn that the speed record for an electric car already stands at 100.242 miles per hour. That is speed!

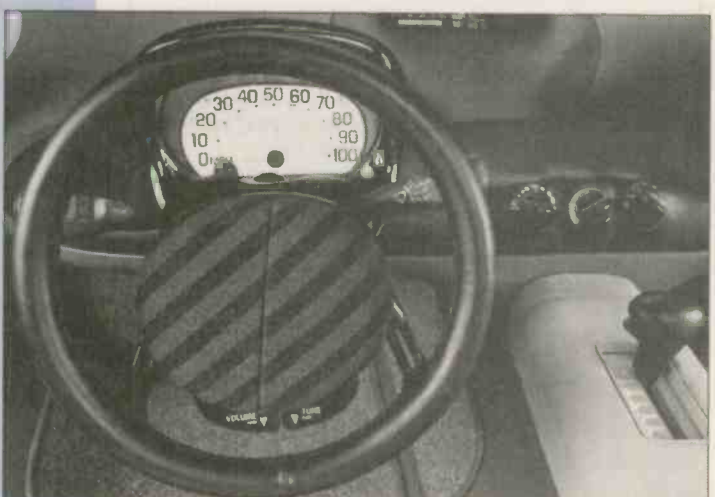
Indeed, there is considerable interest around the world in the development of electric racing cars. In France, Renault has produced an electric version of the Renault Elf Campus, a racing car aimed at young drivers, and launched at the recent Monaco Grand Prix. This race car is the world's first zero emissions single seater and offers the driver a power output of 68bhp at 4000rpm and can cover a kilometre in just 33 seconds, giving it a maximum speed of 105mph. OK, it can only do three Monaco laps before recharging, but improvements are already under way, as are proposals for a world electric car racing circuit with very big prize money for drivers and car builders.

If you think 105mph is fast for an electric vehicle consider the attempt on the 500 kilogram world speed record by a car called the Volta. This vehicle has been designed by UK based Lotus Engineering, in association with electricity company Seeboard, tyre company Michelin and German battery manufacturer Deta. At sixteen feet long, the car should be able to reach speeds of 150mph.

An attempt on the record is being made at the time of writing at Pendine Sands, Wales, the site of many land speed records. The car will be driven by Lotus engineer Rudy Thomann, who was the man behind the design of Chris Boardman's Olympic gold medal winning bike.

Even this record breaking speed looks set to be broken within a year by a car called Bluebird 9, named after Donald Campbell's famous series of world land and water speed record breaking vehicles. Designed by Sussex engineer Nelson Kruschandl this 15ft long car has a designed top speed of over 250mph.

hill, power will be generated and returned to the main battery, thus conserving overall power utilisation. Power regeneration will also provide the vehicle with a braking force. It should be possible to completely do away with mechanical brakes for anything other than emergency operation and instead to rely upon the motors, under computer control, to provide braking in either motive or regenerative mode.



Electric motive power systems which use hub based motors will also permit accurate steering by the simple expedient of creating a differential in rotational speed of wheels on opposite sides of the vehicle. This will operate in much the same way as a tank or tracked vehicle and will allow very accurate manoeuvring. Sensors built into the wheels will give full feedback to the steering column, which will have no mechanical linkage, just a simple rotation sensor attached to the steering control computer.

Future electronics systems

Additional sensors linked into the computer will also be able to provide anti-skid control. Systems such as this are already found on some lorries and top range cars, systems such as the Bosch VDC which measures wheel speed, traction control and steering angle and is linked via a computer to the engine controller to give real time self correcting action to prevent skids.

Schools projects

Electric vehicles are an ideal schools technology project since their design involves such a wide range of different technologies and design concepts, on top of which the development of such vehicles is a direct line to the future, a future in which the environment and the elimination of pollution will be of enormous political and social importance.

One school which has become involved in electric vehicle design is St Richard's RC school in Bexhill-on-Sea. Under the auspices of the school's technology and design teacher, Peter Fairhurst, a team of students were the inspiration and backing behind Lotus Engineering's development of the Volta and its attempt on the land speed record. The school have been closely involved in all stages of the design and building of this car and expect to be at Pendine to see their car break the world record of 100.242mph.

Further sensors will provide the driver with anti collision warnings and, via the computer, automatic avoidance procedures. Indeed, the fully computer controlled car will be able to offer the driver a whole range of additional functions, which range from head up instrument displays, to navigation systems based on satellite global positioning systems.

Electronics and computer control will thus provide the key to the creation of the car of the future, a car that will be light weight, low or zero polluting and very fuel efficient, while offering the kind of performance which drivers expect. In many ways, the development of such vehicles will parallel the revolution which has taken place in computing over the last ten or fifteen years.

This is a move which will see car manufacturing move away from large plants with massive investment, towards smaller manufacturers using standardised components, plastic composite body construction and specialist electronics and computer software. In the future, the commercial difference between two manufacturers could be decided by the software run on the car's computer, a development which could see the automotive equivalent of the low cost PC clones and the rise of new, highly entrepreneurial, car manufacturers.

One thing is certain. New car technology is only just around the corner and with it new opportunities, new generations of industrialists and engineers, and new multi-millionaires. Now is the time for such people to grab a chunk of the future, whilst at the same time helping to make the future an environmentally better place to live. **Nick Hampshire**

For more information

Readers wanting to find out more about electric vehicles and the electronics behind the technology, might find it useful to contact some of the following companies and organisations:

Battery Vehicle Society - 0455 290499
Chloride Plc - 0204 64111
Electric Vehicle Association - 0933 276618
London Innovation - 071 607 8141
Silent Power - 0928 574451
Sinclair Research - 071 636 4488

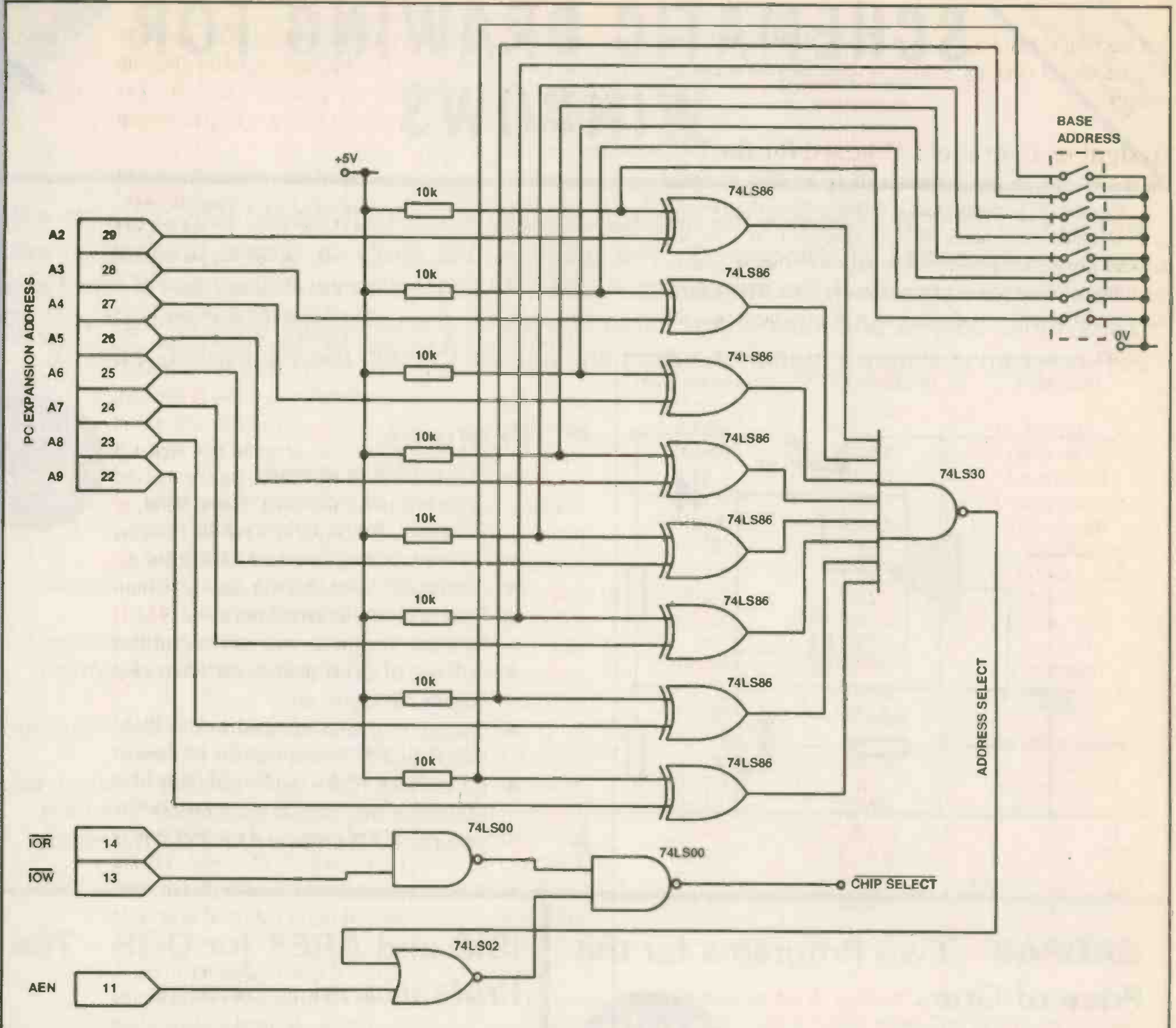


Fig.1. Basic EOR gate based address decoding circuit

Computer Interfacing T

The PC may be a versatile machine, but control of external equipment needs a suitable input/output port

If you compare the IBM PC with one of the older generation of personal computers, such as the BBC Acorn, or the Commodore C64, you will notice that something is missing from the PC. Not something that worries most users, but something which prevents those of us with an experimental bent from using the PC in the same way as we used those earlier machines. What the standard PC lacks is a proper bi-directional input/output port, something that can be used to control external circuitry and equipment.

Of course there is a parallel port on the PC, but the problem with it is that it has been designed for outputting data to a printer. In other words, it is primarily an output port with a couple of bi-directional handshaking lines. This could be used to control external circuitry, but designing the circuitry and the software to use it would be relatively complex for many applications.

The best solution is to use a purposely designed parallel I/O board which plugs directly into the processor bus and which can be easily controlled using programs written in Basic, or any other computer language. Designing a circuit which interfaces directly with the PC bus may sound complex, as indeed it is, but fortunately Intel has done all the work for us, by producing a programmable peripheral interface chip, the 8255, which contains virtually all the circuitry that we need to build a 24 line programmable I/O card. The only additional circuitry needed is some address decoding circuits.

Designing a parallel I/O board for the PC

On the PC, as on any computer using an Intel designed processor the I/O address space is different from the memory address space. In general, the I/O addresses on a PC are decoded using address lines A0 through A9. They need to be carefully decoded because there are a lot of different functions performed by I/O devices on a PC, the keyboard, the

Description	Hex address PC/XT	Hex address PC/AT
Fixed disk	n/i	1F0-1F8
Games adaptor	200-20F	200-207
Expansion unit	210-217	n/i
2nd parallel printer port	n/i	278-27F
Alternate EGA	2B0-2DF	2B0-2DF
GPIB (0)	2E1 *	2E1 *
Data acquisition (0)	2E2-2E3 *	2E2-2E3 *
Serial port 2	2F8-2FF	2F8-2FF
Prototype card	300-31F	300-31F
Fixed disk	320-32F	n/i
Network card	360-36F	360-36F
1st parallel printer port	378-37F	378-37F
SLDC	380-38F	380-38F
2nd Bisynchronous	n/i	380-38F
Cluster (0)	390-393 *	390-393 *
1st Bisynchronous	n/i	3A0-3AF
Monochrome adaptor/printer	3B0-3BF	3B0-3BF
EGA	3C0-3CF	3C0-3CF
CGA	3D0-3DF	3D0-3DF
Floppy diskette controller	3F0-3F7	F0-3F7
Serial port 1	3F8-3FF	3F8-3FF

n/i = not implemented

* = devices which decode the full 16 address bits and can reside in a range above 3FFhex. Thus GPIB (1) resides at 22E1hex etc.

Table 1. IBM PC I/O Map

echniques

printer ports and the disk drive, just to name a few. A list of designated I/O addresses is shown in Table 1.

Unfortunately, we can not predict exactly what I/O addresses are being used in a particular PC because there might be special non-standard add in cards. This means that we need to use an address decoding system which allows us to vary the preset I/O address of the interface circuit. The 8255 chip actually uses four I/O address locations which are selected by the two least significant address lines, A1 and A0, but this still leaves A2 through to A9 as defining the so called 'base address' of the chip.

We can set this base address with the aid of a simple comparator circuit and a bank of presettable switches. The comparator, as shown in Fig.1, can be made from eight two input Exclusive OR gates, the outputs from which are fed to an eight input NAND gate that in turn will eventually provide the chip select for the 8255. On each of the EOR gates one input is connected to one of the address lines and the other via a switch to either logic 0 for 'on' or logic 1 for 'off'. The complete circuit diagram for this address decoding technique is shown in Fig.1.

A more compact solution to the address decoding problem is to use a single chip octal comparator, such as the 74LS688. This single chip replaces the eight EOR gates and the NAND gate used in the previous design, and is the technique we will be using in this design. With either of these circuits it is possible to set the physical base I/O address of the 8255 anywhere within the range $000 hex to $3FC hex.

The output from either the 74LS688 or the NAND gate will go low when the predefined address is selected, but it cannot be directly used to generate the chip select input for the 8255. In order to generate this signal it needs to be combined with three other signals derived from the PC bus. These are the Input/Output Read, or IOR line, the Input/Output Write, or IOW line, and the Address Enable, or AEN line. First the AEN line and the output from the address decode NAND gate are fed into a NOR gate, and the IOR and IWR lines into a NAND gate, then the output from these two gates is fed into another NAND gate to finally produce the CS or chip select input for the 8255.

The 8255 also needs to be connected directly to the IOR, IWR, and Reset line inputs from the PC bus, as well as address lines A0 and A1, and the eight data lines D0 through D7. Apart from a few decoupling capacitors to eliminate any spikes and noise on the power supply lines this is all there is to a simple PC I/O board. A board which offers 24 programmable I/O lines with full buffering latching, and handshaking of data read to or from the board.

This, as can be seen from the circuit diagram in Fig.2, is a very simple circuit and we will not be providing the PCB layout and construction details for this alone, since we will be combining it with other circuitry which will be described in ETI over the next couple of months. The result will be a combined I/O and data acquisition card which will allow your PC to be interfaced to a wide range of external devices, including a range of virtual test equipment.

Using the 8255 I/O circuit.

Before one can think about using the 8255 to control any external circuitry it is essential that one understands how it works, what its limitations are and how it can be programmed to do what you want.

As has already been noted, the 8255 uses four I/O locations. Three of these are eight bit I/O registers and the fourth is a control register. So at the base address is the register for Port A, at base address +1, Port B, at base address +2, Port C, and at base address +3 the Control Register. We can use the computer to read data from, or write data to, any of the ports, but we can only write data to the control register.

It is the control register which determines how the 8255 functions. It determines the mode in which the chip will operate which in turn determines whether a particular I/O line functions as an input or an output line. The 24 I/O lines on the 8255 are grouped into three 8 bit ports, labelled A, B, and C, each of which corresponds to one of the 8255 I/O registers. However, the control register divides these 24 I/O lines into two 12 line groups, Group A and Group B. The lines

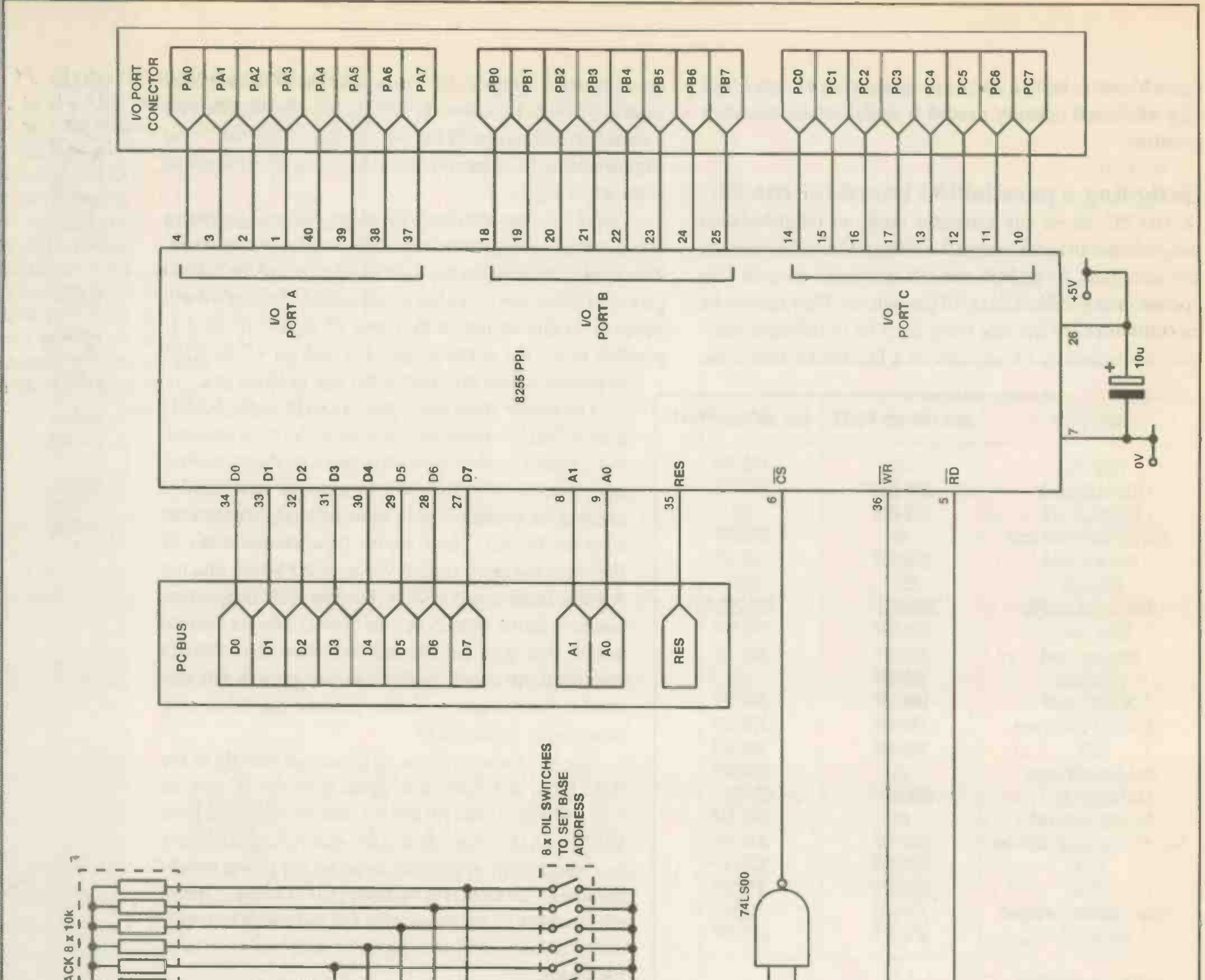


Fig.2. Circuit for an 8255PPI based IBM PC I/O board

in Group A consist of all the lines in Port A and the upper four lines of Port C. The lines of Group B consist of all the lines in Port B plus the lower four lines of Port C.

The control register features three operating modes for each of the two twelve line Groups of I/O lines. These modes are selectable by setting the appropriate bits within the control register, the function of each of the eight bits is shown in Table 1. Bit seven of the control register is the Mode/Bit Set/Reset bit, and is the key to programming the 8255. Normally this will be set to logic 1, where it allows Group A and B Modes to be selected, if set to logic 0 it will reset the 8255 registers.

In Mode 0, each of the 12 line Groups can be configured as a set of eight lines and as a set of four lines, which can be either inputs or outputs. In Mode 1, each Group of 12 lines can be configured to have 8 I/O lines, two handshaking lines and two further lines of I/O. Mode 2 governs all 24 I/O lines of the 8255, the Group A lines are set up as a bi-directional bus with one line from Group B acting as a handshaking line, the remaining lines from Group B being configured to operate in either Mode 0 or 1. This should be made clearer by consulting Table 2.

D7		**Mode selection**
1		Mode Set
0		Bit Set/Reset
D6	**D5**	**Mode selection - Group A**
0	0	Mode 0
0	1	Mode 1
1	x	Mode 2
D4		**Port A**
0		Input
1		Output
D3		**Port C (upper)**
0		Input
1		Output
D2		**Mode selection - Group B**
0		Mode 0
1		Mode 1
D1		**Port B**
0		Input
1		Output
D0		**Port C (lower)**
0		Input
1		Output

Table 2. 8522 PPI chip Mode selection on the Control

Connecting external circuitry

The I/O lines on the 8255 PPI chip are fully latched and buffered, but they are unable to source or sink large amounts of current. This means that when configured as inputs they are unable to accept voltages outside the range normally associated with 5V TTL and CMOS logic circuitry. Furthermore when configured as an output, such lines are incapable of providing more power than is necessary to output data to one or two other TTL or CMOS chips.

It is very important that these limitations are born in mind because any attempts to exceed them will almost certainly lead to the destruction of your 8255, and may well lead to the destruction of your entire PC. So be warned!

The way around the problem is to provide a buffer, or perhaps even isolate, the inputs and outputs of the 8255 from any external circuitry. If the external circuitry is working using normal 5V TTL power then buffering is probably adequate. At higher voltages and particularly if switching mains voltages, isolation techniques are essential. We will be covering both of these subjects in the next issue.

Conclusion

Adding a versatile programmable I/O port to your PC is neither difficult nor expensive. Indeed, such a port is really quite a simple circuit, particularly when it is based around a chip like the 8255 PPI. Given a PC board of sufficient quality, its construction is well within the capability of most electronics and computer hobbyists. With such a board you can let your PC control the world about it, you can give it eyes and ears, you can give it muscles, you can let it be something more than a number cruncher.

We strongly recommend that readers who possess a PC should make the effort to install a parallel board based on the 8255 in their system. This is because in future issues of ETI we will be covering a great many projects which will be connected to a PC via an 8255 based parallel port. These projects will range from test equipment, through control systems, to strange and wonderful gadgets. If you thought that computers were just for programmers, or accountants, then wait and see!

Jim Morton

I/O Address Selection on the PC.

The first thing when using this circuit is to set the address selection switches to an unused part of the I/O address area. This can be chosen with the aid of Table 1, note that there is an area reserved for prototype cards. You should also carefully look at the settings used on any boards already inserted in your machine. The actual way in which the switches are set is shown in the following table. If you get this wrong you will end up with an address contention, in other words two devices at the same I/O address, and the result could range from failure of an I/O device to complete system failure. Do not worry if this does happen, it is unlikely that you have damaged anything, just switch off, reset the address select switches to a new base address and try again.

Build your own board?

Readers who so desire could use the circuit described here to create their own parallel I/O board for the PC. A full description of all the lines used in the PC expansion slot connector is shown below. But a note of caution, PCBs which are built to plug into the PC's internal expansion slot have to be double sided and of very high quality, in terms of both production and dimensions. The edge connector must also be gold plated. The production of such boards is, by and large, not within the capability of most amateurs and it is therefore advisable to either build a board from a kit, use a ready built board, or wait for the ETI board. A list of I/O board suppliers is given at the end of this piece.

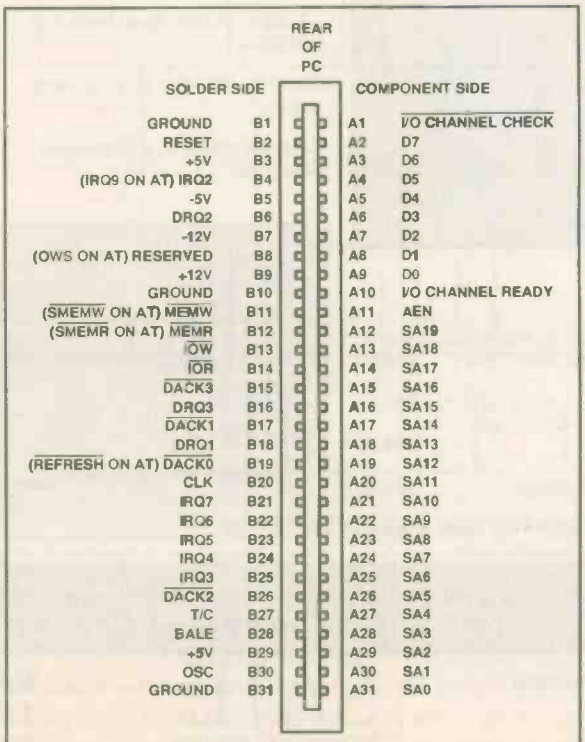


Fig.3. PC expansion slot connector

Programming the 8255.

If you can write a simple program in Basic you can programme the 8255 PPI. The key commands in GW or Q Basic are INP to input a value from an I/O address or OUT to output a value. The first thing to define in a Basic program which uses the 8255 is the base address at which the chip is located. So at the beginning of the program we need to have a line something like this:

```
10 BADR% = &H300
```

This sets up a variable called BADR which contains the base address of the 8255 chip, in this case 0300hex. This variable can then be used when setting the Mode values and in all subsequent I/O operations to this chip. Thus if we want to set up the chip so that the eight lines of Port A function as inputs and the sixteen lines of Ports B and C function as outputs then we would use the following line:

```
20 OUT BADR%+3,&H90
```

With these two lines executed, we can write data to or read data from the three 8255 I/O Ports. Thus if we want to set all the output lines on Port B to logic 1 we would use the following command:

```
30 OUT BADR%+1,&HFF
```

and if we wanted to input state of the I/O lines on Port A into a variable called PORTA, we would use the following line:

```
40 PORTA% = INP(BADR%)
```

It is as simple as that!

I/O Board suppliers.

Maplin Electronics
P.O.Box 3
Rayleigh
Essex
SS6 2BR
Tel 0702 554161

This company can offer a basic 24 line I/O port built around an 8255 PPI chip, available fully assembled and tested, price £29.95, as a kit £21.95, or as just the PCB £12.95. Prices include VAT but not postage.

Alfred Enterprises Ltd
Cummeen
Adare
Co.Limerick
Ireland
Tel +353-61-396-696

This company can offer a basic 24 line I/O board based on the 8255, fully assembled and tested with set-up software. price £33 +VAT, including P&P.

PC Paraphernalia
Almac House
Church Lane
Bisley
Surrey
GU24 9DR
Tel 0483 797959

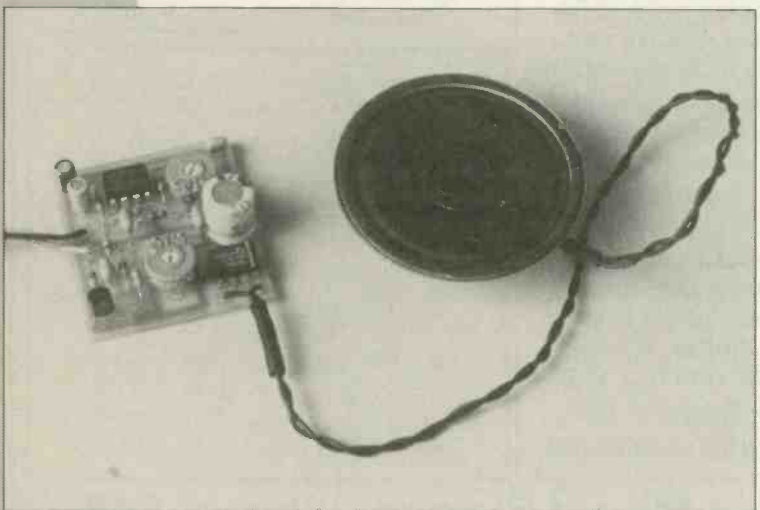
This company provide a whole range of professional PC based data acquisiton, measurement, and instrumentation boards. They include a fully assembled and tested 48 I/O line board based upon the 8255, at £69+VAT.

Not an 8255 PPI board but useful never the less.

R Bartlett
17 Lime Tree Avenue
Tlle Hill
Coventry
CV4 9EY
Tel 0203 473851

This company offer a PC control board with 8 inputs, 8 latched outputs, 3 strobes, and one IRQ, plus an 8 bit A-D and an 8 bit D-A. Fully assembled and tested board with ribbon cable £29plus £1 P&P, etched double sided board only with full instructions for drilling, assembly, and testing £12.50.

Simple Engine Sound for Radio Controlled Models



The satisfaction of roar power

Over the last few months we have been running a series of projects for radio controlled models by Craig Talbot. This is the latest in the series of add-ons for his low power speed controller system. It is a small circuit which gives your model vehicle a realistic engine sound.

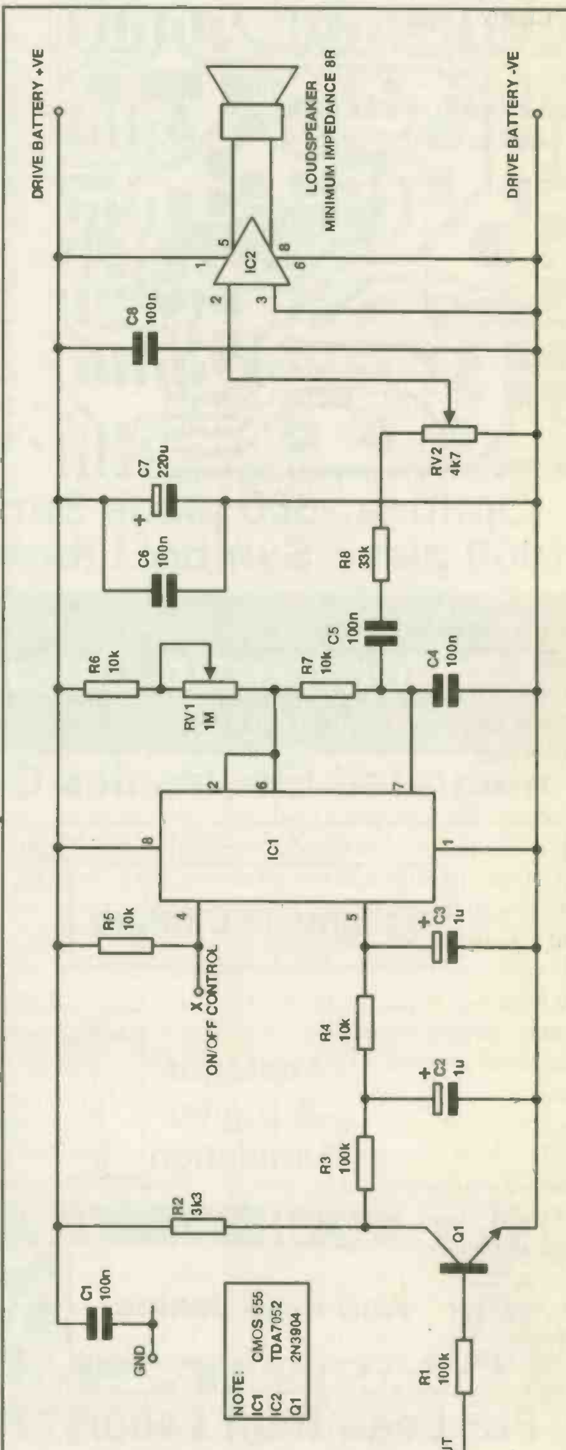


Fig.1. RC engine sound circuit diagram

How it works

The circuit diagram in Fig.1 shows the simple two IC circuit. IC1, the ICM 7555 (or any CMOS 555) runs as an astable oscillator and the frequency modulation input (pin 5) is used to increase and decrease the frequency of oscillation. The dc voltage which causes this increase/decrease is filtered by R3, R4, C2, C3, from the output drive pulses of the Speed Controller (taken from the point marked 'X', as per Fig.3).

As these drive pulses result in a dc voltage that decreases the frequency for increases in speed, it is inverted by Q1 together with R1 and collector load R2. Q1 also acts as a buffer between the Speed Controller and the filter, providing an output that is proportional to the Drive Battery Voltage. The two stages of RC filter reduce the pulses down to a usable dc level. Preset VR1 alters the unmodulated frequency of the 7555, allowing the tickover rate to be adjusted.

Moving the tickover up or down will, of course, move the range up and down. The output is taken from pin 6, in other words across the timing capacitor, C4. This signal is then applied via C5 and R8 to the preset volume control VR2 and hence to the amplifier. The amplifier is a bridge tied output type, which is basically two output amplifiers driving the speaker between them. Pretty impressive output levels at low voltage can be obtained with this type of output.

In this application however, the output level is determined more by the wattage capability of the small speaker, but the amplifier will deliver just over 1W on only 6V, when used with a suitable speaker. The large 220μF capacitor, C8, is required because of the large current changes generated by this amplifier IC, not to mention all the other loads on the drive battery.

Capacitors C1, C6 and C8 act as decoupling for the power rail, to remove some of the higher frequency noise (you may be able to remove one, or even two of these, in some cases). C4 is the timing capacitor for the 7555, while C2 and C3 are part of the filter. That really is all there is in the way of description, it is a very simple circuit in order that it can be kept to a fairly small size.

Design overview

Having a model truck with steering, forward/reverse speed control, lights, horn, direction indicators and brake-lights, I only needed to add engine sound to make it fully realistic.

I recorded a large truck engine, running at tickover and looked at the waveform on a scope. I soon found that a synthesiser would be required to simulate the full sound. Even if I had one, the model would never carry it!

Clearly a simpler approach was needed. This involved using a waveform generator through an amplifier in order to create a suitable waveform that could pass as a realistic engine sound. Out of the usual Sine, Square and Triangular waveforms, the triangular sounded best. An amplifier with its input fed through a low value capacitor and series resistor slightly improved the overall sound, but it still sounded a bit too smooth.

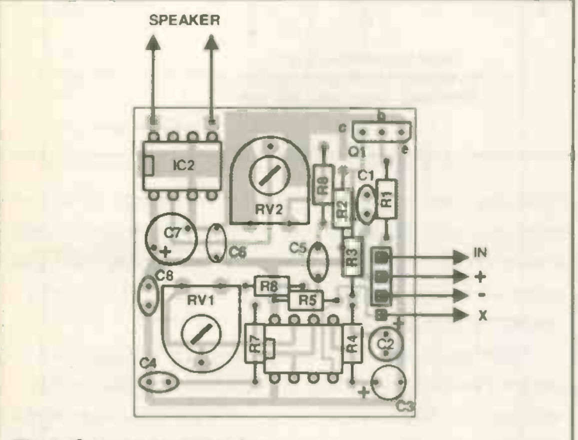


Fig.2. Component overlay

To make a rougher sound, a simple unijunction sawtooth generator was built which produced a series of spikes that gave a sharp edge to the sound. Perhaps not the most elegant sound, but a lot better than a mere electric motor and gearbox. Armed with this circuit, and a need to keep down both size and cost, design proceeded.

An op amp would produce the waveform, but control of the frequency would have proved to be a little more difficult. Voltage or current control would have to be pretty smooth and there were lots of problems involved in creating a variable tickover. More op amps would get around this, but the component count would be high.

The obvious answer was the faithful old 555. This would produce a crude sawtooth, if the output was taken from pin 6 instead of the normal pin 3. It also has a frequency modulation input and this was tried.

The resulting crude sawtooth sounded similar to the previous experiment, but it offered the basic sound and a method to vary the rate. What was now needed was a small amplifier and space demanded an 8 pin DIL amplifier. After trying at least three, the TBA7052 IC amplifier was chosen and the 555 replaced by a CMOS version (ICM 7555) in the interests of low power consumption.

The Low Power Speed Controller, previously described, provides a variable length pulse, where the pulse length is proportional to speed. All that was needed was a simple filter to turn the variable length pulses into a control level. The resulting project is a small PCB with few components and easy to build. It can be used as a slow plodding engine sound for a small boat, or even a screaming fast car sound with slight adjustment.

Do not expect this circuit to have the sound output level of a Disco however, it is only low power. After all, the drive battery has a lot of work to do and it needs to use most of its energy to drive the model along. This circuit draws little current, although an exact figure is difficult to state because it depends on speaker size and impedance, volume level, controller speed and range of frequency.

The output is a sequence of single pulses, so to simulate a four cylinder engine, one needs to run it at about four times the speed of a single cylinder one. Simplicity has been the key to the design, so no attempt has been made to produce the multiple pulses of multi cylinder engines, or the buzz of valves.

As with all this series of projects, a PCB was used, but is not essential.

Construction

The first point to note when constructing this circuit is that as IC1 is a CMOS device, care should taken in handling it. All CMOS devices are sensitive to damage by static charges so observe the normal handling precautions.

There can be some difficulty encountered when soldering components since the board will not lie flat, due to uneven component heights. For this reason very small boards, such as this one, are best clamped in some way, as they tend to run away from the soldering iron, due to lack of weight. A modellers vice or something similar will do the job. A large office Bulldog clip, that is screwed to a heavy block of wood is a good low technology and low cost solution.

This PCB is quite easy to build, see layout drawing Fig.2. The components are not very crowded and are fitted flat to the board. There are no covered components, which means that parts can be fitted in any order. Fitting the preset controls and the ICs first (observing CMOS handling precautions), will probably help you to get your bearings. Ensure that the ICs are fitted the right way round.

The resistors R1 to R8 only need attention paid to their values (see Fig. 2 and Parts list). All except three of the capacitors are 0.1 µF monolithic ceramics that can be fitted either way round. The other three capacitors, C7, a 220µF electrolytic and C3 and C4, which are 1µF electrolytics, must be inserted the right way. Note the polarity of all of these, which are clearly marked on Fig. 2.

When all components are fitted to the PCB, all that remains is the wiring. Connect a red wire at the point marked + (to go to the drive battery Positive) and a black wire to the point marked - (to go to the drive battery Negative). Next, a wire on Input (colour not important). The last connections are a pair of wires from the points marked Speaker which, of course, go to the speaker and can also be connected at this time.

That completes the construction of the PCB.

Selecting the speaker

A 75mm speaker, such as the one used on the prototype, will limit the usable power to a few hundred mW. Increasing the diameter of the speaker will increase the volume as larger speakers tend to be more efficient. This is presumably because of the increase in power of the magnet. Assume a maximum power of 1W with a suitable speaker. If you have a boat which has a very large capacity battery and plenty of

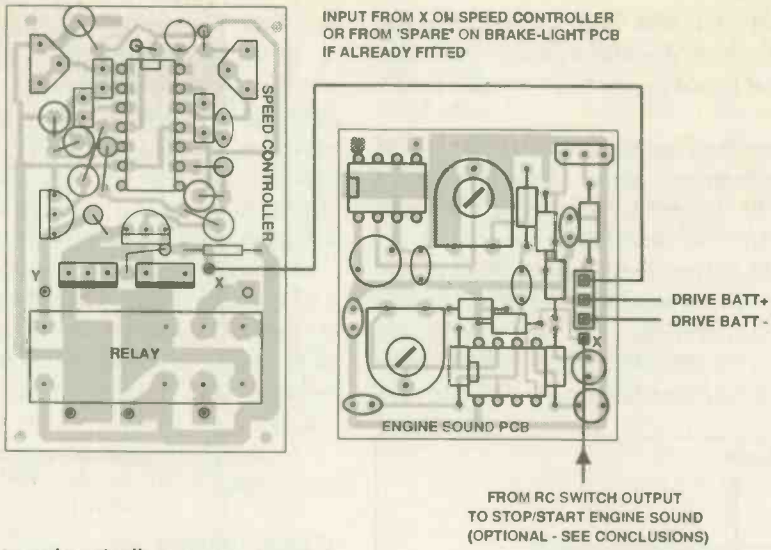


Fig.3. Connection to speed controller

space, a much larger speaker could be used, with an attendant increase in usable output power and a considerable increase in bass response.

The upside of all this, is that very small models will only require low sound levels and can therefore be fitted with the smallest of speakers.

As you will see, the Parts List recommends a Mylar Cone (moisture proof) speaker. The reason is that most models, including land vehicles, may have to operate in at least a damp environment from time to time. A paper cone would be a poor choice from this point of view. Having said that, a paper cone will probably give a better low frequency response for a given size.

Once again, as the unit is versatile and suitable for a huge range of models, every case may be different. Due to this, you will have to decide which type and size suits your purpose. The speaker will need to be in an exposed position in order for you to hear it. It will also need to be mounted on a small panel (baffle) with a hole almost as large as the speaker diameter to give its best performance. Fairly rigid plastic card is ideal for this.

Another type of baffle can be made from a tube, with a diameter as big as the speaker and a few centimetres long. With the speaker glued at the bottom, it gives a good baffle effect. Mounting a Mylar speaker in a hatch with a grating over it would be a good position for a boat.

The impedance is stated as 8 Ohms minimum, and higher impedances will work, with an attendant reduction in wattage. If you have to buy one, then get an 8 Ohm with a cone diameter as large as your model will allow.

If you have speakers in the junk box, try them all. You will be surprised by the results with different sizes and types.

Don't drive the amplifier too hard, you don't want to burn it out. Your fingertip will tell you if it is getting too hot.

PARTS LIST

SEMICONDUCTORS

IC1	CMOS 555 (Observe handling precautions)
IC2	TDA7052 AF Amplifier IC (see Buylines)
Q1	N3904 NPN Transistor

CAPACITORS

C1,4,5,6,8	1µF Monolithic Ceramic (marked 104)
C2,3	µF (16V or more) Min Radial Electrolytic
C7	220µF 16V Min Radial Electrolytic

RESISTORS

R1,3	100K 1/8W 5%
R2	3K3 1/8W 5%
R4,5,6,7	10K 1/8W 5%
R8	33K 1/8W 5%

MISCELLANEOUS

VR1 1M Min Horizontal Enclosed or Open preset
VR2 4K7 Min Horizontal Enclosed or Open preset
Speaker Minimum impedance 8 Ohms Mylar cone (see construction notes)
PCBEngine sound PCB (see Buylines)

BUYLINES

The TDA7052 is probably available from several suppliers, but if you have difficulty, it is available from Maplin, Tel. 0702 554161. Part No UK79L, or Electromail, Tel. 0536 204555, Part No 654-485
Engine sound PCB is available from ACTion, 140 Holme Court Ave., Biggleswade, Bedfordshire, SG18 8PB.
Cost, £2.85 plus 50p postage and handling
Cash with order only, cheque or postal order made payable to ACTion. Also available is a range of kits for building the various radio control circuits covered in this series. SAE to the above address for further details.

Testing

To do a full test, the Low Power Speed Controller will be required, but a quick test can be done without it.

Set the Tickover preset VR1 to the centre position and turn the Volume control VR2 fully anti-clockwise, then just move off the stop in a clockwise direction (about an eighth of a turn will do). Setting a low volume will ensure that it will not be too loud at switch on. Next, connect the red and black drive battery leads to the drive battery. As soon as this is done a sound should be heard. Adjust the volume control preset to a suitable level for your needs.

Moving the tickover control will cause a change of frequency and its final setting can be done when the Speed Controller is connected, if you prefer. If it is OK, then the drive battery leads should be disconnected from the battery.

Next, connect the wire you connected to Input, to the point marked 'X' on the Speed Controller (see Fig.3). Connect the negative from both the Speed Controller and the Engine sound PCBs to the drive battery negative, then connect the positive to the dead side of the power switch in the Speed Controller lead. This will ensure that the sound goes off when the model is switched off.

The unit can now be tested using radio control. The tickover setting can be adjusted while the Speed Controller is in a stop condition to produce the sound of tickover revs that is appropriate to your model. As the control stick on your transmitter is moved away from its centre position, the revs sound will increase. The sound level can now be finally set to offer the best volume level and sound for your particular model. As the unit will probably be subjected to considerable vibration during its life, the two presets can be sealed with a small spot of enamel or nail varnish if you wish.

Conclusion

In this project I have tried to make the tickover adjustable between a slow plodding diesel marine engine to a fast car engine. The increase in rate at tickover is of course reflected at the top end of the speed, so as to get up to a fairly high rate when set for a fast car. As I said earlier, it was originally made for a truck, which is between the two extremes of revs. All this is of course a compromise, but nevertheless, I think you will agree, much better than no sound at all.

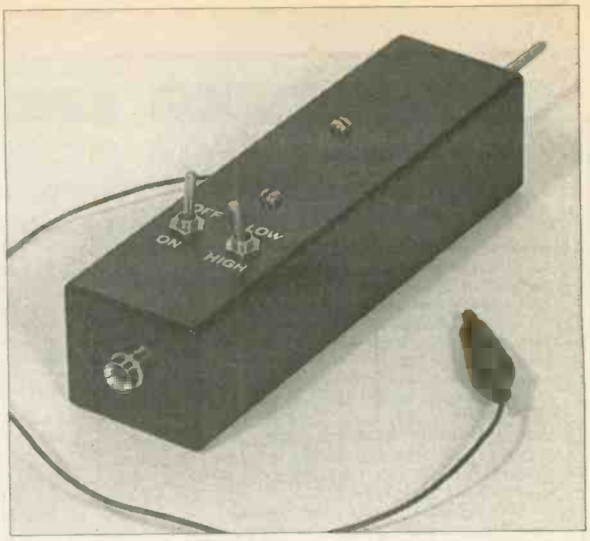
You will have noted a point on the Engine Sound PCB layout marked 'X'. An R/C Switch Output can be connected to this point to start and stop the engine sound. This would add the feature of being able to 'start' the engine sound running. It would, however use another channel to do this. Anyway, it's there if you want to use it and it only cost one resistor. If you prefer to use a toggle switch, all you need to do is switch 'X' point on the Engine Sound PCB to drive battery negative, at some suitable location.

The other detail is that you may want to run both the Brake-lights PCB and the Engine Sound PCB from the Speed Controller. This can be accomplished by using the spare pad on the Input of the Brake-light PCB to connect to the Input of the Engine sound PCB. This is what the spare hole is for.

Whatever you decide to use it for, or on, I do hope that it adds to the pleasure you get from your model.

Craig Talbot

An RF Hound



Eradicate unwanted background hiss with this month's cover PCB project

Radio frequency instability is the cause of many of those nasty hissing sounds and whistles which can bedevil the builders and designers of audio equipment. Indeed, determining the presence of any radio frequency (rf) instability is a common problem when fault finding on audio equipment. A handy piece of test equipment designed to solve this problem is the subject of this month's cover board project, from well known electronics expert Robert Penfold.

Audio equipment utilises semiconductors, which mostly have good gains at frequencies 100 or even 1000 times higher than the 20kHz upper limit of the audio range. This makes high frequency instability a virtual certainty unless the designer is careful to take appropriate countermeasures. Even when due care is taken with the circuit design and component layout, instability can occasionally be a problem.

Sometimes, high frequency instability produces tell-tale signs that indicate the likelihood of its presence. These signs include too much or too little background hiss and erratic variations in the background hiss level. There can also be odd whistling sounds, caused by stray pick up of radio signals which react with the rf oscillations to produce heterodyne beat notes. A high hum level on the output signal is another warning sign.

These noises are caused by the instability, resulting in a large high frequency signal being fed to the loudspeaker. This gives high loading on the power supply, with a consequent increase in the ripple level on its output. The most obvious of the tell-tale signs is when smoke wafts out of a tweeter! This is caused by strong instability producing a high power output signal, practically all of which is directed to the tweeter. Few tweeters are designed to handle high power levels (which they would not receive in normal use).

When high frequency instability is suspected, the definitive test is to use an oscilloscope to examine the output waveform of the equipment. Obviously, many electronics hobbyists are not equipped with an oscilloscope and, in general, oscilloscopes are not the most portable of devices. This r.f. probe offers a simple alternative. A LED indicator at the rear of the unit switches on when a rf signal is detected.

The unit also has a low sensitivity setting. When in this mode, the unit requires an input level of almost 1V peak to peak, before it will produce even a weak glow from the LED indicator. Higher input levels produce greater LED brightness, up to saturation point with an input of about 10V peak to peak. This mode enables the rough strength of the input signal to be gauged.

The unit has a wide bandwidth and is reasonably sensitive from around 50kHz to more than 50MHz. It is insensitive to signals at low and middle audio frequencies, making it possible to test for instability that only occurs when an input signal is present. The input impedance is 100k shunted by about 15p, which should ensure that loading effects on the test circuit do not produce erroneous results.

It is worth mentioning that in addition to detecting rf signals where they should not be present, this probe can also show that an rf signal is present and correct. For example, without an oscilloscope it can be difficult to determine whether or not a crystal clock oscillator is functioning correctly. This unit will indicate whether or not such an oscillator is producing any output and it will do the same for any subsequent divider stages that produce a high enough output frequency.

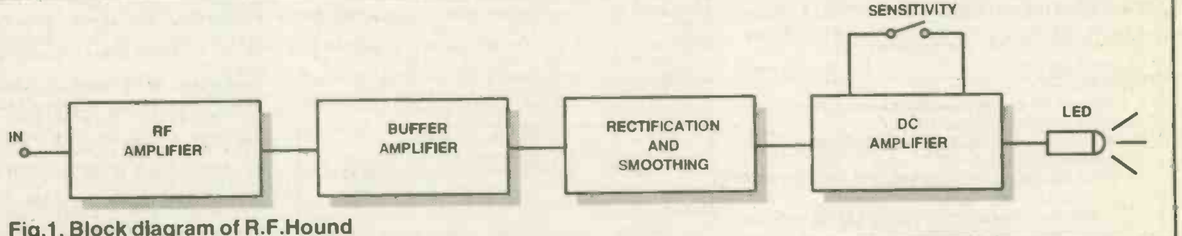


Fig.1. Block diagram of R.F.Hound

System Operation

This rf probe uses the simple arrangement shown in the block diagram of Fig.1. An rf amplifier at the input provides a small but useful amount of voltage gain. This stage is also designed to have built-in highpass filtering, so that the unit is insensitive to low frequency signals. A buffer amplifier provides a low enough output impedance to drive the next stage successfully. This stage is a simple rectifier and smoothing circuit, which provides a positive dc output voltage roughly proportional to the rf input level.

The next stage is a dc amplifier and the LED indicator is

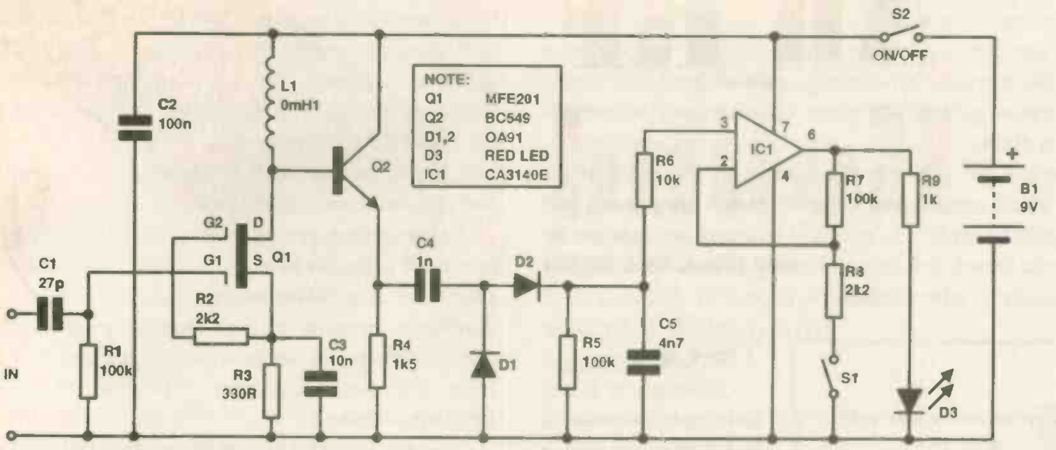


Fig.2. Circuit for R.F.Hound

driven from the output of this amplifier. Normally, this stage exhibits a voltage gain of slightly under 50 times, which ensures that quite low rf input levels will fully turn on the LED indicator. With the sensitivity switch set to the low sensitivity position, the dc amplifier has unity voltage gain. As explained previously, quite high input levels are then needed in order to produce full brightness from the LED indicator.

Circuit Operation

The full circuit diagram for the rf probe is shown in Fig.2. The rf amplifier is based on dual gate MOSFET TR1. This is used in the common source mode and it provides good gain over a wide bandwidth. R1 provides biasing for the gate 1 terminal of TR1 and also sets the input impedance at low frequencies. A further function of R1 is to provide simple highpass filtering in conjunction with C1. This capacitor also provides dc blocking at the input. C3 only provides efficient

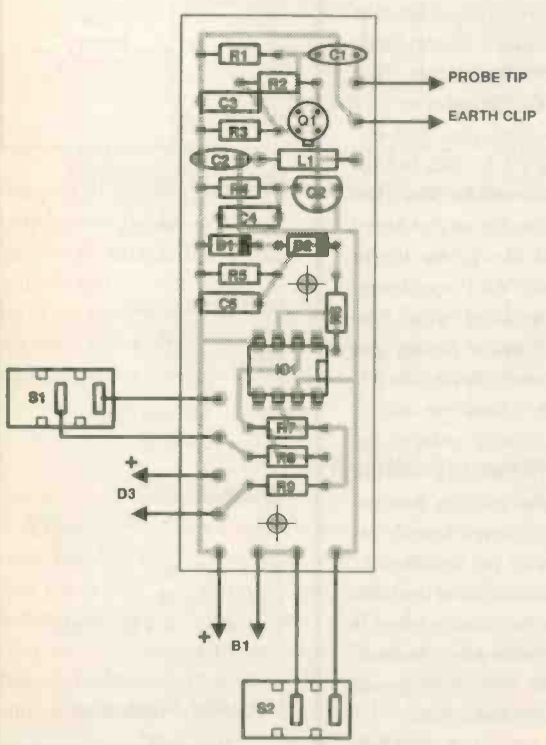


Fig.3. Component overlay

bypassing of R3 at rf frequencies, giving further highpass filtering. TR2 is used as a simple emitter follower output stage at the output of TR1.

The rectifier and smoothing circuit is a simple half-wave type based on D1 and D2. The latter are germanium diodes, which are better than silicon types in this application, due to their much lower forward conduction thresholds.

The dc amplifier uses IC1 in a simple non-inverting mode circuit. The unit is in the low sensitivity mode when S1 is open. IC1 then has a closed loop voltage gain of unity due to the 100% negative feedback loop through R7. Closing S1 boosts the sensitivity by bringing S1 into action. This decouples some of the negative feedback, and boosts the closed loop voltage gain to almost 50 times. IC1 drives LED indicator D3 via current limiting resistor R9. The maximum LED current is only a few milliamps, but most modern LEDs will give very good brightness from a modest input current.

No negative supply is used for IC1, since the CA3140E will work properly as a dc amplifier using a single supply rail. Note that most other operational amplifiers (uA741C, LF351N, TLO81C, etc.) will not operate properly in this circuit. The total supply current is about 7mA with the LED switched off, or about 12mA with the LED at full brightness. A PP3 size battery gives a reasonable operating life and is the largest battery that is practical for a small probe-type unit such as this.

Construction

The component overlay for the printed circuit board is provided in Fig.3. This also shows the small amount of point-to-point wiring. In most respects, construction of the board is very straightforward, but if everything is to be accommodated properly in a small probe type case it is important that the height of the board is restricted to no more than about 9mm. The leadout wires must therefore be trimmed very short on the underside of the board and it might also be necessary to angle some of the components at about 45 degrees, in order to prevent them from projecting too far above the board. In particular, C1, C2, and TR2 might need to be adjusted in this way.

Unless a suitably low-profile socket can be found for IC1, it must be soldered directly to the printed circuit board. Unfortunately, the CA3140E has a PMOS input stage which is static-sensitive. However, provided the normal anti-static precautions are observed and this component is soldered into place using an iron having an earthed bit, it is unlikely that it will come to any harm. D1 and D2 are germanium diodes, which are more vulnerable to heat damage than the more usual silicon types. Consequently, each soldered joint should be completed quite swiftly when soldering these two components in place.

Single-sided solder pins are fitted to the board at the points where connections to the off-board components will eventually be made. The pins will probably protrude too far above the board, but they are easily pruned back slightly using a pair of wire clippers.

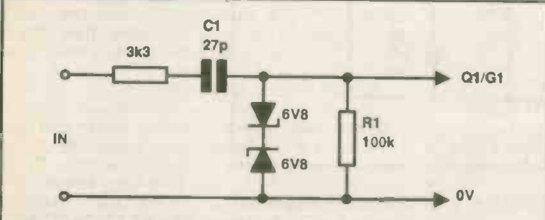


Fig.4. Modified input circuit with overload protection

The Case

Although it is not absolutely essential to build this unit as a probe style device, this is definitely the most appropriate form for a project of this type. The probe approach has the advantage of avoiding a long screened cable at the input, and the input capacitance that this would introduce. This extra capacitance could give misleading results by damping down instability, or blocking rf oscillators that worked perfectly well before the unit was connected to their outputs.

The board has been designed to fit into a Maplin 'small narrow box', which is well suited to probe style projects. The approximate internal dimensions of this box are 120 x 30 x 25mm, which represents something very close to the minimum practical size for this project. A long M3 or 6BA screw mounted centrally at the front end of the case acts as a probe tip. The end of the screw is filed down slightly to give a conventional rounded tip. A solder tag is fitted over the screw on the inside of the case to provide an easy connection point.

The chassis connection to the equipment under test is made via an insulated lead about 500mm long and terminated in a crocodile clip. A small hole for this lead is drilled well towards the front of the case, on the left hand side (as viewed from the rear). The circuit board is bolted in place on the top panel of the case using 6BA or metric M3 screws. The board should be mounted with C1 and R1 as close as possible to the front panel of the case.

D3 is mounted centrally on the rear panel of the case. S1 and S2 are mounted onto the top panel of the case, just behind the circuit board. The unit is then ready for the hard wiring to be added. Due to the small internal dimensions of the case, it is much easier to complete this wiring with the circuit board temporarily dismounted from the case.

The battery fits into the space above the circuit board and should be held firmly in place when the lid of the case is screwed into place. If there is not quite enough space for the battery, the circuit board is slightly too high and the offending components must be settled down lower on the board.

In Use

The crocodile clip lead is connected to the earth rail (the 0V supply rail) of the equipment under test. It must be emphasised here that this unit is only suitable for testing equipment that is battery powered, or mains powered via a supply circuit that provides proper isolation from the mains supply. It should not be used with equipment that has a 'live' chassis.

For most testing the sensitivity switch should be set at the 'high' sensitivity position. The LED indicator should then light up quite brightly even if only a fairly low level of oscillation is present. You may sometimes find that the LED indicator lights up with the probe tip not quite touching the test point! This happens where the signal at the test point is both strong and at quite a high frequency. Stray coupling then provides sufficient signal transfer to activate the probe.

As pointed out previously, the low sensitivity position can be used if you wish to gauge the approximate amplitude of oscillation. Also, some audio equipment seems to produce significant amounts of high frequency noise which can produce ambiguous results with flickering of the LED indicator. With such equipment, it is better to use the low sensitivity setting.

The unit has very low sensitivity at middle and low audio frequencies, making it possible to feed in an audio test signal and then check for rf instability using the probe. However, bear in mind that a squarewave or pulse signal will contain harmonics well into the rf spectrum. Consequently, it is not possible to use a squarewave or pulse test signal and then use the probe to check for ringing or other mild forms of instability. This type of testing is only possible using an oscilloscope. It is possible to use a sinewave or triangular test signal and to then use the probe to check for more severe forms of intermittent instability.

Overload Protection

The probe can withstand quite high input levels without sustaining damage, but when used to test high power audio amplifiers there is the potential for very high input levels. It would be advisable to use the modified input circuit of Fig.4 if the unit is to be used for testing very high power audio equipment. This involves the addition of a simple zener diode clipping circuit, that limits the input to TR1 to about plus and minus 7.5 V. The 3k3 resistor can be wired between the circuit board and the probe tip in place of the existing connecting wire. The two zener diodes can be wired direct onto R1. The protection circuit inevitably reduces the performance of the probe and, in particular, it significantly reduces its bandwidth, but oscillation well into the megahertz range is not normally a problem with very high power audio amplifiers.

R. Penfold

PARTS LIST

RESISTORS (0.25W carbon film)

R1,5,7	100k
R2,8	2k2
R3	330
R4	1k5
R6	10k
R9	1k

CAPACITORS

C1	27p ceramic plate
C2	100n ceramic disc
C3	10n polyester
C4	1n polyester
C5	4n7 polyester

SEMICONDUCTORS

TR1	MFE201
TR2	BC549
D1,2	OA91
D3	Red panel LED
IC1	CA3140E

MISCELLANEOUS

L1	0.1mH (100uH) rf choke
S1,2	SPST sub-min toggle
B1	9V (PP3 size)

Printed circuit board
Case about 124 x 33 x 30mm
Battery connector
Crocodile clip and lead
Wire, solder, fixings, etc.

POWER AMPLIFIER MODULES-TURNTABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE (A4) S.A.E. 60p STAMPED FOR CATALOGUE ★

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

THOUSANDS PURCHASED BY PROFESSIONAL USERS

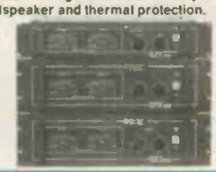
THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- **MXF200** (100W + 100W) **MXF400** (200W + 200W) **MXF600** (300W + 300W) **MXF900** (450W + 450W)

ALL POWER RATINGS R.M.S. INTO 4 OHMS, BOTH CHANNELS DRIVEN

FEATURES: ★Independent power supplies with two toroidal transformers ★ Twin L.E.D. Vu meters ★ Level controls ★ Illuminated on/off switch ★ XLR connectors ★ Standard 775mV inputs ★ Open and short circuit proof ★ Latest Mos-Fets for stress free power delivery into virtually any load ★ High slew rate ★ Very low distortion ★ Aluminium cases ★ MXF600 & MXF900 fan cooled with D.C. loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.



SIZES:- MXF200 W19"xH3½" (2U)xD11"
MXF400 W19"xH5¼" (3U)xD12"
MXF600 W19"xH5¼" (3U)xD13"
MXF900 W19"xH5¼" (3U)xD14¾"

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL. £12.50 EACH

OMP XO3 STEREO 3-WAY ACTIVE CROSS-OVER

Advanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: bass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass invert switches on each bass channel. Nominal 775mV input/output. Fully compatible with OMP rack amplifier and modules.

Price £117.44 + £5.00 P&P

STEREO DISCO MIXER SDJ3400SE
★ ECHO & SOUND EFFECTS★

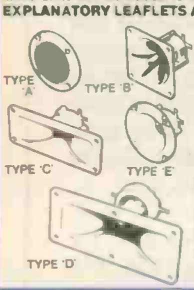
STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. **MANY OUTSTANDING FEATURES:**- Including Echo with repeat & speed control, DJ Mic with talk-over switch, 6 Channels with individual faders plus cross fade, Cue Headphone Monitor. 8 Sound Effects. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.

Price £144.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if two are put in series. FREE EXPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.



TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 + 50p P&P.

TYPE 'B' (KSN1005A) 3½" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 + 50p P&P.

TYPE 'C' (KSN1016A) 2"x5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 + 50p P&P.

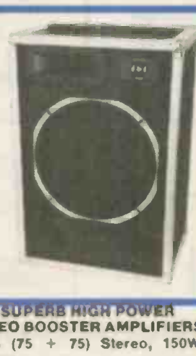
TYPE 'D' (KSN1025A) 2"x6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 + 50p P&P.

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 + 50p P&P.

LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 + 50p P&P.

ibl FLIGHT CASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest speaker technology and enclosure designs. Both models utilize studio quality 12" cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands.



POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET
FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz

ibl FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR
ibl FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR
SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair

IN-CAR STEREO BOOSTER AMPS

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono
ALL POWERS INTO 4 OHMS

Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

OMP MOS-FET POWER AMPLIFIER MODULES
SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P

OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE £259.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (60p STAMPED) FOR COMPLETE LIST.

McKenzie and Fane Loudspeakers are also available.

EMINENCE:- INSTRUMENTS P.A., DISCO, ETC

ALL EMINENCE UNITS 8 OHMS IMPEDANCE

8" 100 WATT R.M.S. ME8-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. PRICE £32.71 + £2.00 P&P

10" 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS97dB. PRICE £33.74 + £2.50 P&P

10" 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID.
RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. PRICE £43.47 + £2.50 P&P

12" 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR.
RES.FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. PRICE £35.64 + £3.50 P&P

12" 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. PRICE £36.67 + £3.50 P&P

12" 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID.
RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. PRICE £46.71 + £3.50 P&P

12" 300 WATT R.M.S ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC.
RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. PRICE £70.19 + £3.50 P&P

15" 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR.
RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. PRICE £50.72 + £4.00 P&P

15" 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR.
RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. PRICE £73.34 + £4.00 P&P

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8" 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. PRICE £8.90 + £2.00 P&P

10" 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. PRICE £13.65 + £2.50 P&P

10" 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. PRICE £30.39 + £3.50 P&P

12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. PRICE £42.12 + £3.50 P&P

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. PRICE £9.99 + £1.50 P&P

6½" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. PRICE £10.99 + 1.50 P&P

8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. PRICE £12.99 + £1.50 P&P

10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. PRICE £16.49 + £2.00 P&P

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

PHOTO: 3W FM TRANSMITTER

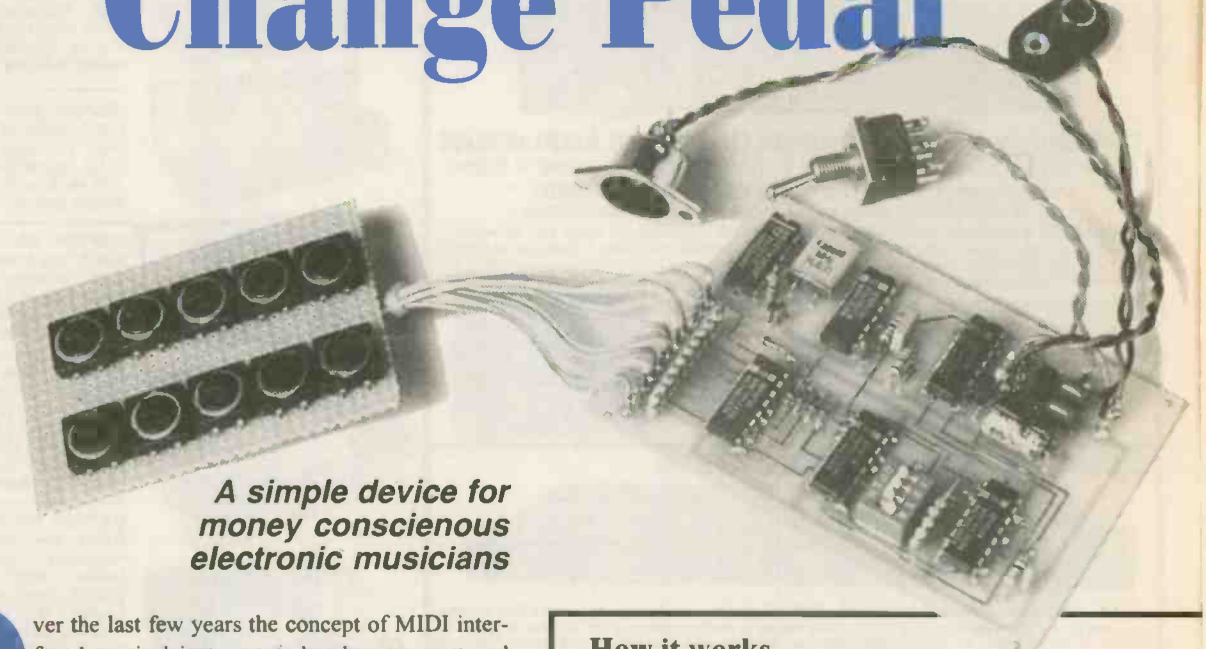
POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.

BARCLAYCARD VISA

B.K. ELECTRONICS

UNITS 1 & 5 COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR.
Tel.: 0702 - 527572 Fax.: 0702 - 420243

A MIDI Program Change Pedal



A simple device for money conscienous electronic musicians

Over the last few years the concept of MIDI interfaced musical instruments has become part and parcel of the lives of most musicians. So much so, that today there is a great deal of MIDI equipment available, not just musical instruments, but equipment of all sorts and for many different applications. However, much of this equipment is, by and large, very expensive, and in some cases vastly over complicated with features which may be of no use to the user whatsoever.

A classic example of this is the MIDI program change pedal. Normally an expensive piece of equipment, but one that is both cheap and easy to make. To show readers how, ETI regular contributor Pete Sapwell has produced a design for a simple MIDI program change pedal. A design which does just what it says it does - sends MIDI program change commands down one of the sixteen MIDI channels.

Design overview

The project described here was designed with a colleague in mind, a guitarist. He uses a signal processor which was controlled by a dedicated MIDI prog change pedal. Unfortunately, he had this unit stolen. During his set, he needed to change programs on his signal processor quickly. Random access was obviously important, 'stepping through' by pressing a switch several times in succession would take too long and a mistake would also be more likely. The design which we came up with is fairly small and with ten small switches it could be fitted into a case, fixed to a guitar strap, or built into a foot sized controller.

To keep the circuit simple, a maximum of ten programs was decided on (he only needed four). I considered using an UPC and a programmed EPROM, but I thought this would be fairly wasteful for such a simple task and I wanted to exercise my brain, so decided to use discrete logic instead. The full circuit diagram is shown in Fig.1.

How it works.

Referring to Fig.1, SW1-SW10 are the program change switches. The signals from these are decoded into inverse binary by IC5, and then fed to the 24 bit parallel to serial shift register, comprising IC3, IC4 and IC6. SW11 is used to set up the required MIDI channel number.

If all of the inputs of IC5 are at logic '1' (no switch depressed), all its outputs are at logic '1'. Once inverted, this represents the binary for prog '1' (0000). Since no switch needs to be pressed to achieve this, SW1 is connected straight in to the 'wired' OR gate comprising D2 - D6. Any switch depression will result in an output change on IC5 causing one of the diodes to conduct discharging C3. This results in the output of IC2a going high. The components C4, R3 and D1 change the leading edge to a brief positive going pulse which is buffered and inverted by IC2b. The action of these components debounces all the switches, preventing retriggering.

The negative going pulse from IC2b is fed to the Shift/Load inputs of IC3, IC4 and IC6, causing the data present on the parallel inputs to be loaded into its internal shift registers. As soon as this signal goes high, the data is clocked out to the driver TR1. This then inverts all the data and sends it to the outside world.

The 31250 baud rate generator is composed of IC1, R1, X1, C1 and C2. A 31.250KHz signal is available at pin 6 of IC1. This signal 'clocks' the 24 bit shift register continuously. The 'top' of the shift register is set to logic '0' so that after a prog change has been sent, the MIDI out socket will revert to no activity.

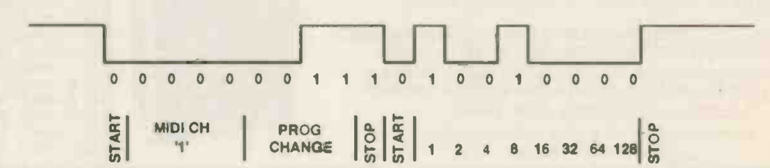


Fig.2 MIDI output timing diagram

MIDI is transmitted in serial over two wires at a rate of 31250 bits per second (31250 baud). There is no signal sent separately to synchronise the communication between units, data is sent asynchronously. Start and stop bits are used to

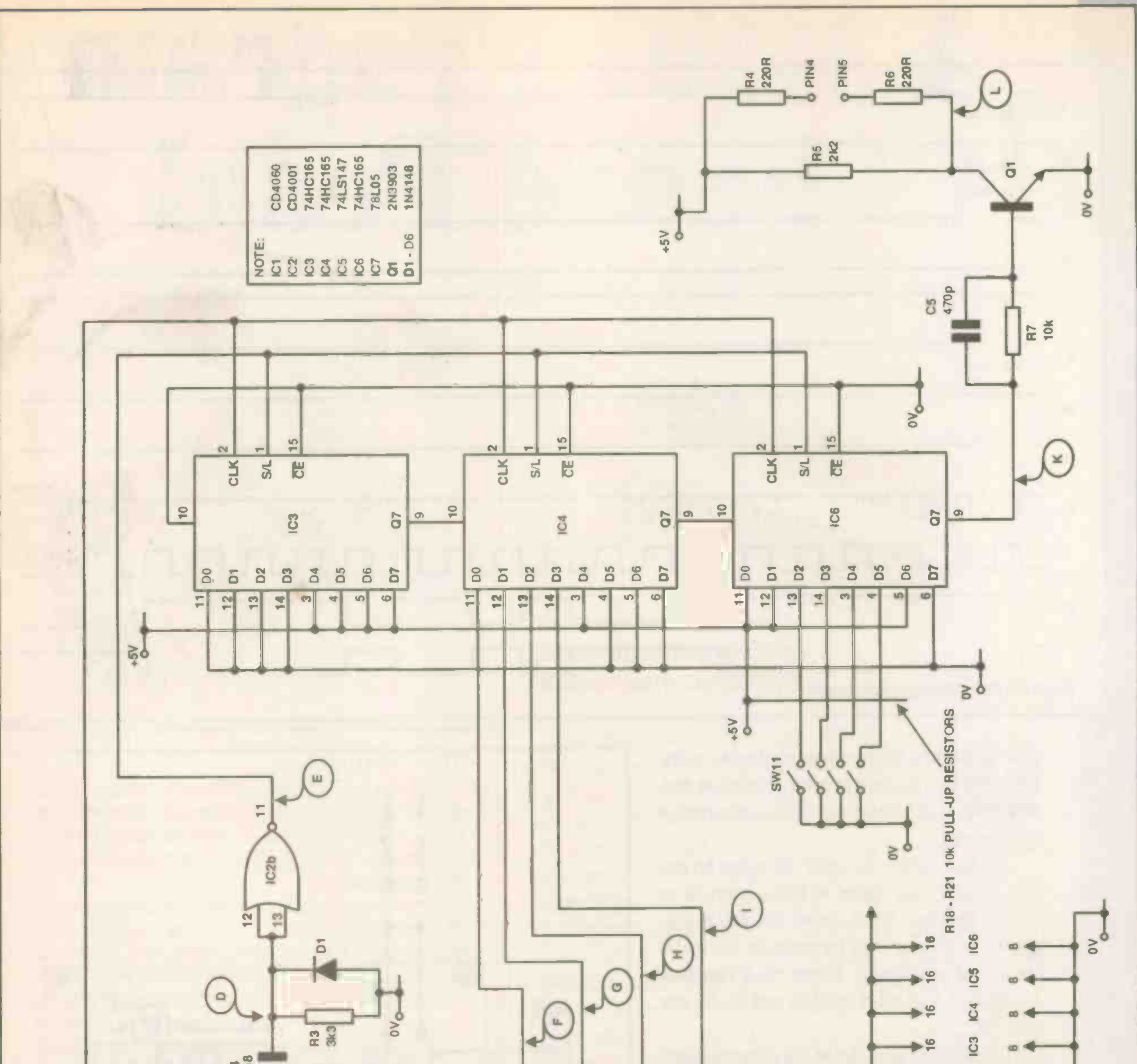


Fig.1 Circuit diagram for MIDI change pedal

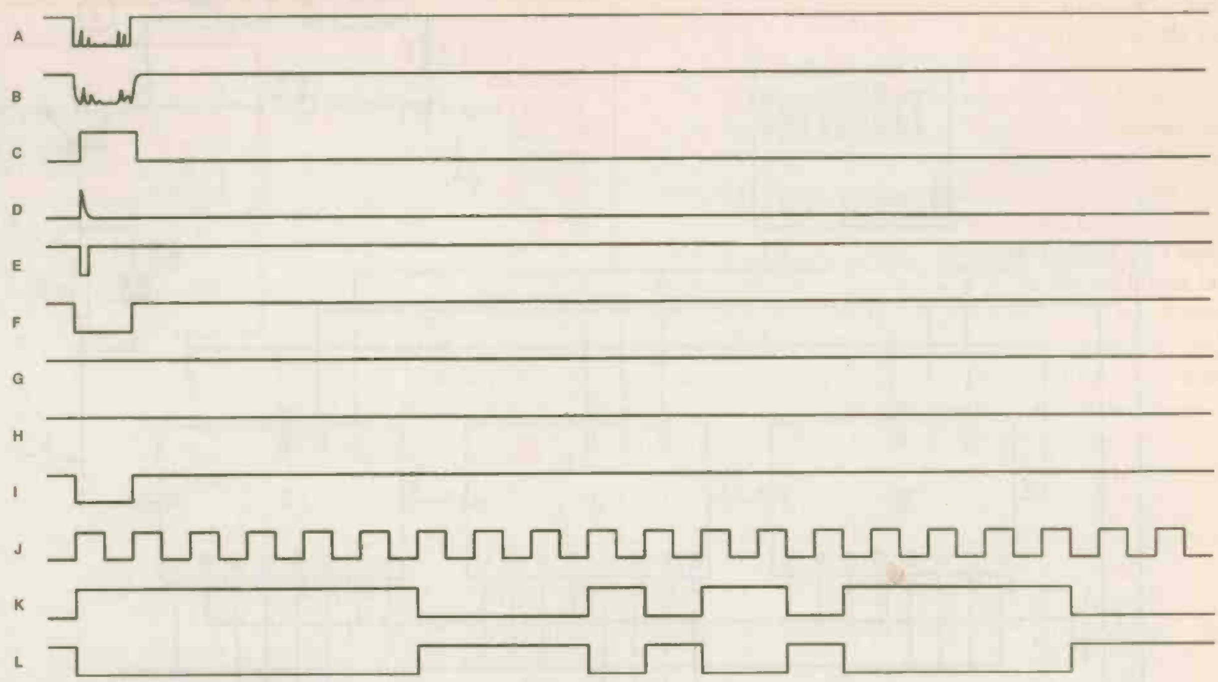


Fig.3 Circuit timing waveforms

delimit the data and synchronise the two units. No parity bits are sent as error protection and, generally, if an erroneous signal is received, it is ignored.

The receiving unit 'waits' for a start bit and then samples the signal at fixed intervals to extract the data. Fig.2 shows the MIDI program change command for program '10' and is composed as follows:- 1 start bit, 8 data bits, 1 stop bit, 1 start bit, 8 data bits and finally one stop bit.

The first nibble is the MIDI channel (0000 = ch1, 1111 = ch16), the second nibble (0011) is the MIDI program change command, the last byte represents the program number (10010000 = program 10) All MIDI data is sent least significant bit first, start bits are '0' and stop bits are '1'.

Construction and testing

Referring to Fig.4, construction is fairly straight forward on the PCB. The board is double sided and needs soldering top and bottom. Where you find a pad on the top foil, solder to it! A short length of wire should be soldered in place at 'X'.

I found it hard to get hold of SIL resistors and so decided to mount a number of discrete resistors vertically and solder their top ends together. Take care not to damage the static sensitive ICs, and fit these last along with the semiconductors.

SW11 is used to set up the MIDI channel on which the unit will operate. I used a DIL switch, but you could save money by just fitting wire links here. Fig.6 is a table of link/switch positions against MIDI channels. Conversely, at slightly more expense, a rotary

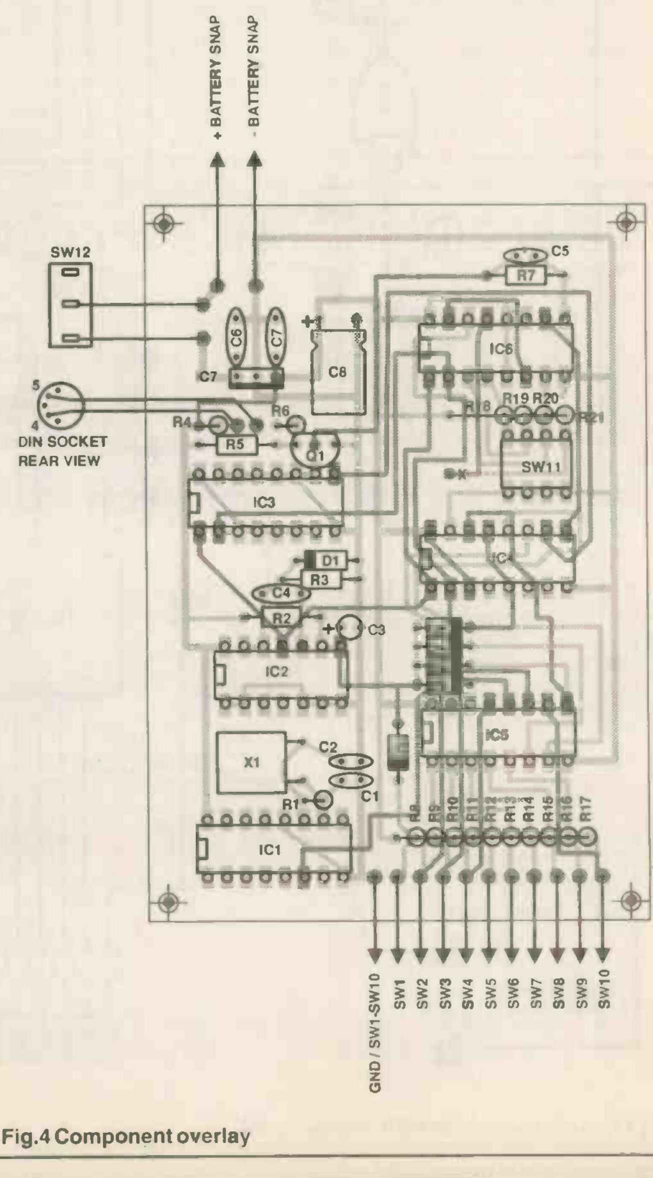


Fig.4 Component overlay

PROJECT

binary switch could be wired in, to provide quick access to any channel.

I decided not to include a design for the case, as I thought this would be a matter of personal preference, the layout of switches and their type being best chosen by the eventual user.

If the circuit is built on anything other than a PCB, then the use of a dual trace scope is likely to be needed if the unit doesn't work. Fig.3 shows the timing diagram for the unit and should provide an aid when debugging. As for testing, connect the unit to a 9V battery via an ammeter and the current drawn should not exceed about 5mA. If all is well, connect the unit into a MIDI device and hit a button. The result will confirm the unit as working (I hope!).

The unit draws around 1mA when on 'standby', so it will run quite happily off a 9V battery for some time!

D Sapwell

PARTS LIST

RESISTORS

All .25W Carbon or Metal Film

R1 3M9
R2,7,8-21 10K
R3 3K3
R4,6 220R
R5 2K2

CAPACITORS

C1,2 22pF Min Ceramic
C3 47uF Tant 35V Elect
C4 6n8 Polyester
C5 470pF Min Ceramic
C6,7 100nF Polyester
C8 220µF 10V Radial Elect

SEMICONDUCTORS

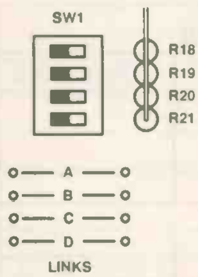
IC1 CD4060
IC2 CD4001
IC3,4,6 74HC165
IC5 74LS147
IC7 78L05
D1-D6 IN4148
TR1 2N3903

MISCELLANEOUS

SW1-SW10 Momentary Switch
SW11 4Way DIL switch or wire links
SW12 On/Off switch
X1 4MHz crystal
5 Pin DIN socket
PP3 Battery connector
17 Off 1mm Vero pins

BUYLINES

All the components are readily available from Maplin Electronics, PO Box 3, Rayleigh, Essex, SS6 8LR, apart from device 74LS147, which is stocked by Express Components, PO Box 517, Hove, East Sussex, BN3 5QZ. TEL 0273 206875



SW11 LINK	REQUIRED MIDI CHANNEL															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A		*		*		*		*		*		*		*		*
B			*	*			*	*			*	*			*	*
C					*	*	*	*					*	*	*	*
D									*	*	*	*	*	*	*	*

* — FIT LINK / TURN SWITCH ON

Fig.5 Link settings

Car Alarm

Protect your car from thieves and vandals with this infra-red alarm project

Pick up a newspaper, switch on the radio or TV, and the odds are that you will hear yet more stories about the horrendous increase in both car thefts and thefts from cars. Indeed, there must now be few people who have not either had a personal experience of such crime or know someone who has.

It seems that we in the UK are not alone in this respect, as according to ETI contributor Magnus Pihl, the same increase in car related crime is happening in his native Sweden. As he points out the only way to protect oneself and one's car from becoming another statistic is to install a car alarm, but cheap and reliable systems are hard to find, a fact that has prompted him to design his own system.

The following is the design for a car alarm which controls the central locking system, together with an infra red remote control key for turning the alarm off and on. This project is divided into two units, the alarm and the infra red transmitter. This month we take a look at the alarm circuit.

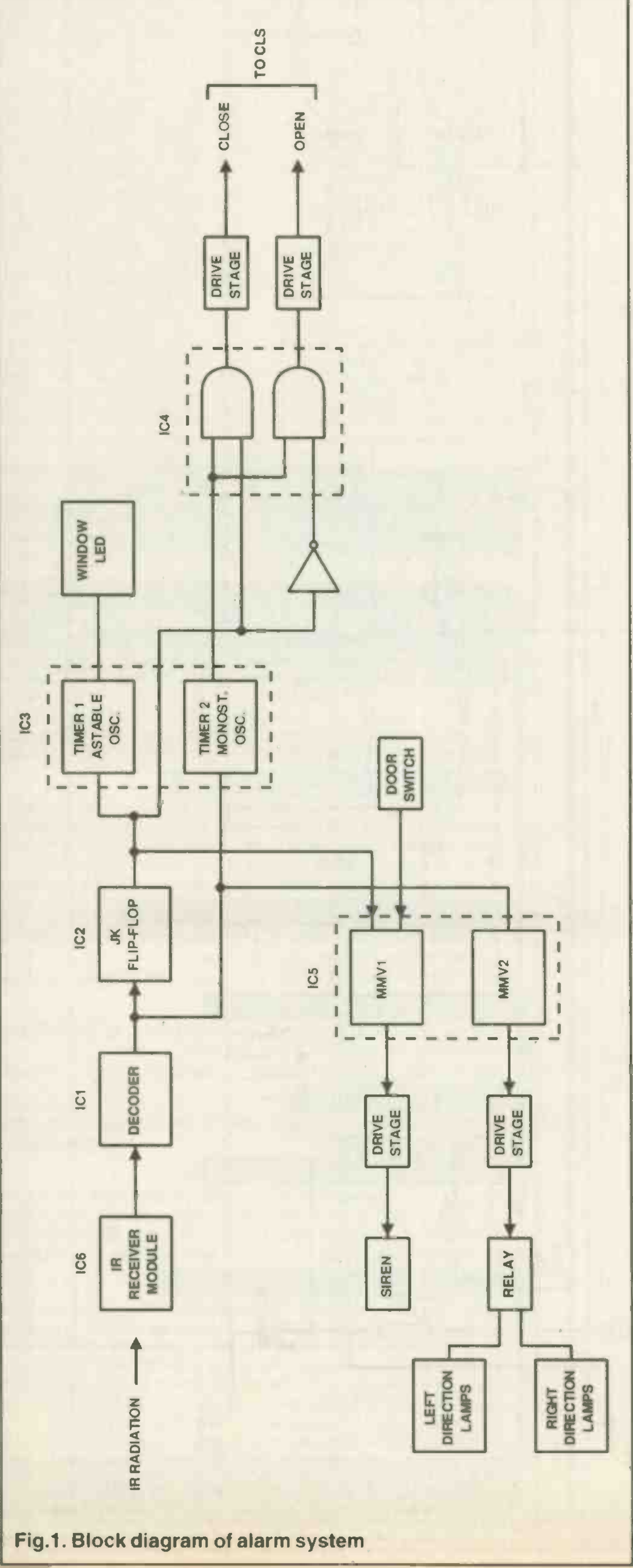


Fig.1. Block diagram of alarm system

How the alarm works

The block diagram in Fig.1 shows that the IR-radiation from the transmitter is picked up by the IR-receiver module IC6, an HC-NE01. The TTL-data output from this circuit is then inverted and fed to the decoder-circuit IC1. If the code input by the receiver is correct, then the JK-flip-flop is clocked by the pulse.

The clocking of the JK-flip-flop then triggers Timer 1 to start flashing the window-LED. Next Timer 2 is triggered by the output of IC1. The function of this Timer is to determine how long the Central Locking System, or CLS, runs. The function of the following AND gates is to separate the open and close signals. These signals then go through two drivers for the relays in your car's CLS. If your car does not have a CLS then you can make one with the aid of two relays, which will be explained later in this article.

The output from the decoder and the JK-flip-flop is also used as input to IC5. The MMV2 in IC5 decides how long the indicator lamps should stay lit. Because of the high current involved, these lights are driven by a relay. MMV1 is set running when a door is opened and the alarm is activated. It is coupled via a driver circuit to the car's horn.

Construction of the circuit

If we look at the actual circuit diagram in Fig.2, you can see that R1, R2 and Q1 are used as an inverter, thus the IR-receiver module HC-NE01 has inverted data at its output pin. In order to keep the cost down as well as controlling the size of the receiving PCB, the design uses a fully integrated component for receiving the code. Normally several OP-AMPs and additional circuitry needed, but the HC-NE01, remote control receiver will do the job even better, on top of which it is small and only costs about £3. It should be noted that this module is often used in TV's and VCR's and has a very wide and long distance receiving area. It is low-cost, extremely compact and fully TTL-compatible. It will only detect burstwaves at 37.9kHz. Wavelength 940 nm. Current dissipation is 3mA.

The twelve presettable inputs to the UM3750 decoder circuit will give a total of 4096 different combinations. This is a sufficient number of combinations to prevent any other

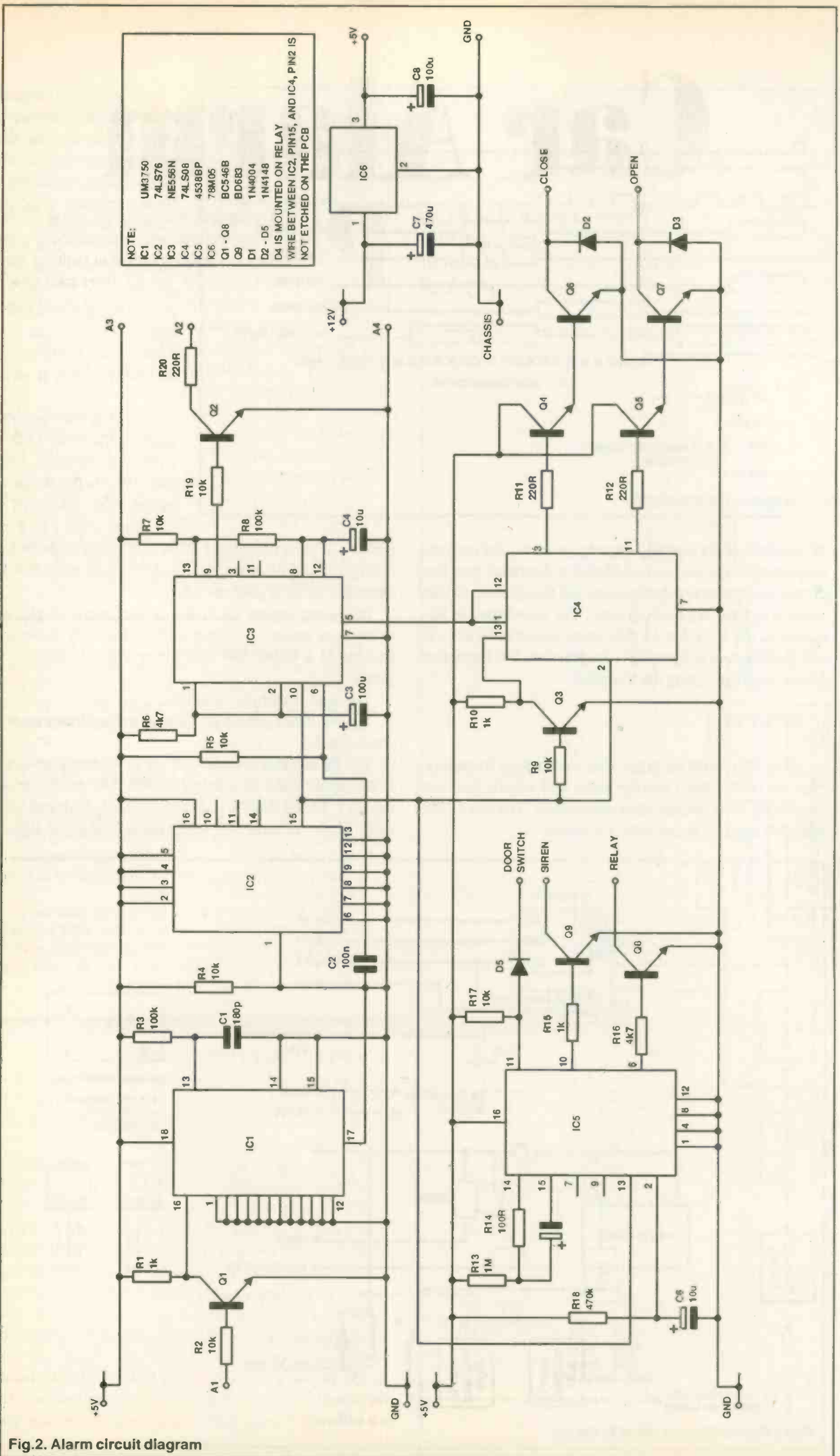


Fig.2. Alarm circuit diagram

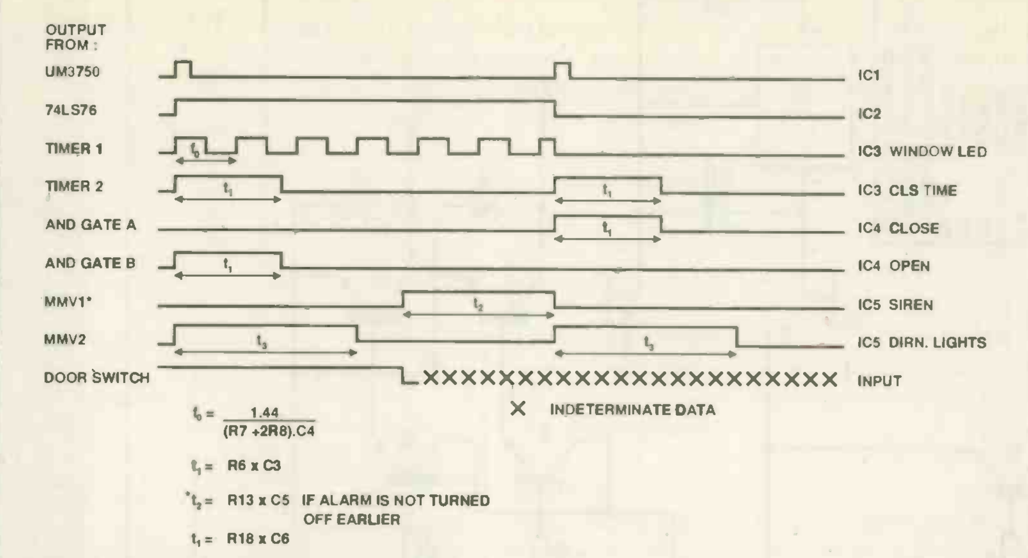


Fig.3. Waveform diagram of alarm circuit

To set pin 17 (transmitter accepted) high, the twelve correct digits must be sent four times, before it accepts the transmission code. When the transmission stops, pin 17 drops low again.

IC 2 (74LS76) is a JK-flip flop. When a pulse from the output of IC1 reaches pin 1, it changes from low to high and vice versa. The output on pin 15 indicates if the alarm system is on or off.

IC 3 (NE 556) uses this signal to flash the LED in your car's window. The other timer in this IC has its trigger input connected to the output of IC 1 by a capacitor C2 and a resistor R5. This is designed to generate a rapid pulse which activates the timer that pulls or pushes the electronic locks in your car's doors.

For motor driven CLS, this pulse length should not exceed one second. For pneumatic systems, 6 seconds is enough. In a Volvo 240 with motor CLS, 0.5 seconds is ample.

The time is set by t = R6 * C3.

The two AND gates in IC 4 are used to separate the open/close signals.

The On/Off signal from IC 2, pin 15 is connected to pin 2. The signal is also inverted by Q3, R9, R10, and connected to pin 13. The CLS-pulse is then connected to both gates next input. Now, we have two independent open/close signals,

IR transmitters accidentally opening your car. The external resistor and capacitor can be adjusted to determine how fast the twelve digit security code is sent and thus provide further security against unauthorised entry. The recommended frequency is 100 KHz, but the first prototype ran at 26 KHz. It will probably run at many other frequencies. The frequency can be calculated using the formulae:

f= 2/R3*C1.

Using this formulae to set your own unique frequency, plus the twelve digit security code, will secure your car completely from unauthorised transmitters. The use of 5% tolerance resistors is perfectly acceptable.

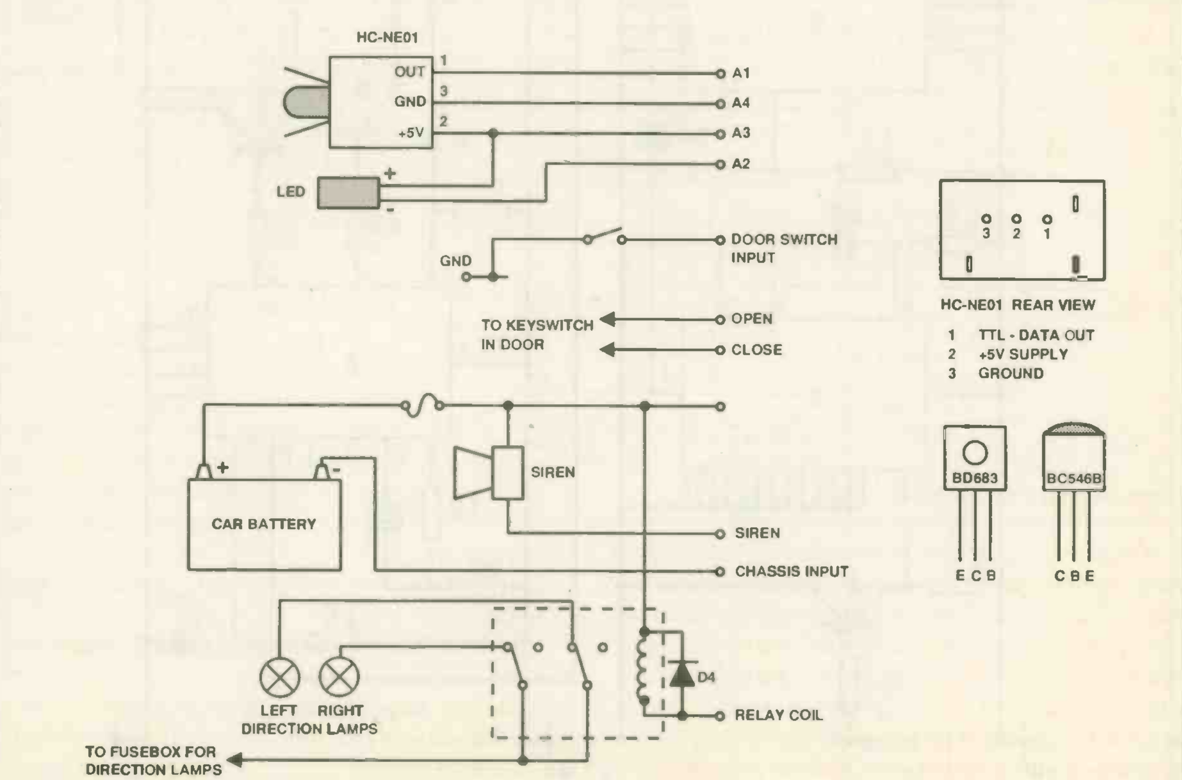


Fig.4. Connecting the alarm to the car

which are driving the Darlington stages Q4-Q7.

The rest of this circuit is the alarm system which comprises IC 5, a 4538B dual monostable mulbrivator. The length of time that power is supplied to the siren is determined by the formulae:

t= R13 * C5.

To confirm that the alarm system has receieved the transmission from the transmitter, all indicator lamps will be lit for a few seconds. The timer device is coupled at IC 5. Once again, the time is set by t= R18 and C6.

Q8 and Q9 are driver stages and don't need any further explanation. A closer look at Fig. 3 will help you understand the system better, when it is running.

Building the project.

After you have etched the PCB and cleaned it with acetone, the first task is to set the identity code. On the PCB, pins 1-12 on IC1 are connected to ground and in order to set your own code the appropriate tracks should be cut. You must of course set the same ID-code when you construct the transmitter. IC1 uses internal pull-up resistors. Calculate your own transmission rate for the UM 3750 and mount the resistor and capacitor.

As always, mount diodes, resistors, capacistors first, and finish with IC's, some resistors are mounted vertically. Solder all wires to a connector to make it easier to troubleshoot the PCB. At all times, study the "PCB-overlay".

Notice that D4 is mounted directly onto the relay's coil connections.

The relay is mounted close by the PCB-card. If you want to put the project in a case, this poses no problem, but is not absolutely necessary and costs money. A good place to put it is under the steering column near the fusebox. But on no account should you forget to isolate the PCB from the chassis, this is very important.

All that is left is to connect all wires and mount the final CLS- motor, see Fig.4.

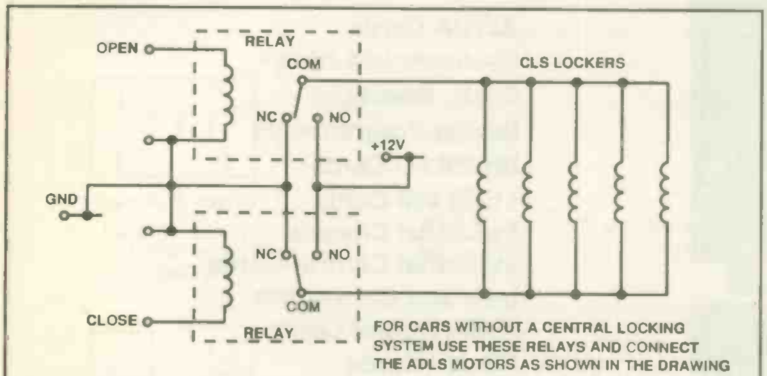


Fig.5. Central locking circuit

If the driver's door is not fitted with a CLS motor then in many cases you can fit one yourself. A local car-dealer that sells used parts should be able to supply one (for a Volvo 240 a complete working motor with axis cost about £14 in Sweden). It should be connected properly and the key-switch in the door used to open/close the doors removed. Connect the system in parallel to the passenger door. Notice that the driver's door will not be locked or unlocked until the door is closed.

For people who do not own a car with CLS, then one can easily join two relays as Fig. 5 shows. You must make sure that the relays can handle the current and that the motors dissipate. Note that the motor dissipates several times more current when connected to the door's lock.

Use an external fuse at 1A and connect it in the power lead.

The CLKS signals from the PCB are connected to the key switch in the door, that was removed earlier. Next, connect the door-input to the door switch in the driver door. Connect the left and right direction lamps to the relay and feed the common pins with 12V power. Do not use the same pin for left and right indicator lamp. If you do, they will always light/flash together!

Finally, connect the horn, power, ground and IR-detector leads to their appropriate connections. When, everything looks OK, turn on the power. Make sure that you can easily turn off the power if anything should go wrong. It is a good idea to sit in the car whilst testing it, otherwise, if you are unlucky, the system might well lock the doors permanently. This will mean that you will not be able to open the door, even with a key, until the power is turned off. A total disaster for both the CLS motors, the battery and yourself.

If the system works properly, cut out or copy the labels and attatch them on your windows. Enjoy it, and watch out for thieves!

Troubleshooting

If there is no response to the transmitter, use an oscilloscope to make sure the IR-diode is transmitting and the ID-code is being fed to the UM 3750 in receiver module. If these are OK, then check that both UM 3750s have the same code and that they are running with the same frequency.

If doors are open when they should be closed, swap open/close leads.

If the driver's door is open when the other is closed, swap leads on CLS motor in driver door.

If the fuse keeps blowing when activating the system, ensure that you only connect the power to the relay's coil by the fusebox in your car.

BUYLINES

The PCB consists of 5 integrated circuits. There shouldn't be any problem to find any of these, or equivalent circuits. In the UK try Maplin, Radiospares, etc. Otherwise, according to Magnus Pihl, the IR-module HC-NE01 and the security circuits UM 3750 can be bought at ELFA AB in Sweden (Stockholm). ELFA AB, 171 17 Solna, Sweden. Phone: +46 8 7353535. Order number for IR module is 75-220-06 and for UM3750 it is 73-691-43.

PARTS LIST

Alarm

Resistors

R1,R10,R15	1k
R2,R4,R5,R7	10k
R9,R17,R19	10k
R3	100k (see text)
R6,R16	4k7
R8	100k
R11,R12,R20	220
R13	1M
R14	100
R18	470k

Capacitors

C1	180pF (see text)
C2	100nF
C3	100µF/16V, axial
C4,C6	10µF/16V, radial
C5,C8	100µF/16V, radial
C7	470µF/25V, radial

Semiconductors

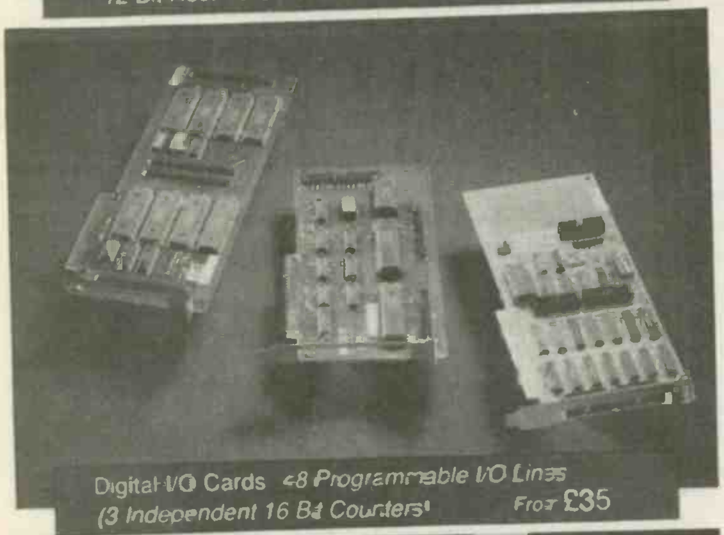
IC1	UM 3750
IC2	74 LS76
IC3	NE 556N
IC4	74 LS08
IC5	4538 BP
IC6	78M05
Q1-Q8	Bc546B
Q9	Bd683
D1	1N4004
D2-D5	1N4148
LED	5mm, red, rectangular.

Miscellaneous

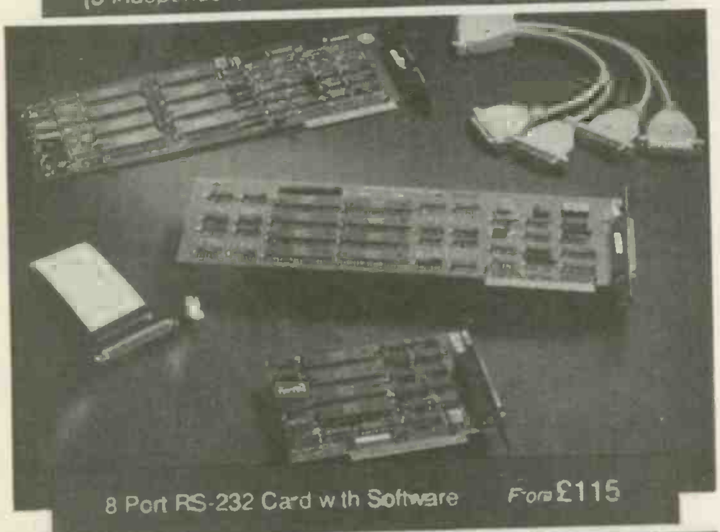
HC-NE01	IR-receiver module.
Relay	2-pole, 10A, 12V.
CLS motor	(see text).
FUSE, 1A	With fusecase.
SIREN	12V, 0.5A (120dB)

Suitable wire, connectors, case

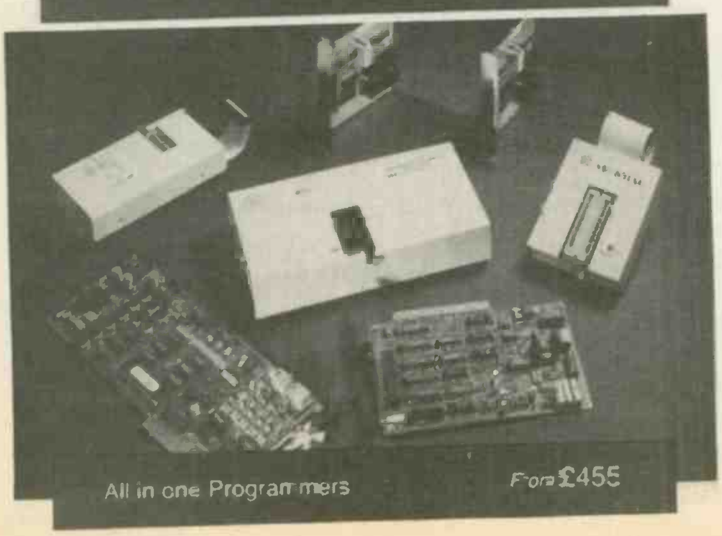
AD/DA Conversion Card
12 Bit Res. 16 Channels I/P
From £55



Digital I/O Cards 48 Programmable I/O Lines
(3 Independent 16 Bit Counters)
From £35



8 Port RS-232 Card with Software
From £115



All in one Programmers
From £455

Roline Systems Ltd

Voice Communications Card
Intelligent Telephone Card
From £175

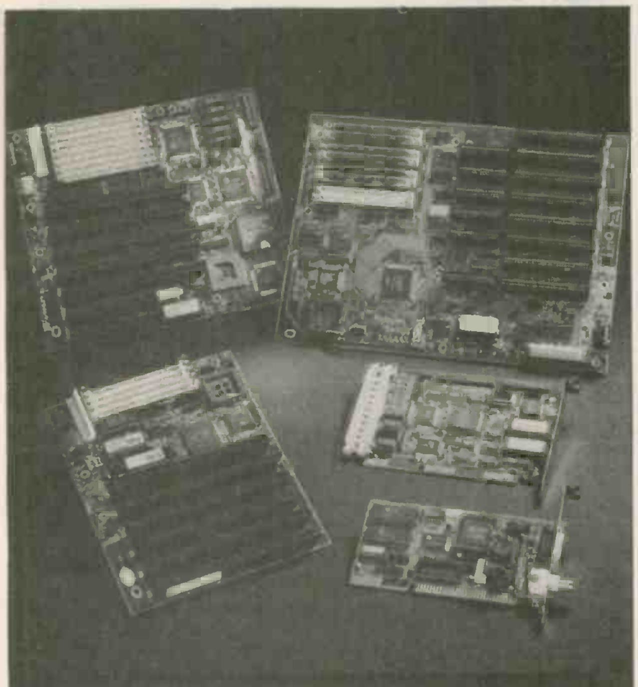
PC Based Industrial and Lab, Data Acquisition, Control and Measurement, Instrument Cards

AD/DA Cards
Plus Accessories & Software
C.P.U. Boards
Device Programmers
Digital I/O Cards
I EEE 488 Cards
Industrial Chassis
Industrial Control Cards
Interface Convertors
Relay Output Cards
RS 232 Cards
Single, 2, 4, 8, 16, Port
RS 422 Cards
Single, 2, 4, 8, Port
PC ROM Disk Cards
Slot Extender Cards

For further information,
Product/Price List
Call Us On :

Tel: 0902 20267

Roline Systems Ltd
Imex House
Imex Business Park
Upper Villiers Street
Wolverhampton
West Midlands
WV2 4NU



IDE Cache Controllers *From* £79

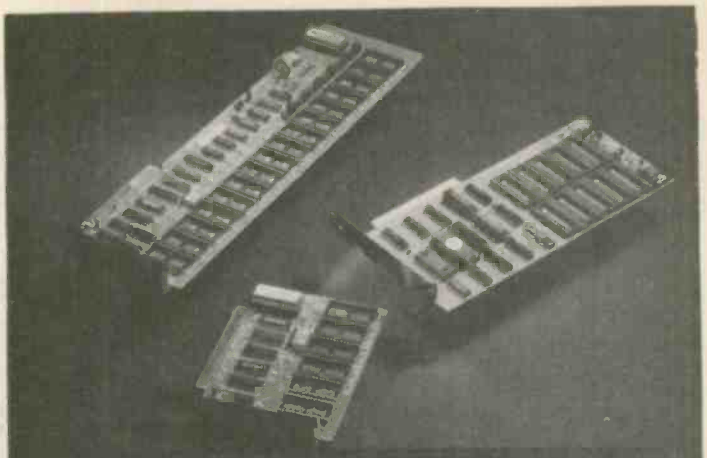
Specialist PC & Multimedia Add-on Cards

- PC - Telephone Voice Communication Cards
- Fax Modem Cards
- Voice Recognition Cards
- Voice Digitiser Cards
- TV/Video - PC Adaptor
- Video Grabber Cards
- Video/TV - PC - Video/TV Cards
- Sound Cards

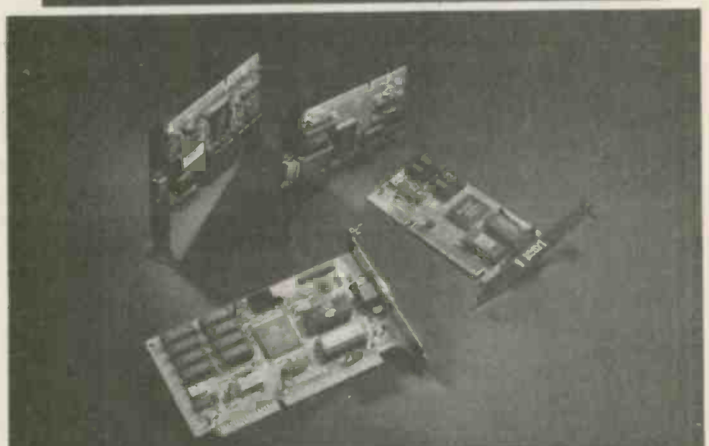
Components

- Cases
- Floppy Disk Drives
- Hard Disk Drives
- From 40MB to 2.1GB
- Keyboards
- Monitors
- Mother Boards
- Cache Controller Cards
- Network Cards
- Tape Back Up Units

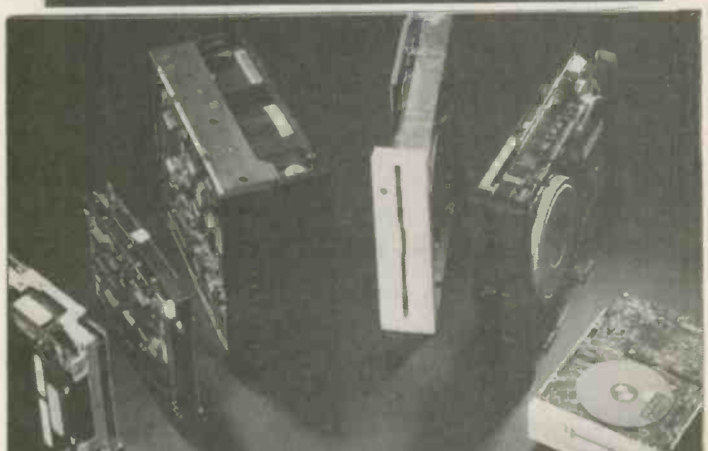
Fax: 0902 28439



PC ROM Disk Cards up to 1.2 Mb *From* £99



PC Video Master
Frame Grabber and VGA to TV Converter *From* £345



1.0 GB 3½ HDD *From* £785

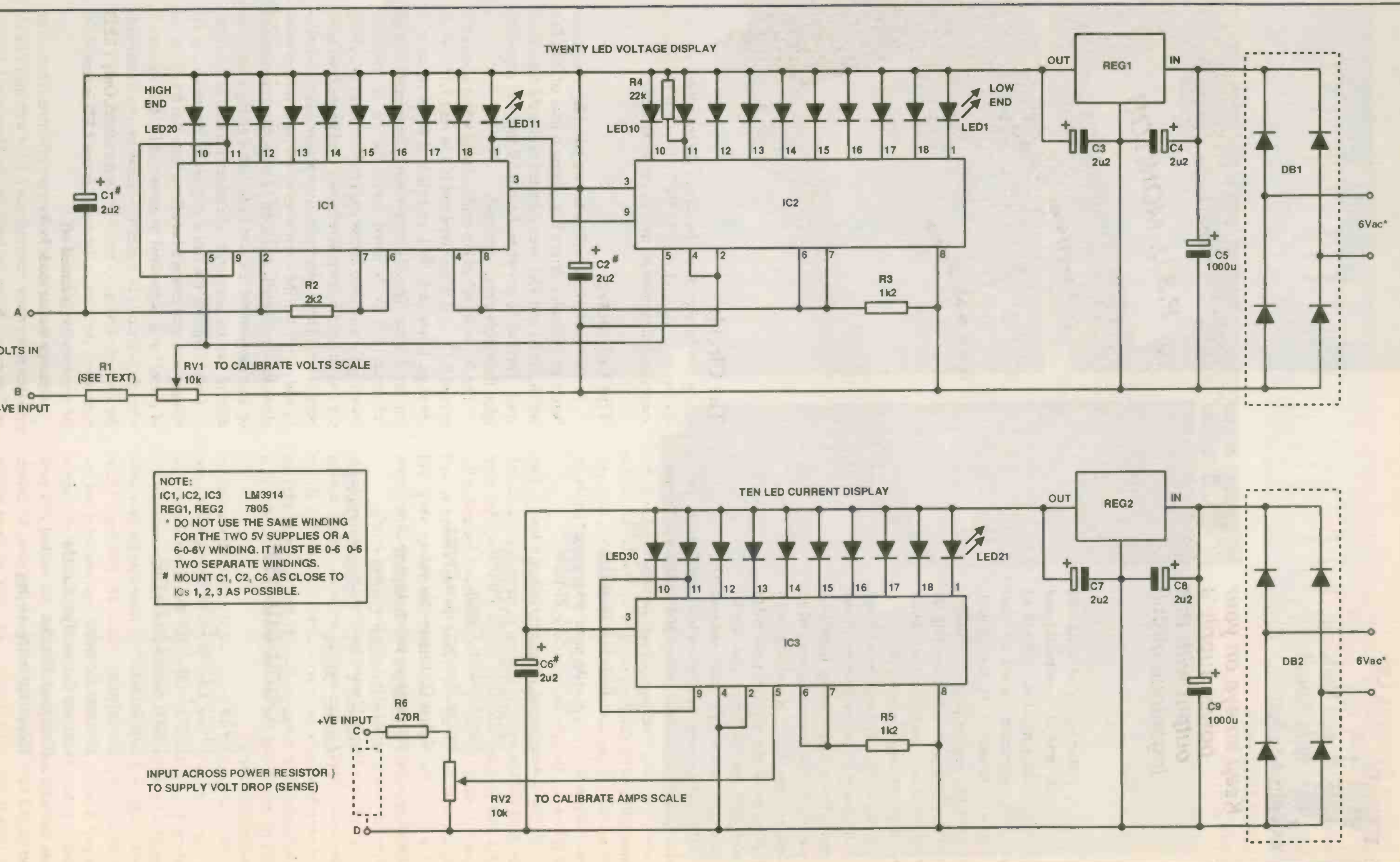
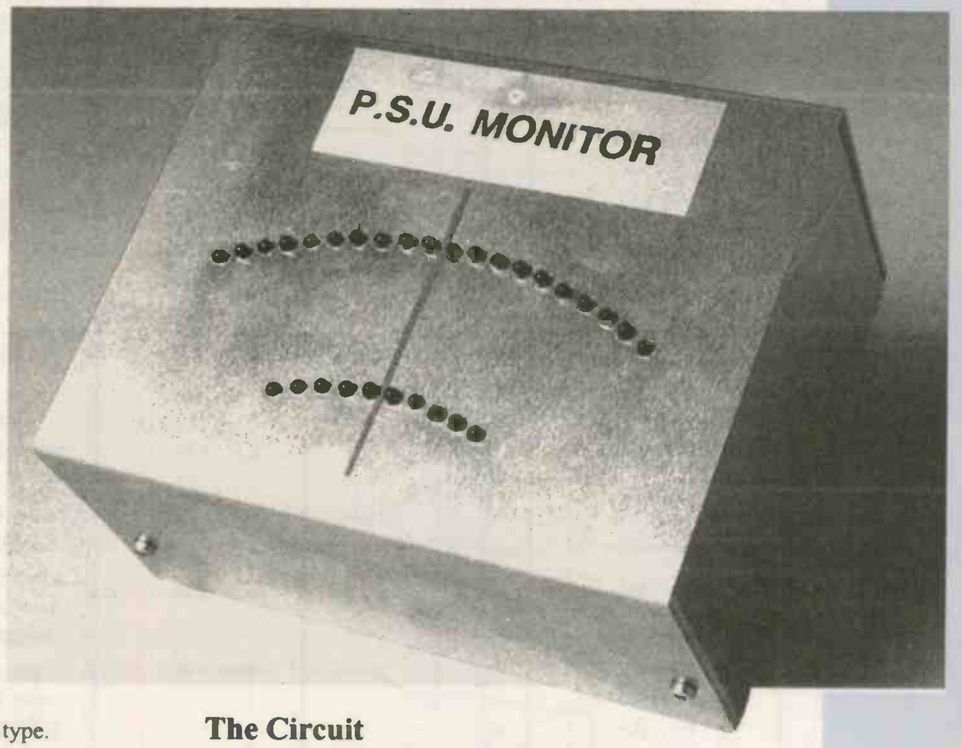


Fig.1. Circuit diagram for PSU monitor

A PSU Output Monitor

Keep an eye on your power supply's output with this ingenious circuit



A power supply of some sort, is, next to a voltmeter and soldering iron, a piece of equipment owned by most electronics hobbyists. In this project, one of ETI's regular project designers, Bob Noyes, describes an interesting little circuit which can be used to monitor the output of your power supply.

When working at the test bench, most small projects are powered by the 'power supply'. Power supplies range from laboratory types with several outputs and all kinds of trips, cut outs and four digit displays showing everything you want to know (and several things you don't), down to the home-built, crude, but useful type.

The middle range of supplies have moving coil meters which are useful, as both current and voltage can be monitored at the same time, but with age the accuracy diminishes drastically and the damage caused by overloads can result in the needle bending leading to false reading. Also, with age, the clear plastic covers over the meter get scratched and begin to yellow, as does the background scale plate.

If a circuit needs monitoring but no current is built in, then the good old test meter is inserted in series into the circuit. This will give an indication, but as a resistance has been inserted into the circuit an error is introduced: increasing the resistance of the circuit will reduce the total current as well as reducing the regulation, because the voltage drop will depend upon the current being drawn. Uneven current consumption will give the effect of a modulated supply.

This Power Supply Monitor has been designed to upgrade these more simple power supplies and even replace moving coil meters that have come to the end of their life. It will give a voltage reading using 20 LEDs in a barographic display, as well as monitoring the current using 10 LEDs, also in a barographic display.

So as not to upset the regulation, the current sense resistor is inserted in the 0V line, after the smoothing capacitor/s and before the regulation circuit inside the power supply, although a small current is drawn by the regulator circuitry it's not enough to cause a problem. This procedure has been tried in several old power supplies without any problems. These ranged from an all transistor type - age unknown but rumoured to have been used by Faraday - to a '723' with series pass transistor and the good old L200. All worked very well and ranged from 500mA flat out to one that gives 8A before the volts start to suffer. Fitting instructions are given later in the text.

The Circuit

As can be seen from the circuit diagram there are two distinct and independent parts, the voltmeter with its power supply and the ammeter, with its power supply.

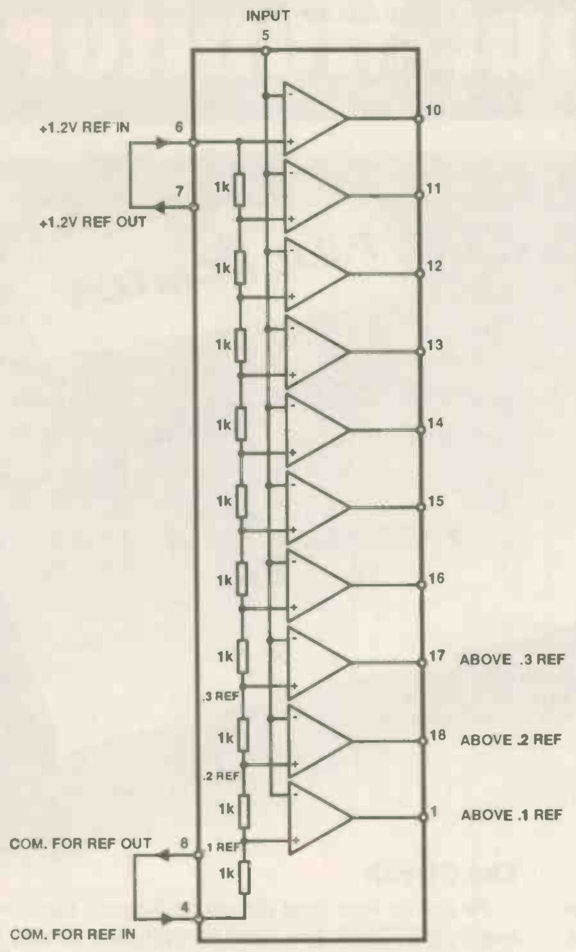
The Voltmeter

At the heart of the voltmeter are two LM 3914 linear barographic display driver ICs, giving a total of 20 LEDs which, via R1 and VR1, are calibrated to give the desired full scale. This can be anywhere from 0-5V to 0-6V, depending upon the supply being upgraded.

The 3914s are wired in a configuration which allows IC2 to read 0.12-1.2V in ten steps and IC1 to read 1.32-2.4V in ten steps. Inside each 3914 is a ladder of 10 1K resistors, as per the diagram (greatly simplified). The internal voltage reference of 1.2V is wired across the 10 1K resistors, meaning the volt drop across each resistor is 0.12V, giving the resolution. An external reference could have been used, but this would have added to the component count, complexity and cost. When the op amps sense the input voltage going above these potentially divided 0.12 steps, the corresponding op amp turns on the relevant LED, hence giving a bar mode display. Internal circuitry can be selected for bar or dot mode.

Once triggered, the LEDs stay on in 'bar mode', as the voltage increases giving a bar effect. Note that R4 seems out of place, but it is required to ensure LED 10 is turned off when the second 3914 comes into operation - this is to do with the internal workings of the 3914 (in dot mode). Only 1 LED is on at any one time in dot mode, as one LED is turned on, the previous one is turned off.

Although the bar mode looks more effective, it consumes up to ten times more current in each 3914 with all 10 LEDs on. This means the supply has to be capable of supplying this current and the 3914 can get hot, coming close to its maxi-



A SIMPLIFIED DIAGRAM OF THE RESISTOR POTENTIAL DIVIDER AND COMPARATORS TO GIVE THE 10 LINEAR OUTPUTS. THE 3915/3916 HAVE RESISTORS OF DIFFERENT VALUES TO MAKE OUTPUT LOG OR SEMI-LOG.

Fig.2. Resistor potential divider

mum power dissipation - not to be recommended in an important meter such as a voltmeter. The value of R1 is chosen to give the ideal setting of VR1 somewhere in the middle. All the rest of the volt drop should appear across R1, so for

10 volts full scale 1/2 volt per LED R1 = 10K
20 volts full scale 1 volt per LED R1 = 27K
30 volts full scale 1.5 volts per LED R1 = 47K

and so on. The selected value is fitted into R1's position on the PCB.

For the best and most accurate results, the voltage is monitored as near to the output terminals as possible, but if a switch is included in the output circuit, the unswitched side should be monitored. This means that the supply can be turned on at the mains with the output switched off and the output can be adjusted to the correct voltage before power is applied to the outside world via the output switch (see diagram). This is extremely useful when using TTL or other circuitry that can be overloaded, or possibly give an error if the supply is too low.

The ac supply to the monitor is brought into the terminals from its own transformer, which is important because using existing taps already connected in the supply could cause great damage to the existing supply as well as the monitor.

The Ammeter

The ammeter can monitor very low to very high currents because the main current flow is not through the monitor PCB but through a bypass sense resistor, mounted elsewhere in the power supply.

The requirements of the monitor are that at least 1.2V are dropped across this sense resistor at full scale, i.e. maximum current. The monitor, although called an ammeter, is in fact a volt meter measuring voltage dropped across the sense resistor. The relationship between voltage drop and the current developing it, is given by the good old ohms law, when

V = I x RV = volts dropped
I = current in amps
R = sense resistor in ohms

In a perfect world, where the reference built in to the 3914 is exactly 1.200000V, the sense resistor is made with the same accuracy and all the leads and wires have no resistance at all, there wouldn't be any need for a calibration pot, VR2, to set the calibration. Unfortunately, this is not the case and errors can creep in everywhere. So, instead of developing exactly 1.2V across the sense resistor we actually try to develop in the order of 1.5V, which means that this voltage is too high for a direct reading. By using R6 VR2, this over-voltage can be potentially divided down to the correct level required to give full scale. The reference built in is very stable, it doesn't vary much in value with time or temperature, but this exact reference does vary between ICs.

The size of the current being monitored dictates not only the value of the sense resistor but its size due to dissipation. As the chart shows, at the lower end of the scale - say 500mA -this resistor should have a rating of at least 1W up to 25W for monitoring 10A. The dissipation power of the resistor is given by

W = I x V   W = watts
I = current in amps
V = volts across resistor

I is the maximum value likely to be achieved, i.e. the power supply's maximum. The resistor size shown is one that allows this dissipation with a good safety margin, i.e. 10A through 0.15n drops 1.5V - good old ohms law again.

Actual dissipation is W = I x V, W = 10 x 1.5, therefore 15W dissipated, only at full power. The resistor recommended is a 25W device and so runs well within its specification. The dissipation will be much less at lower currents, i.e. at 2A only 0.3V are developed across it, so a dissipation of only 0.6W occurs.

The 1W 3n resistor could be mounted on the original power supply PCB if room can be found, but it is recommended that any one of the others is mounted off the board and on insulated pillars - care being taken to find a place that has good internal air flow to keep this resistor as cool as possible. If the 25W one is required then a good heatsink is needed. In such a supply, a large heatsink should already be available to keep the output devices cool. This could then be used by bolting the 25W resistor to it. When soldering to high power resistors a good mechanical joint should be used as well as good soldered one, i.e. the leads are wrapped around the terminals on an insulated pillar in the middle order resistors -7, 10W - and the wires pushed through the hole and twisted around the terminal of the 25W ones. This means that if the solder was to get a little soft, due to heat, the wires will not fall off because no strain is put on the joint. These high current carrying wires should be as short as possible and the wire used should be large enough to withstand the expected current range.

used for the voltage monitor and the current monitor are slightly larger than may have been expected for a 5V supply requiring only a few milliamps. The reason is to supply a good clean 9V into the regulators enabling them to operate at this low voltage without any detectable ripple. This means that the 5V regulators can operate without heatsinks as they only dissipate a few milliwatts. The regulator tabs should not be allowed to touch anything because although the voltage monitor one is at supply 0V, the current one is effectively connected to the other side of the sense resistor from 0V, making it slightly negative in respect to the power supply, 0V.

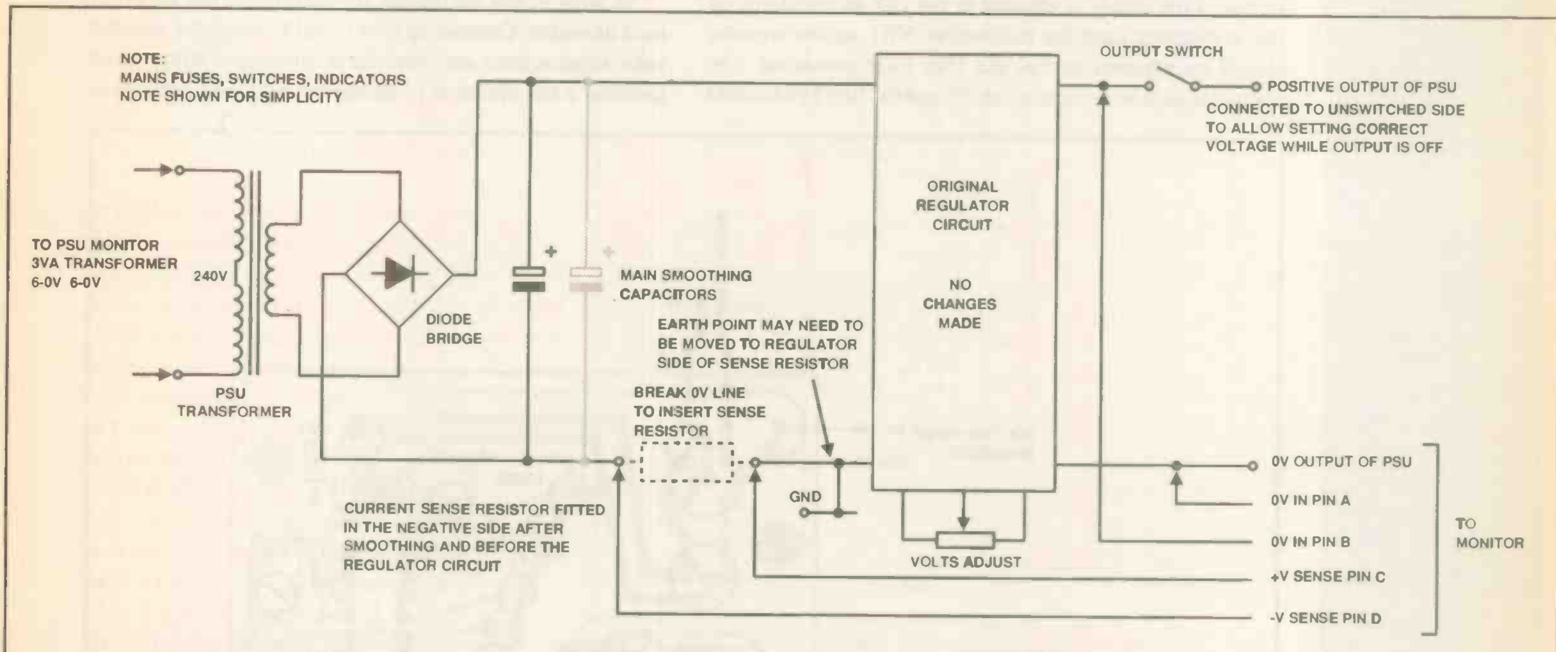


Fig.3. Adding monitor to PSU

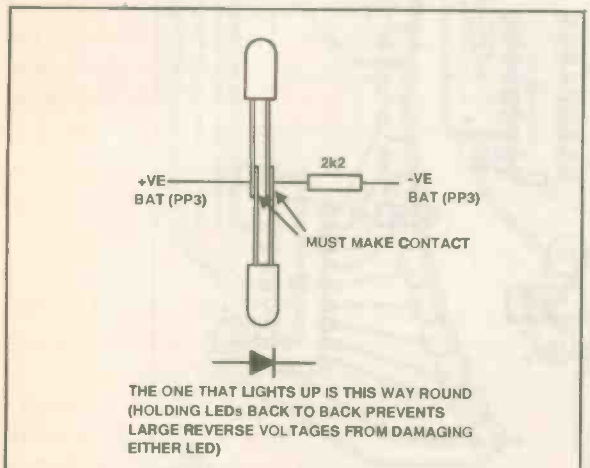


Fig.4. Testing LED polarity

As with the voltmeter monitor, a completely separate 6V winding is needed to power the circuit. Although it comes from the same transformer as the voltmeter supply, it must be electrically isolated from it and any other part of the original power supply circuit. When fitted, this transformer can be wired in parallel across the main transformer mains connections.

It may have been noticed that the smoothing capacitors

Connecting The Monitor To A Power Supply

Because no actual power supply is featured, these instructions are general rather than specific.

Firstly, the monitor should be up and running as a separate unit in its own right before it's permanently connected into its host power supply. When running, i.e. with the two 6V ac supplies connected and with no input going to the voltage or current terminals A, B, C and D, all the LEDs should be off. If any are on, these should be investigated and corrected before continuing.

Terminals A and B of the voltage monitor connections can then be made, making sure B is connected to the positive of the supply using longer leads than will be required when permanently mounting the monitor. This will enable easy access to the monitor for calibration and testing. units are switched on and a multimeter used to determine the exact voltage coming out of the power supply. This should be adjusted to around 80-90% of full output of the power supply, never used 100%, i.e. the 20th LED as this comes on and stays on even when the voltage exceeds the true setting - a bit like a moving coil meter will show full scale deflection when the needle hits the end stop and even if the voltage is increased the needle stays in the same position. So for greatest accuracy the higher end of the scale is used, but not its extremity. Any error is divided between as many LEDs as possible. If the calibration was set at say 20% of the scale, any

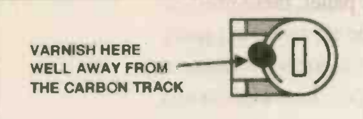


Fig.5. Calibration potentiometer

error would be multiplied up to 5 times at the full scale end.

The resolution of the LEDs should be known depending upon the highest voltage out, i.e. if the highest voltage out is 10V, then the resolution can be one LED per 1/2V, i.e. each increasing LED indicates the voltage increasing by 1/2V. If the highest voltage is 20V then a resolution of 1 LED per volt is selected. 30V means 1.5V per LED and so on.

For the purposes of this article and for simplicity, a full scale of 20V is presumed. This means 1 LED per volt, so the output of the supply is adjusted to say 18V as monitored on the multimeter used for calibration. VR1 on the monitor should be adjusted so that the 18th LED comes on. The voltage should be reduced to say 5V and the fifth LED should come on - all the LEDs in between have come on and gone off (at this point the current monitor remains blank because it has yet to be connected). A slight tweak may be required to RV1 so as to improve the precise point at which the LEDs come on, comparing this to the meter. Once this has been completed, a small dab of nail varnish may be used to stop the vibration (sometimes experienced, especially with higher current supplies) from causing the pre-set to re-adjust itself with use. Only a small dot of nail varnish is required and it should not get onto the track of the pot as this could affect its resistance as well as preventing further adjustment and hence calibration (see diagram).

In order to test the current monitor, the power supply is used unmoded. Connect up pins C and D across the selected value sense resistor and place the multimeter in series. As an ammeter a test circuit is produced by using odd resistors to

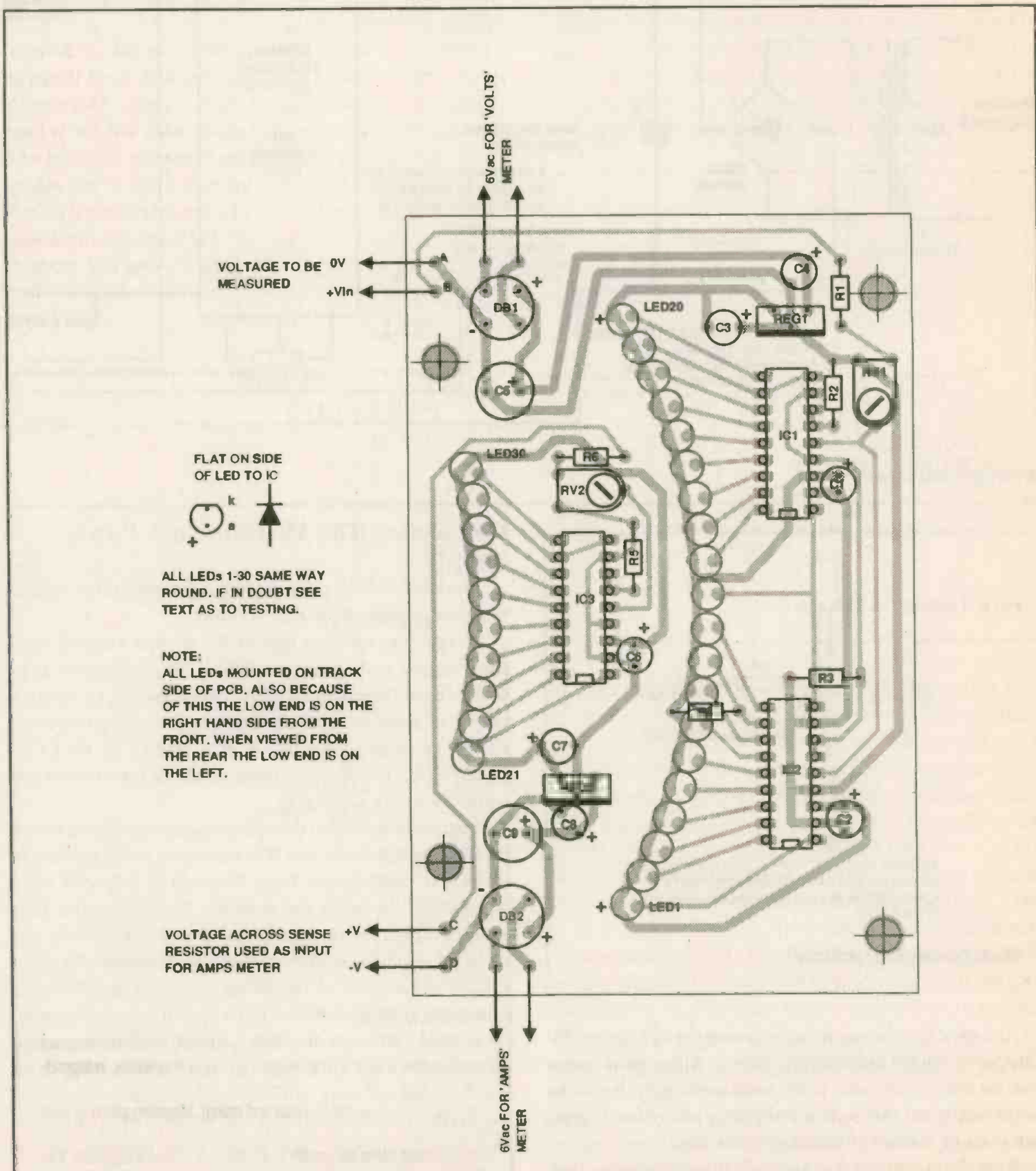


Fig.7. Component overlay

hand, the voltage is adjusted to give around 80-90% of the rated current output. RV2 is adjusted to give a corresponding reading to that on the multimeter.

Although there is a volt drop across the sense resistor and the multimeter, the accuracy is unaffected as the series current is the same all round the circuit, i.e. the current through the sense resistor is the same as the current through the multimeter, giving the reading used for calibration. For the sake of this article I assume a maximum of 1A. The chosen sense resistor is 1.5n (from the chart), at least 2.5W.

AMPS RANGE	SENSE RESISTOR	COMMENTS	WATTAGE
0 - 500mA	3R	CAN BE MOUNTED ON PCB	1 WATT
0 - 1 AMP	1R5	MAY BE MOUNTED ON PCB	2.5 WATT
0 - 2 AMP	0R82	MOUNT ON PILLARS	7 WATT
0 - 5 AMP	0R33	MOUNT ON PILLARS	10 WATT
0 - 10 AMP	0R15	MOUNT ON HEATSINK	25 WATT

Table.1. Sense resistor values

The connections are made across the resistor and connected to C and D, with C the most positive (see diagram). A high power resistor of 4.7n has been found (any value from 2.2n to 15n) to work, but the higher the value, the higher the power it will be expected to handle (15n at amp develops 15W).

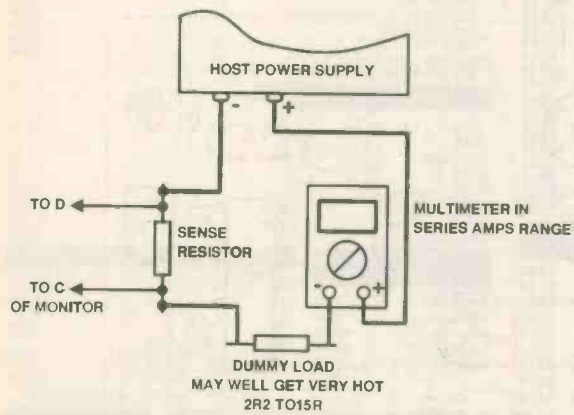


Fig.6. Testing the PSU monitor

A series circuit is produced as per the diagram and the multimeter set to a range to show 1A. The voltage from the power supply is increased until the multimeter shows 800mA. VR2 is adjusted so that the 8th LED comes on. As the voltage, which should be around 6V, is reduced the multimeter's current should reduce with a corresponding reduction on the LEDs, because at 1A full scale, each LED indicates 100mA - again, a final little tweak may be necessary. A further up and down the scale comparison is carried out, checking the monitor against the multimeter.

If everything is OK and all the LEDs illuminate correctly, VR2 can be set with a dab of nail varnish. While doing these tests, great care must be taken because high temperatures may be experienced in the load resistor (in this case 4.7n) especially with the higher currents. Once the calibration has been carried out, the sense resistor can be mounted inside the power supply and the mains transformer also mounted. Great care must be taken with mains connections!

It may be possible to drill out the front panel but more than likely a new front panel will be required. This will mean repositioning controls and output terminals. Care must be taken that as well as room on the front panel, there must be enough room inside so that none of the repositioned items foul the insides of the power supply and no mains connections are left exposed, i.e. on the back of the mains switch (they should all be sleeved).

Because mains is involved, the new front panel must be earthed, although the output of the supply need not be. This earthing should be done using a non-load bearing bolt and a solder tag and wired straight back to the mains lead earth using a correctly coloured wire - green and yellow , of sufficient size.

In extreme conditions, a new box may be required to fit everything in - again care should be taken mounting heavy items like transformers, to make sure they are secure and safe and that no wires are trapped. Also ensure that all removable panels are well earthed. A template is shown to indicate where to drill the 34 holes required on the front panel, 30 for LEDs and 4 for mounting.

The colour of the LEDs is not important so different colours can be used, i.e. the upper current 8, 9 and 10 can be red with 5, 6, 7 orange and 1, 2, 3, 4 green. This gives a pleasing effect. The same idea can be used with the voltage but can only be done if the front panel is drilled with individual holes, one for each LED. If one oblong hole is cut and a piece of coloured polarised filter is used, only one colour of LED is suitable, the colour of the polarising filter. When using this mode of display, oblong LEDs can be used for greatest effect, but check they all fit first.

Bob Noyes

PARTS LIST

RESISTORS

R1	see text
R2	2K2
R3	1K2
R4	22K
R5	1K2
R6	470n

CAPACITORS

C1,C2,C3,C4	2µ2 16V
C5	1000µF 16V
C6,C7,C8	2µ2
C9	1000µF

SEMICONDUCTORS

VR1	10Kn Sub Min Horizontal
VR2	10Kn Sub Min Horizontal
REG	1 7805
REG	2 7805
DB 1	WOO5
DB 2	WOO5
IC1	LM3914
IC2	LM3914
IC3	LM3914

MISCELLANEOUS

30 3mm LEDs (colours not important, see text) which are mounted on back side of board. Transformer, 0.6 06 3VA upwards, independent windings.

Sense resistor (see text for value and rating). Mounting pillars or heat sink.

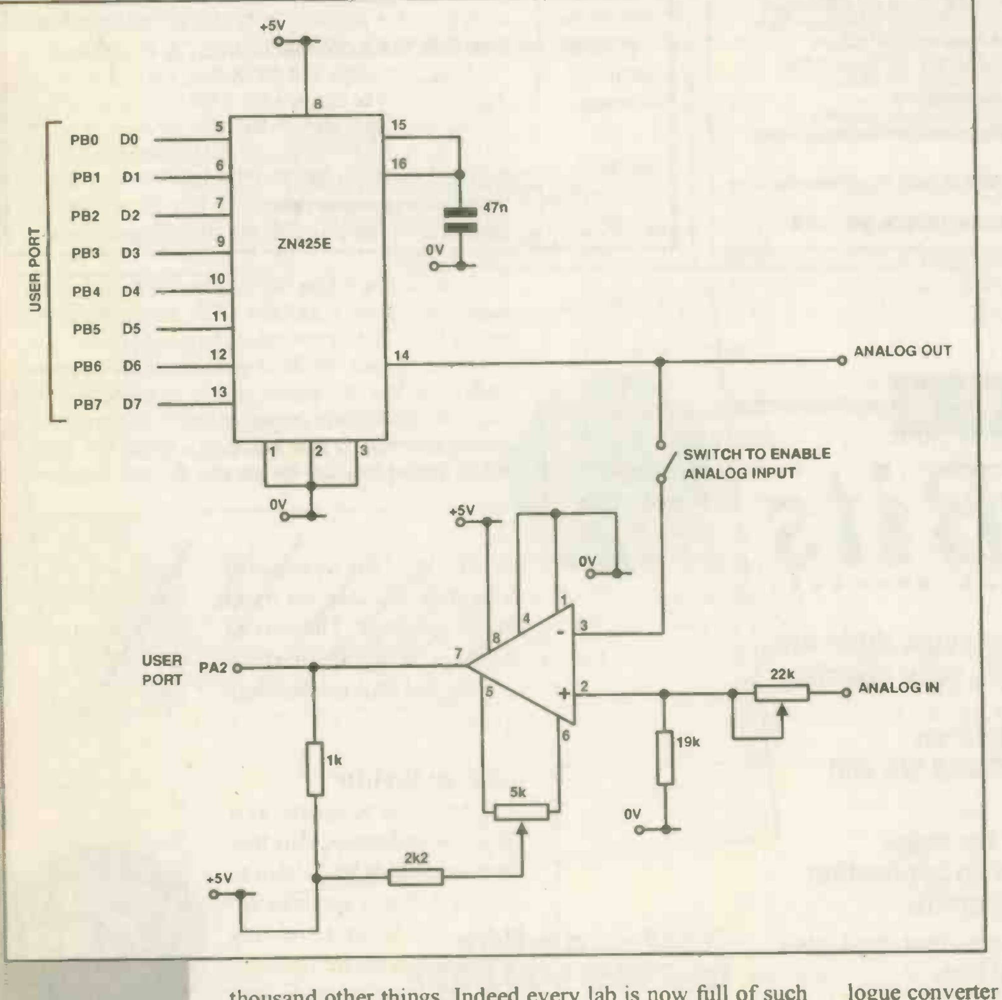
Most of these items are readily available from a host of suppliers. The high value 25W resistors can be obtained from Electrobase/RS.

Experimentally Speaking...

Sensors and data logging

The design of an experiment to investigate a specific phenomena and the collection of suitable data from that experiment lies at the heart of scientific research methodology. Devising the experiment is often an enormous challenge and working out the results can be very satisfying, but the actual process of taking all the measurements can be very repetitive and tedious.

It is hardly surprising, therefore, that scientists have always jumped at techniques which enable them to automate some of the measurement and data collection work. Such techniques have been made much easier with the advent of electronic circuitry to perform many of the most common measurements. Electronic circuits can now be built which measure temperature, pressure, humidity, light intensity, acidity/alkalinity, mechanical stress, gas composition and a thousand other things. Indeed every lab is now full of such electronic measuring equipment.



With electronic measuring circuitry, it becomes possible to build systems which will record sequences of measurements, thereby saving the experimenter the tedium of standing over his experiment for hours, taking measurements every five minutes. Such recording systems are known as data loggers.

However, for the amateur experimenter and for schools science departments, the use of a commercial data logger is out of the question, as they are far too expensive. But there is a cheap and easy solution to this problem, a solution which involves the use of a cheap computer, making it possible to continuously record, for several hours without human attendance, one or more experimental parameters which can be measured by simple analogue sensors.

A digital data logger.

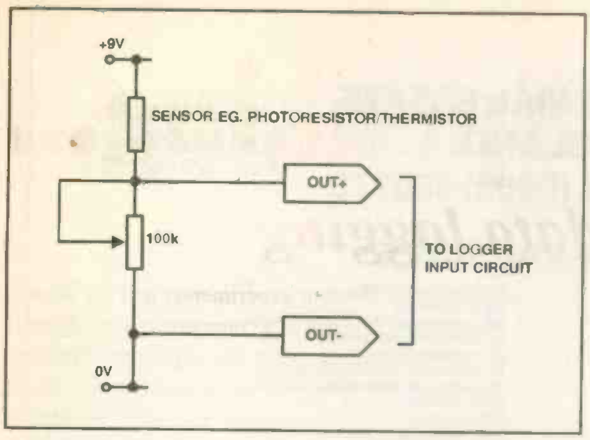
The function of a data logger is to log, or record, information, but by its very nature a computer works using binary logic. A pulse is either 'on' at logic high, or 'off' at logic low. This is fine if all you want to do is measure and record the state of a set of switches, but most sensors used to measure scientific experiments are not on/off. They produce a variable output voltage, they are analogue devices rather than digital devices.

So if we want to use a computer to record analogue information coming from sensor circuits we need to be able to convert analogue information, the variable output voltage, into digital information. We can do this with the aid of an analogue to digital converter circuit. This can be connected to the parallel user port of a cheap personal computer, such as the Commodore 64. This circuitry plus a bit of software to control it and input the digitised data, constitutes our simple data logger.

The analogue to digital converter circuit is very simple and cheap to build. It consists of a low cost digital to analogue converter IC and a voltage comparator, the circuit is shown in Fig.1. The comparator has two inputs, one, the voltage to be measured, the other a variable reference voltage derived from the digital to analogue converter. Only when the two voltages match will the comparator generate an output. In this circuit, the computer's parallel I/O port provides the eight data output lines which go into the digital to analogue converter and the single input line input from the comparator.

In operation, the computer ramps up the output voltage from the digital to analogue converter from zero volts until the required voltage is reached. The computer just goes through a simple loop which increments the voltage from the D/A, then tests to see if there is an input from the comparator. If there is not it goes back through the loop. If there is an input from the comparator then the value output to the D/A is taken as the input voltage and stored in a suitable database.

Since there are eight output lines going into the D/A, there



could be 28, or 256, steps before a matching voltage is indicated by the comparator. This means that such measurements can be a rather slow process. Much faster is a successive approximation technique, which requires just eight loops instead of up to 256.

A successive approximation technique starts by setting the most significant bit, bit 8, to logic 1 and all the other bits to logic 0. The program then tests to see if the resulting voltage is greater or less than the voltage being measured. If it is larger, then bit 8 is left set, if smaller then it is cleared. The same process is repeated with bit 7 set to logic 1, leaving bit 8 set to the value defined in the previous loop and all the other bits set to logic 0. Depending on the result bit seven is left set or cleared. This same process is then repeated for bits 6, 5, 4, 3, 2, 1 and 0 in turn. The result, a voltage measurement in just eight program loops.

By using a successive approximation technique and sufficiently high sampling rates. It is possible to use the combination of computer and analogue to digital converter as a low frequency storage oscilloscope, something which can be used to record and analyse the human voice, vibrations, or even bird song.

We can also trade off sampling rate for sampling several channels of analogue information coming from different sensors. We can do this on low voltage systems with the aid of an analogue switch IC which can be controlled by more output lines from the I/O port. In this way, one can easily measure and record data from eight different sensors without any great loss in maximum sampling rate on any one of them.

Using the simple data logger.

What has been described so far in this article is a very simple data logging technique and one which lends itself to being used with some equally simple measurement circuits. By far the simplest measurement circuits are those based around a sensor which exhibits variable resistance. This could be a photoresistor for measuring changes in light intensity, or a thermistor for measuring changes in temperature. The circuitry for both of these is just a simple voltage divider chain, and an example is shown in Fig.2.

More complex are those sensors which involve a change in output current, sensors such as the photodiode. The best way to convert such a current change into a voltage change is to use an operational amplifier. A technique which has the added advantage in that it allows one to adjust the amplifier gain in order to improve or reduce the sensitivity of the sensor. A typical circuit for use with a photodiode is shown in Fig.3.

The calibration of a particular sensor is always a problem. If the sensor has a linear response then the two ends of the graph can be determined experimentally.

If the response is not linear, then the computer can be used to convert the input value into a measurement value. Indeed, so long as one can adjust the sensor's output voltage range so that it equals the input voltage range of the analogue to digital converter it is possible to use the computer to perform the calibration. In a linear response system all that one needs to do is multiply all input values by a constant.

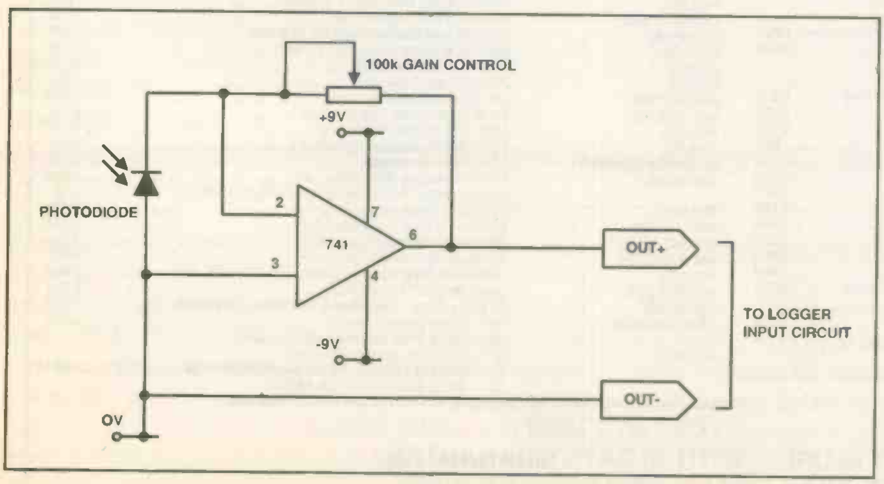
Besides measuring the output of a sensor, the other main requirement in logging data from an experiment is to keep an accurate track of time. This can be done in one of two ways. The first is not that accurate and involves using delay loops within the controlling program. The second method is to us a real time clock, such as the one which is built into every PC. Wherever possible the real time clock should be used.

Electronics in schools science projects

This is the first of a new and regular series of articles which will feature ideas drawn from schools science projects, projects that involve to some degree the use of specialist electronic circuitry. This article is an example of the kind of material we will be publishing and we are looking for the participation of schools and students in creating this series.

To help encourage such participation, and as a reward for ingenuity, we will be offering a fee of £50 to those students, or schools, whose ideas are published in this series. So as well as getting your names in print, you will also get some money to put towards further experiments. In a later issue of ETI we will also be announcing an annual award for the best 'Young Electronics Engineer' of the year and contributors to this series will automatically be entered.

Anyone wishing to have their ideas published in this section should first of all write to the Editor of ETI. Students should also enclose a letter from their teacher or tutor verifying the proposed contents of the piece. We do not want ideas which have been simply copied from other sources, what we are looking for in this column are original ideas designed to help in the running of a scientific experiment, or as an experiment in its own right. So on with the thinking caps, and lets see what you have developed.



In conclusion

This use of a computer as a simple digital/analog data logger is one which lends itself to a lot of different applications. In this article we have only looked at sensors for light and temperature which can be easily attached to this type of data logger but, with a bit of ingenuity, it is possible to build a wide range of different sensors thereby enabling one to log the results from a great many different experiments.

TELNET

8 CAVANS WAY, BINLEY INDUSTRIAL ESTATE, COVENTRY CV3 2SF, ENGLAND. TELEPHONE (0203) 650702. FAX (0203) 650773

KEITH MORRIS
Tel: 0203 650702
Fax: 0203 650773

LIST OF TEST EQUIPMENT AVAILABLE

OSCILLOSCOPES		
GOULD	054200 – Digital Storage	£250
HEWLETT PACKARD	182C-100 MHz 4 Channel	£300
HEWLETT PACKARD	1740A-100 MHz Dual Channel	£350
HEWLETT PACKARD	1741A-100 MHz Dual Channel with Analogue Storage	£350
HEWLETT PACKARD	1744A-100 MHz Dual Channel with Analogue Storage	£350
PHILIPS	3211 – 15 MHz Dual Channel	from £150
PHILIPS	3217 – 50 MHz Dual Channel	from £250
PHILIPS	3226 – 15 MHz Dual Channel	from £150
PHILIPS	3240 – 50 MHz Dual Channel	from £250
PHILIPS	3261 – 120 MHz Dual Channel	from £325
TEKTRONIX	453 – 100 MHz Dual Channel	£250
TEKTRONIX	515A	£150
TEKTRONIX	2445 - 150 MHz 4 Channel	from £1250
TEKTRONIX	7313 - 100 MHz 4 Channel with Analogue Storage	from £350
TEKTRONIX	7403N - 60 MHz 4 Channel	from £300
TEKTRONIX	7603 - 100 MHz 4 Channel	from £350
TEKTRONIX	7623 - 100 MHz 4 Channel	from £500
TEKTRONIX	7904 - 500 MHz 4 Channel	from £750
TELEQUIPMENT	D75 - 50 MHz Dual Channel	£225
TEKTRONIX	465 - 100 MHz	£450
TEKTRONIX	465B - 100 MHz	£500
TEKTRONIX	468 - 100 MHz Digital Storage	£850
TEKTRONIX	7834 - 400 MHz Analgoue Storage	from £750
TEKTRONIX	7704A - 300 MHz	from £650
TEKTRONIX	7613 - 100 MHz Analgoue Storage	from £400
TEKTRONIX	7844 - 400 MHz	from £750
TEKTRONIX	454 - 100 MHz	from £300
MARCONI		
TF GTA 9A	Milliwatt Power Meter	£250
TF PSU	0-30V-3A Twin	£100
TF 1313A	0.1% Universal Bridge	£100
TF 893A	AF Power Meter	£75
TF 1066B/6	FM Signal Generator	£100
TF 1073	R/F Attentuator 0-100db	£50
TF 1073A	R/F Attentuator 0-100db	£70
TF 1245	Q Meter	£250
TF 1247	20-300 MHz Oscillator	
TF 2016A	AM/FM Signal Generator 10KHz-120MHz	£175
TF 2081/4	Digital Error Detector	£250
TF 2091B	(White) Noise Generator	£250
TF 2092B	(White) Noise Receiver	£250
TF 2103	Sine/Square 10 MHz Oscillator (Battery)	£50
TF 2213/1	X-Y Display	£200
TF 2300	FM/AM Modulation Meter	£195
TF 2300B	FM/AM Modulation Meter	£200
TF 2330	Wave Analyzer 20 Hz-50 KHz	£100
TF 2370/1	110 MHz Spectrum Analyzer	£1250
TF 2432a	560 MHz Digital Frequency Meter	£200
TF 2600A	Video Voltmeter	£75
TF 2600	Sensitive Valve Voltmeter	£75
TF 2604	Electronic Voltmeter	£75
TF 2606	Differential DC Voltmeter	£75
TF 2700	Universal Bridge	£125
TF 2802/2	Pattern Generator and SLMS	£250
TF 2904	Colour Gain and Delay Test Set	£150
TF 2905/6M	Sine/Square Pulse & Bar Generator	£150
TF 2909	Grey Scale Generator	£150
TF 6057B/1	Signal Source (4-8 GHz)	£250
TF 2437	Timer/Counter 100 MHz	£150
HEWLETT PACKARD		
15520A	6 Db Hybrid (Return Loss Sheet)	£25
1600A	Logic State Analyser	£100
1615A	Logic Analysers	£200
180 TR	With 8755B - Sept Amplitude Analyser (Rack Mounted)	£350
1825 A	Time Base and Delay Generator (Scope Plug-in Unit)	£75
196A	Oscilloscope Camera	£50
3200B	VHF Oscillator 10-500 MHz	£175
3300A	Function Generator with 3305A Sweep Plug-In	
3400A	3400 a RMS Voltmeter	£150
3406A	Broadband Sampling Voltmeter	£175
3580	Spectrum Analyser 5 Hz-50 KHz	£1250
3582	Spectrum Analyser Dual Channel 25 KHz	£3K
3585	Spectrum Analyser 20 Hz-40 MHz (GPIB)	£5K
3710A	IF/Baseband Transmitter Fitted with 3716A B/B TX	£1.5K
3702B	IF/Baseband Receiver Fitted with 3705A (Differential Baseband Detector) 3710A and 3702B Make Up Microwave Link Analyser	
3730A	Down Converter with 3738A Oscillator (6.3-8.5 GHz) O/P 70 MHz.	£200
3750A	Attentuator (0-100 MHz)	£100
3762A	Data Generator	£750
3763A	Error Detector	
3964A	Instrumentation Recorder (As New Immaculate Condition)	£500
400 FL	AC Voltmeter	£150
400 F	AC Voltmeter	£150
400H	Vaccum Tube Voltmeter	£50
400E	AC Voltmeter	£150
415 E	SWR Meter	£275
4204 A	10 Hz-1 MHz Oscillator	£100
651 B	Test Oscillator 0-10 MHz	£150
8491 A	20dB Attentuator 0-12.4 GHz	£100
8620C	Sweep Oscillator (Mainframes)	£250
8690 B	Sweep Oscillator with 894A Plug-In (8-12.4GHz)	£500
8750 A	Storage Normalisers	£400
938 A	Frequency Doubler (I/P 9-13.25 GHz) (O/P 18-26.5 GHz)	£250
X752 C	10dB Directional Coupler	£100
435A	Power Meter	£450
RACAL DANA		
Series 1200	Universal Switch Controller	
11-1478	Sensing Heads	
11-1572	Sensing Heads	
845-1	1 MHz Frequency Standards Distribution Unit	
3100	Synthesizer 40-130 MHz	

5002	Wideband Level Meter	£650
5003	Digital Multimeter	£150
9000	Microprocessing Timer/Counter 500 MHz	£275
9081	Synthesized Signal Generator - 520MHz	£600
9083	2 Tone Signal Source	£225
9242D	Programmable Power Supply 25V-2A	£300
9246S	Programmable Power Supply 25V-10A	£400
9300B	RMS Voltmeter	£275
9300	RMS Voltmeter	£250
9341	LCR Databridge	£250
9500/9515	Universal Counter/Timer 512 MHz	£200
9824	UHF Frequncy Meter 0-560 MHz	£150
9839	Frequency Counter (UHF) - 560 MHz	£160
9901	50 MHz Universal Counter Timer	£100
9903	50 MHz Universal Counter Timer	£100
9905	Frequency Counter - 200 MHz	£125
99017	Frequency Meter (UHF Freq. Counter - 560 MHz)	£175
9919	Frequency Meter (UHF Freq. COunter - 1 GHz)	£275
9932	Instrument Interface	£125
9303	True RMS R/F Level Meter	£650
9475	Rubidium Frequency Std	£3.5K
9084	Synthesised Signal Gen.	£700
TEKTRONIX		
Type G	Oscilloscope Plug In Unit - Wideband Differential Calibrated Pre-Amp (as NEW)	£75
PM 104	Personality Module	£40
TM 515	Mainframe (Traveller Power Module - 5 Compartment)	£150
P 6201	Fet Probe	£100
P 6451	Data Acquisition Probes	£25
5-3A	Sampling Heads	£150
106	Square Wave Generator	£100
109	Pulse Generator	£75
191	Constant Amplitude Signal Generator (350 KHz - 100 MHz)	£100
603	Storage Monitor	£75
1921-PI	Storage Display Unit	£75
4041	Disc Drives	£50
4926	Disc Drives	£50
WANDEL AND GOLTERMANN		
AZD-1	Display Expander	£100
PRT-1	PCM Regeneration Test Set	£250
PS 12	200 Hz-6 MHz Level Oscillator	£500
PS 12	200 Hz-4.5 MHz Level Oscillator	£500
PS-60	6KHz-18.6 MHz Level Oscillator	£500
PSG-1	Test Signal Generator (TV Colour Carrier - 4.429687 MHz)	£50
RFZ-5	Reflection Co-Efficient Attachment	£75
RG-1	Noise Generator 0-100 KHz	£50
SG-3	Display Unit	£350
SPM-3	Selective Level Measuring Set	£150
SPM-60	6 KHz-18.6 MHz Level Meter	£500
SPM 12	200 Hz-6 MHz Level Meter	£500
SPM 12	200 Hz-4.5 MHz Level Meter	£500
MISCELLANEOUS		
DATRON	4700 (with OPT's 20+90) Autocall Multifunctional Calibrator	£5.5K
DATRON	1071 Autocall Digital Meter	£1.1K
DATRON	1061 Autocall Digital Meter	£850
DATRON	1051 Autocall Digital Meter	£650
DATRON	1041 Autocall Multifunctional Voltmeter	£500
ANRITSU	ME538C Microwave System Analyser	£3K
ADRET	740A Synthesizer 0-512 MHz	£1500
MARKEM	175 Hot Foil Label Printing Machine	£2500
DAYMARK	Auto Transistor Tester/Sorter Cost new £50K NOW	£6K
AVO	RM 215 - L/2 Breakdown Leakage & Ionisation Tester	£750
PULSETEK	192 Oscilloscope Calibrator (as new)	£1250
GOULD	Biomation K100-D Logic Analysers	£300
ADRET	2230A 0-1 MHz Synthesizer	£250
ADVANCE	J2 A/F Sie. Generator 15Hz - 50KHz	£100
ADVANCE	SG 68 Low Dist. Osc (0-150 KHz) Sine/Sq Wave	£150
BRADLEY	192 Oscilliscope Calibrator	£550
GALLENKAMP	300 Plus Series Thermostat/Cyclic Timer/Temp Cycling Oven	£900
FISCHER	Beta 2040/2060 Coating Thickness Computer Plus many extras all for	£2.5K
FLUKE	8010 Digital Multimeter	£125
FLUKE	931B RM Differential Voltmeter	£125
FLUKE	8922A True RMS Voltmeter	£250
HATFIELD	1015 Level Measuring Set 30 Hz-120 KHz	£150
HATFIELD	1016 Level Osc. Set 30 Hz-120 KHz	£150
PHILIPS	5167 Function Generator 1-10 MHz	£400
PROJECTINA	CH 9435 Photo Microscope	£800
SIEMENS	W2008 Level Oscillator 200 Hz-18.6 MHz	£500
SIEMENS	D2008 Level Meter 200 Hz-18.6 MHz	£500
LYONS	PG-75a Pulse Generator	£200
LYONS	PG-2b Pulse Generator	£250
MULTICORE	Universal Solderability Tester	£300
MULTICORE	Mk III Solderability Test Machine	£250
PHILIPS	8226 Six Line Pen Recorders	£250
PHILIPS	6671 High Resolution 120 MHz Counter	£150
SYSTRON DONNER	101D Pulse Generator	£125
THANDAR	TP600 Prescaler (BrandNew) will increase Freq. Range of Counter by Factor of 10	£20
TREND	1-9-1 Data Transmission Test Set	£200
WATANABE	WTR 211 3 Way Chart Recorder	£200
WAYNE KERR	TE 2090 Transducer Equipment	£100
WAYNE KERR	Autobalance Universal Bridge	£200
KIKUSUI	AVM 23/25 Dual Channel VRMS SinadDB+CAL O/P	£100
HELPER LTD	Sinadder S101 Automatic	£120
THANDAR	TF 200 + Case + (600 MHz & 1000 MHz) Prescalers	£175
NEW TOWARD LTD	8115 Digital Sweep Function Generator & Freq. Counter (with manuals)	£200
FARNELL	NO55P314 (55 watts) Switch Mode Power Supplies BRAND NEW Cost NEW £55 now Give +5V @ 3.5A +12V @ 3A-12@1A	£20

Many more items such as power supplies, multimeters & AVO's etc available.
Please send S.A.E. for details.

ALL EQUIPMENT IS USED, WITH 30 DAYS GUARANTEE.
PLEASE CHECK AVAILABILITY BEFORE ORDERING.
CARRIAGE CAN BE ARRANGED – VAT TO BE ADDED TO TOTAL PRICE OF ALL GOODS AND CARRIAGE.

SURVEILLANCE

TELEPHONE ORDERS may be made on (0442) 66551 ACCESS or VISA

ETI ELECTRONICS TODAY INTERNATIONAL

PCB Service November

Price code	Price (inc. VAT)
C	£1.80
D	£2.50
E	£3.25
F	£4.00
G	£4.75
H	£5.50
J	£6.62
K	£7.20
L	£8.80
M	£10.60
N	£13.10
O	£15.80
P	£17.90
Q	£21.80
R	£23.90
S	£25.90
T	£29.00
U	£32.20
V	£35.80
W	£37.90
X	£40.70

E9311-1 Car Alarm .... G
E9311-2 MIDI Change Pedal (Double Sided) .... H
E9311-3 RC Engine Sound .... J
E9311-4 PSU Monitor .... N
E9310-FC RF Hound .... D

PCBs for the remaining projects are available from the companies listed in Buylines.
Use the form or a photocopy for your order. Please fill out all parts of the form. Make sure you use the board reference numbers. This not only identifies the board but also tells you when the project was published. The first two numbers are the year, the next two are the month.
Terms are strictly payment with order. We cannot accept official orders but we can supply a proforma invoice if required.
Such orders will not be processed until payment is received.

E9207-FC Surround Sound Decoder .... F
E9208-1 Dynamic Noise Limiter .... F
E9208-2 Touch Controlled Intercom (2 boards) .... H
E9208-3 MIDI Keyboard .... K
E9208-FC Battery charger .... F
E9209-1 Intercom for light aircraft .... H
E9209-2 Alarm protector C
E9209-3 Temperature controller .... M
E9209-FC 45W Hybrid power amp .... F
E9210-1 Universal I/O Interface for PC (2 Sided) .... N
E2910-2 Rapid Fuse Checker .... E
E9210-3 Heartbeat/Audio Listener .... E
E9210-FC Wizards Hat .... E
E9211-1 Electronic Die .... E
E9211-FC Car Alarm .... F
E9212-1 Digital Circuit Tester .... F
E9212-2 Communications Link by RS232 L
E9212-FC Mains Inverter .... E
E9301-2 Fading Festoonery .... G
E9301-FC Infra Red Receiver .... F
E9302-1 EPROM Programmer (2 Sided) .... N
E9302-2 Sound to MIDI Board L
E9302-3 Puddle Tec .... E
E9302-4 DiscoAmiga Light Selector .... H
E9302-FC Infra Red Transmitter .... E
E9303-1 Ni-Cd Battery Charger .... E
E9303-2 IC Tester .... E
E9303-3 Disco Amiga (motor driver board) .... H
E9303-4 Direct Conversion Reciever (2 Sided) .... N
E9303-FC LED Stoboscope .... F
E9304-1 Solo Mic Pre-Amplifier .... F
E9304-2 Multimate Tester C
E9304-3 The Keepsafe Alarm .... F
E9304-4 Proving Unit .... E
E9304-5 Infra Guide Receiver Module C
E9304-6 Infra Guide Transmitter .... F
E9304-FC (AutoMate) Peak Program Meter .... F
E9305-1 Pentacode Main Board .... F
E9305-2 Pentacode Relay Board .... F
E9305-4 Vibration Detector .... D
E9305-FC The Fuzztone .... E
E9306-1 Graphic Equaliser .... F
E9306-2 Super Spooker .... H
E9306-3 Middle & Side Stereo Coding .... D
E9306-FC The Chaperon .... F
E9307-1 Car Battery Tester (Double Sided - Surface Mount) .... E
E9307-2 Mind Trainer .... F
E9307-FC Microwave Monitor .... F
E9308-1 Window Monitor (4 Boards) .... K
E9308-2 Alternative 12V Supply .... M
E9308-3 Single Channel Lumitec .... E
E9308-4 Four Channel Lumitec .... H
E9308-FC Twi-light Zone .... F
E9309-1 RF Signal Generator .... F
E9309-2 MIDI Analyser CPU Board .... K
E9309-3 MIDI Analyser Display Board .... J
E9309-4 Metronome .... G
E9310-1 Hot Wire Cutter .... F
E9310-2 Electronic Picture .... H
E9310-3 Sega Box .... J
E9310-4 Transistor Amp (2 Boards) .... N
E9310-5 Home Minder (2 Boards) .... N
E9310-FC Continuity Tester .... D

ETI PCB Service, Reader's Services, Argus House, Boundary Way, Hemel Hempstead HP2 7ST

Please Supply:

Quantity	Ref No.	Price Code	Price	Total Price
	E		£	£
	E		£	£
	E		£	£
			Post & Packing	£ 0.75
			Total Enclosed	£

Please send my PCBs to:

Name ....

Address ....

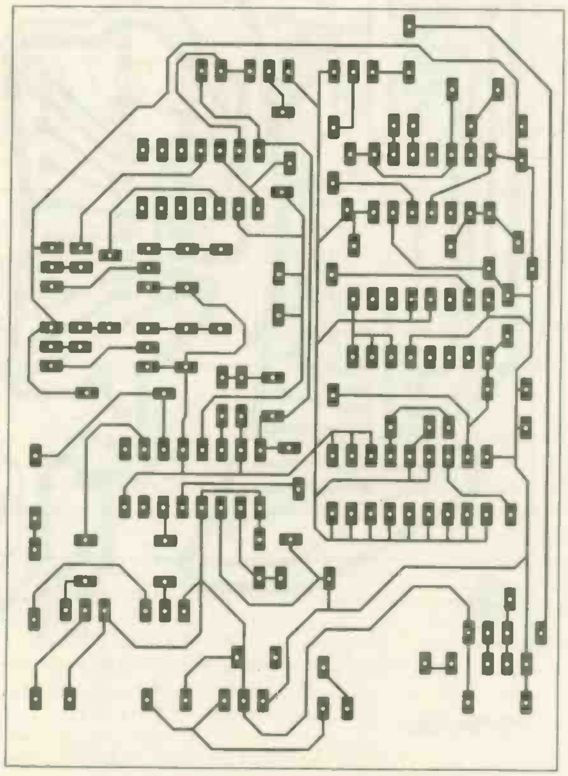
....

.... Postcode ....

CHEQUES SHOULD BE MADE PAYABLE TO ASP

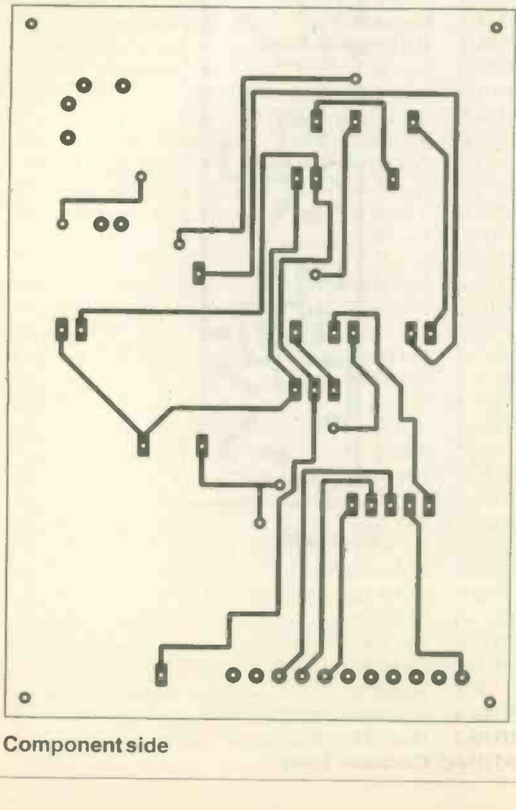
PCB Foils

The PCB foil patterns presented here are Intended as a guide only. They can be used as a template when using tape and transfer for the creation of a foil.

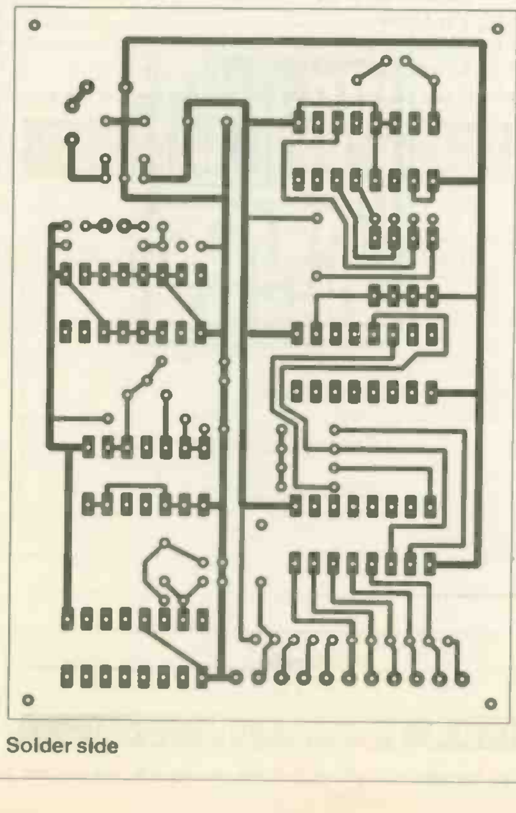


Car alarm

MIDI pedal

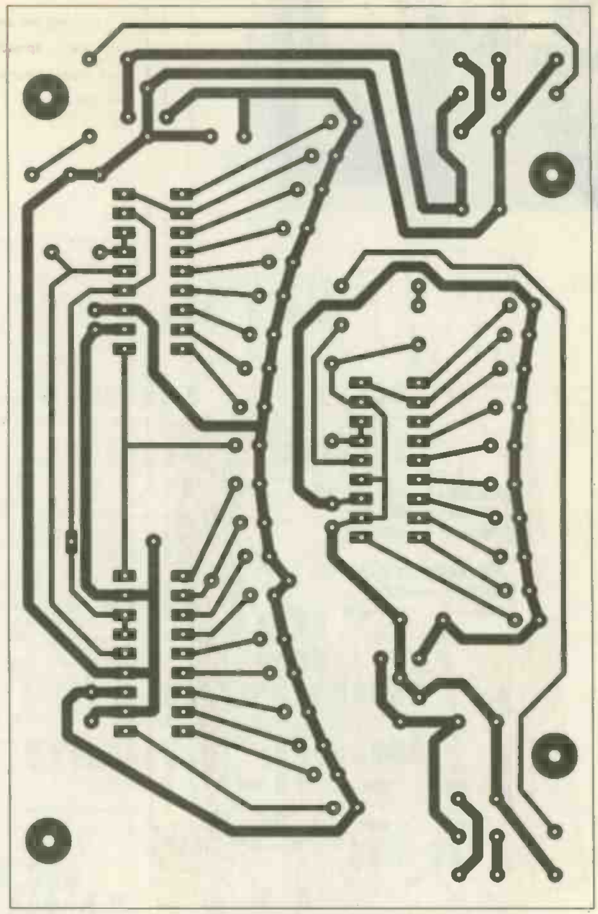


Component side

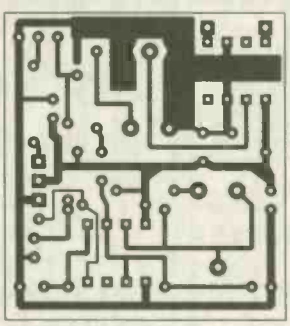


Solder side

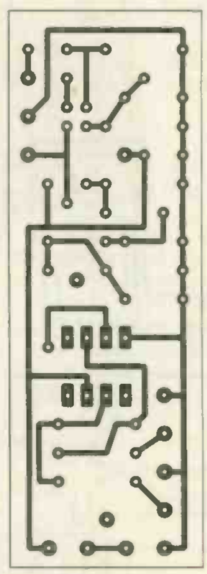
FOILS



PSU Monitor



RC Engine sound



RF Hound

ETI Classified

James Gale
0442 66551

Send your requirements to:
ETI Classified Department, ASP, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST
Lineage: 60p per word (+ VAT) (minimum 15 words)
Semi display: (minimum 2.5cms)
£8.00 + VAT per single column centimetre
Electromart £24.00 (+ VAT)
} Per Insertion

VISA
Access

Ring for information on series bookings/discounts.
All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

FOR SALE

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220/240V AC 50/60
OUTPUT 0-260V

	Price	P&P
0.5KVA 2.5 amp max	£29.00	£4.65
		(£39.54 inc VAT)
1KVA 5 amp max	£37.40	£6.25
		(£51.29 inc VAT)
2KVA 10 amp max	£54.00	£7.80
		(£72.62 inc VAT)
3KVA 15 amp max	£71.50	£7.80
		(£93.18 inc VAT)
5KVA 25 amp max	£126.50	
		(Plus Carriage)

Buy direct from the Importers. Keenest prices in the country

COMPREHENSIVE RANGE OF TRANSFORMERS-LT-ISOLATION & AUTO
(110-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

WIDE RANGE OF XENON FLASHTUBES
Write/Phone your enquiries

ULTRA VIOLET BLACK LIGHT FLOURESCENT TUBES
4ft 40 watt £12.00 (callers only) (£14.10 inc VAT)
2ft 20 watt £7.44 + £1.25 p&p (£10.21 inc VAT)
12in 8 watt £4.80 + 75p p&p (£6.52 inc VAT)
9in 6 watt £3.96 + 50p p&p (£5 24 inc VAT)
6in 4 watt £3.96 + 50p p&p (£5 24 inc VAT)

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes £6.05 + £1.40 p&p (£8.75 incl)

400 WATT UV LAMP
Only £34.00 + £2.50 p&p £42.89 inc VAT)

160 WATT SELF BALLASTED BLACK LIGHT MERCURY BULB
Available with BC or ES fitting. price inc VAT & p&p and VAT £25.55

12V D.C. BILGE PUMPS
500 GPH 15ft head 3 amp £19.98
1750 G P H 15ft head 9 amp £34.55
Also now available 24V D.C. 1750 GPH 15ft head 5 amp £35.55. All designed to be used submerged. PRICES INCLUDE P&P & VAT

EPROM ERASURE KIT
Build you own **EPROM ERASURE** for a fraction of the price of a made-up unit kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit £14.00 + £2.00 p&p (£18.80 inc VAT)

SUPER HY-LIGHT STROBE KIT
Designed for Disco, Theatrical use etc.
Approx 16 joules. Adjustable speed £50.00 + £3.00 p&p (£62.28 inc VAT)
Case and reflector £24.00 + £3.00 p&p (£31.73 inc VAT).
SAE for further details including Hy-Light and industrial Strobe Kits.

"BOFFINS SPECIAL" – UNIQUE OFFER
Surplus Precision Medical Unit. Internally in excellent condition. Designed primarily to eject a precise controllable amount of fluid from a medical syringe (latter not supplied). Contains the following removable components: Dual Micro Processor Boards and EPROMS. Escap Precision 12V DC Motor with 300.1 Gear Box and optical encoder coupled to a precision threaded drive mechanism. Mains supply with 6 x 1.5V Ni-Cad A.A. cells back-up. L.C.D. Digital read-out 17mm high with legends. Audible warning.
These are sold for the dismantling of the exceptional quality components. Regret no Circuits available
Ridiculously low price: £16.00 + £4.00 p&p
(£23.50 incl VAT).

12V D.C. GEARED MOTOR
12V D.C. Reversible precision-built Motor Output speeds no load approx. 12V-26 rpm: 9V-20 rpm: 6V-12 rpm. Will work at lower voltages and still retain a reasonable torque. Ideal for robotics etc. Size: L. 40mm. W. 29 mm. H. 39mm. Shaft: 3mm dia x 10mm long. Price: £8.00 + 50p p&p (£10.00 inc. VAT)

TORIN CENTRIFUGAL BLOWER
230V AC. 2,800 RPM, 0.9 amp, 130mm diameter, impellor outlet 63 x 37mm, overall size 195 x 160 x 150mm long. Price £17.50 + £2.50 p&p (£23.50 inc. VAT)

SOLID STATE RELAY
7 amp « 240V. A.C. when mounted on suitable Heatsink. Can be driven from T.T.L. or Computer output between 3-10V D.C. Size: 24mm x 17mm x 15mm high. Fixing centres 30mm (TO-3). Price: £3.00 + 40p p&p (£4.00 inc. VAT)

GEARED MOTORS
71 RPM 20lb inch torque reversable 115V AC input including capacitor and transformer for 240V AC operation. Price inc VAT & p&p £23.50.

SOLID STATE EHT UNIT
Input 230/240V AC. Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec. 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, eg supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.81 inc VAT) NMS

SAVE POUNDS!!!
Build your own forged bank note detector. Can detect counterfeits amongst a quantity of notes. Complete kit of parts less case. 240V a.c. including 5" uV black light tube, starter and holder, a pair b1 - pin tube holders. Total price including p&p & VAT only £13.99

WASHING MACHINE WATER PUMP
Brand new 240V AC fan cooled. Can be used for a variety of purposes. Inlet 1 1/2 in. outlet 1 in. dia. Price includes p&p & VAT. £11.20 each or 2 for £20.50 inclusive

MICROSWITCH
Pye 15 amp changeover lever microswitch, type S171
Brand new price 5 for £7.05 inc VAT & p&p

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
FAX 081 995 0549 081-995 1560
ACCOUNT CUSTOMERS MIN. ORDER £10
Showroom open Monday/Friday
VISA
Ample Parking Space

CATALOGUE £1.00 + 25p P&P

LEDs 3mm or 5mm red or green .... 6p each yellow 11p each
High intensity red, green or yellow 5mm .... 30p each
Cable ties 1p each £5.95 per 1000 £49.50 per 10,000
Stepping motor 4 phase 12v 7.5 step 50 ohms £8.95
SAA1027 stepping motor driver chip £3.95
FM Transmitter kit good quality sound £8.50
High quality photo resist copper clad epoxy glass boards

Dimensions	single sided	double sided
3x4inches	£0.95	£1.07
4x8 inches	£2.40	£2.68
6x12 inches	£5.37	—
12x12 inches	£10.66	—

Special Offers
Computer grade capacitors with screw terminals 38000uf 20v £2.50
87000uf 10v £1.95, 68000uf 15v £2.95, 10000uf 16v £1.50
7 segment common anode led display 12mm £0.45
LM2931AT5.0 low drop out 5v regulator TO220 package £0.85
BS250 P channel mosfet £0.45, BC559 transistor £3.95 per 100
74LS05 hex invertor £10.00 per 100, used 8748 Microcontroler £3.50
TV Mains switch 4A double pole with momentry contacts for remote control pack of 10 £3.95 box of 60 £19.95
DC-DC convertor Reliability model V12P5 12v in 5v 200ma out 300v input to output isolation with data £4.95 each or pack of 10 £39.50
Hour counter used 7 digit 240v ac 50Hz £1.45
Resistor pack 2500 resistors 1/8-2W 50 different values £8.95
QWERTY keyboard 58 keygood quality switches new £5.00
QWERTY keyboard with serial output no data (used) £5.00
Wide range of CMOS TTL 74HC 74F Linear Transistors kits rechargable batteries capacitors tools etc always in stock. Please add 95p towards P&P vat included

JPG ELECTRONICS
276-278 Chatsworth Road Chesterfield S40 2BH
Access/Visa Orders (0246) 211202 callers welcome

!!!! ON OFFER THIS MONTH !!!!

Red Super Led 5mm	15p	Crystal Earphone	65p
IR Receiver	20p	Neon Bulb	
0.1uF X rated	65p	25OAC	15p
0.1 Poly	5p	BO332 PNP Darl	40p
33uF 16v RAD	10p	BC639 100V 1A	30p
47uF 35v RAD	10p	LM337 VREG	45p
4.7uF 16v RAD	10p	LM7924 VREG	45p
2.2uF Non Pol	30p	2718 Eprom	£1.00
25OuF 16v RAD	10p	2732 Eprom	£1.65
27OOpF 1% Tol	10p	Contact Restorer	£1.25
Contact Cleaner	£1.25		
Flux-Off	£1.25		
2pf-26pF	65p	2pf-10pf Trim	40p
IN4001	6p	Tilt Switch	£1.00
47uF 350v DC	45p	4Way Tilt SW	£2.95
74HC75	30p	5 Watt 300 OHM	10p
Crystal 45Mhz	40p	20Ouf 300V DC	85p

STRIP OF ASSORTEO COMPONENTS 1M LENGTH £1.
WIDE RANGE OF ELECTRONIC COMPONENTS ALWAYS IN STOCK RING FOR DETAILS
- FM TRANSMITTERS ALSO IN STOCK -

ELEY ELECTRONIC LTD
100-104 BEATRICE ROAD, LEICESTER, LE3 9FF
TEL: 0533 515944
PAY BY:- VISA/ACCESS
OPEN 10-6 MON-SAT

SWC SCIENTIFIC WIRE COMPANY

ENAMELLED COPPER WIRE
TINNED WIRE SILVER
PLATED COPPER WIRE
SOLDER EUREKA WIRE
NICKEL CHROME WIRE.
BRASS WIRE LI TZ WIRE
BIFILAR WIRE MANGANIN
WIRE TEFZEL WIRE NICKEL
SAE BRINGS LIST 18 RAVEN RD LONDON E18 1HW
FAX 081 559 1114

FREE REGULATED POWERSUPPLY 9-25vDC+LED Auto Cut out + 12 project cat. £1 p&p K.I.A. 1 Regent Rd, Ilkley. Stereoamps 40w +6 bar equaliser. 240 volt £17. Poweramps 100w/£9.

PC STORAGE SCOPE. Turn your PC into a 4 channel digital storage scope variable timebase & triggers, 1 shot or real time mode. Measures up to 25kHz depending on PC speed. Requires VGA. £16.50 Tel: 0453 835692 24hrs.

BARCLAYCARD VISA

COOKE INTERNATIONAL
SUPPLIER OF QUALITY USED TEST INSTRUMENTS

ANALYSERS, BRIDGES, CALIBRATORS, VOLTMETERS, GENERATORS, OSCILLOSCOPES, POWER METERS. ETC
ALWAYS AVAILABLE

ORIGINAL SERVICE MANUALS FOR SALE
COPY SERVICE ALSO AVAILABLE

EXPORT, TRADE AND U.K. ENQUIRIES WELCOME
SEND LARGE S.A.E. FOR LISTS OF EQUIPMENT AND MANUALS
ALL PRICES EXCLUDE VAT AND CARRIAGE
DISCOUNT FOR BULK ORDERS SHIPPING ARRANGED

OPEN MONDAY TO FRIDAY 9AM - 5PM
COOKE INTERNATIONAL
ELECTRONIC TEST & MEASURING INSTRUMENTS
Unit Four, Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex, PO22 0EB Tel (+ 44) 0243 545111/2 Fax + 44) 0243 542457

ELECTROMART

LIVERPOOL

PROGRESSIVE RADIO
87/93 Dale Street
Tel: 051 236 0982 051 236 0154
47 Whitechapel
Tel: 051 236 5489
Liverpool 2
'THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9.30-5.30

"BUGS....Do you need a circuit for a bug? Dozens of circuits available, from very basic to crystal control. We also specialise in unusual & interesting circuits.
Ready Built Bugs available ex-stock. We are cheaper than ANY other company for ready made Bugs. In fact we sell ready made bugs cheaper than our rivals are able to sell identically in kit form. Miniaturisation is our speciality.
Free lists available. Send S.A.E. to: Gainsford Electronics, 71 Gainsford Road, Bitterne, Southampton. SO2 7AW.

PLANS

ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teslas, surveillance devices, pyrotechnics and computer graphics tablet. 150 projects. For catalogue. SAE to Plancentre Publications, Unit 7, Old Wharf Industrial Estate, Dymock Road, Ledbury, Herefordshire, HR8 2HS.

TO ADVERTISE TELEPHONE JAMES GALE ON 0442 66551

WANTED

SURPLUS COMPONENTS WANTED

☆ COMPLETE CLEARANCE
☆ BEST PRICES PAID
☆ PCB BOARDS POPULATED

CONTACT
D.T.S. SERVICES
Tel: (0602) 208955
or Fax: (0602) 484530

TURN YOUR SURPLUS TRANSISTORS, ICS ETC INTO CASH immediate settlement.
We also welcome the opportunity to quote for complete factory clearance.
Contact:
COLES-HARDING & CO.
Sandall Road, Wisbech, Cambs PE13 2PS
BUYERS OF SURPLUS INVENTORY ESTABLISHED OVER 15 YEARS
Tel: 0945 584188
Fax: 0945 475216

ETI/POWERTRAIN VOCODER main PCB foil pattern wanted. Hallvard Tangeraas, Fjellhaug, Sinsenveien 15, 0572 Oslo, Norway

COMPONENTS

ELECTRONIC components clearance sale. Resistors, Transistors, I.C.'s etc. Foir a FREE catalogue phone 0992 582710.

FOR DETAILS OF ADVERTISING RATES TELEPHONE 0442 66551

KITS

NEW VHF MICROTRANSMITTER KIT tuneable 70-115MHz, 500 metre range, sensitive electret microphone, high quality PCB, SPECIAL OFFER complete kit ONLY £5.95 assembled and ready to use £9.95 inclusive P&P. 3 Watt FM transmitter kit £15.95 Credit card orders telephone 021 486 3092 Cheques/PO's to: Quantek Electronics, (DEPT ETI) 3 Houldey Rd, Birmingham, B31 3HL. Send 2 x 1st Class stamps for details of these and other kits.

BASIKITS for beginners from multivibrators to radios. S.A.E. for details. 23 Gloucester Avenue, Margate, Kent.

COURSES

Start training now for the following courses. Send for our brochure — without obligation or Telephone us on 0626 779398 ETI 11/93

Name ______________________

☐ Telecomms Tech C&G 271
☐ Radio Amateur Licence C&G
☐ Micro-processor
☐ Introduction to Television

Radio & Telecommunications Correspondence School
12 Moor View Drive, Teignmouth, Devon TQ14 9UN

TO ADVERTISE TELEPHONE JAMES GALE ON 0442 66551

ETI

ELECTRONICS TODAY INTERNATIONAL
CLASSIFIED ADVERTISEMENT DEPARTMENT
ARGUS HOUSE, BOUNDARY WAY, HEMEL HEMPSTEAD HP2 7ST

Rates: Lineage 55p per word + VAT minimum 15 words.
Semi-display £14.00 per single column cm plus VAT. No reimbursement for cancellations. All ads must be pre-paid.

Name ....
Address ....
.... Daytime Tel. No: ....
Signature .... Date ....
PLEASE DEBIT MY ACCESS/BARCLAYCARD No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ Expiry Date ....

☐ **FOR SALE** ☐ **COMPONENTS** ☐ **PLANS** ☐ **OTHERS STATE**

OPEN FORUM

Electronics Today International has been published for nearly 23 years and, in the course of that time has informed, led and inspired countless numbers of readers across the world. Readers who are interested in electronics and technology. Readers who want to be part of the future.

Under ETI's guidance, such readers built computers before IBM even thought of the PC. They investigated the potential of new integrated circuits before they found their way into consumer products. They dreamt of using technology to make their fortunes or just to make the world a better place.

Technology as we know it today, of which electronics is a major part, represents the very frontier of human endeavour, a frontier which is daily being pushed ever forward into the future, along a path which started fifty thousand years ago with the makers of simple stone tools. But readers of magazines like ETI do not want to remain in the past, they want to be part of the future, part of that onward rolling wave of advancement.

This desire shows clearly in readership surveys. Over 70% of our readers have their own personal computer, an overwhelming majority are avid viewers of programmes such as Tomorrow's World and a great many are readers of magazines such as New Scientist.

As the new editor of ETI, I see it as both my own, and the magazine's, duty to be there with our readers at the leading edge of technology. To share in the excitement and the opportunity that goes hand in hand with leading edge developments, while at the same time showing how such technology can be used in a socially responsible manner to create a better world for everyone. Along with this, we must retain the unique practical element which has distinguished ETI from other magazines.

We will be looking at the electronics involved in advanced computer designs, as well as using electronics to help the disadvantaged. We will be looking at ways of using technology to improve the environment, at alternative energy sources and measurement of environmental change. We will be looking at the use of electronics in schools and education, as well as continuing the tradition of informing our readers of new ideas and inspiring them to create new ideas of their own.

We will also be improving the practical side of the magazine by commissioning new projects from some of the best writers and designers in the country. Projects which can be built by our readers without having to have any more than a basic set of tools and equipment. Projects which can be built on a budget, but at the same time provide devices which are not readily available and which will be useful in the home, at work, or in the laboratory.

Because so many of our readers have their own computer, we will also be looking at ways in which readers can use this technology to assist them in their work with electronics. We will be looking at new software for electronics engineers and at ways in which your computer can be turned into a range of different pieces of test equipment. We will also be looking at the use of microprocessors and microcontrollers in electronics applications and the software needed to make them work.

We will be introducing, in the next issue, a computer conference system which will enable any reader with a PC and a modem to communicate with other like minded individuals around the world. A system which will enable participants to swap ideas, seek help, find that unusual component, data sheet, or piece of equipment, download free software, access vast databases and of course download the CAD files and any related software from ETI projects.

The ETI computer based conference system is the modern way for enthusiasts to talk to enthusiasts. ETI readers will thus have access to a 24 hour, 7 day a week, direct line to us and to all the other readers. With the ETI conference system you need never be alone!

In fact, communication between readers is a primary function of a magazine like ETI. We rely on you, our readers, for letters, projects and information about what is happening in some of the more obscure areas of technology. If you have a good idea, or have developed an interesting project then let us know and you too could be a project author. Let us know what you think of the magazine as well, what articles you would like to read, what projects you would like to make. Without such interaction we can not guarantee to always give you the of magazine that you want.

What we at ETI want to do is to keep on going from strength to strength, increasing readership and the quality of the contents, for at least another 23 years. To keep our readers up to date with the latest developments in electronics and encourage them to make things and carry out experiments using these latest techniques. To provide our readers who are involved in the industry and in education, with useful ideas which can be used to make development work easier. Above all, we want to live up to the claim on our front cover - that we bring you, our readers, tomorrow's technology today.

Nick Hampshire

ETI

ELECTRONICS TODAY INTERNATIONAL

EDITORIAL
Editor *Nick Hampshire*
Sub Editor *Jim Bluck*

CREATIVE
Art Editor *Peter Kirby*
Designer *Iain Houston*
Technical Illustration *John Puczynski*
Photography *Manny Cefai*

ADVERTISEMENT SALES
Display Sales
Tony Hill
Advertisement Copy Control
Marie Quilter
Classified Sales
James Gale

MANAGEMENT
Managing Director
Terry Pattisson
Circulation & Promotions Manager
Debra Stupple
Production Manager
Tony Dowdeswell
Group Editor
Stuart Cooke
Group Advertisement Manager
Claire Jenkinson

ABC CONSUMER PRESS

ISSN 0142-7229

Subscription rates...UK £23.40 Europe £29.50 Sterling Overseas £31.00 US Dollars Overseas $56.00

Published by Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead HP2 7ST. Telephone (0442) 66551. UK newstrade distribution by SM Distribution Ltd, 6 Leigham Court Road, London SW16 2PG. Telephone 081-667 8111. Overseas and non-newstrade sales by Magazine Sales Department, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST. Telephone (0442) 66551. Subscriptions by Argus Subscription Services, ETI, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. Telephone (0737) 768611. US subscriptions by Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA90505 USA. For Visa/Mastercard orders in USA - Telephone (310) 375 6258 Fax (310) 375 0548. Pacific Time: 9am-9pm Weekdays. 10am-6pm Weekends. Typesetting and origination by Ebony, Liskeard, Cornwall. Printed by Wiltshire Ltd. Bristol.

AN Argus SPECIALIST PUBLICATION

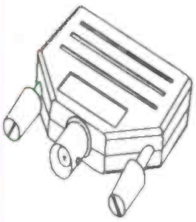
Argus House, Boundary Way, Hemel Hempstead HP2 7ST
Telephone (0442) 66551
Fax (0442) 66998

Low cost data acquisition for IBM PCs & compatibles...

A unique range of low cost data acquisition products for IBM PCs and compatibles. Installed in seconds they simply plug directly into either the serial or parallel port. They are completely self contained, require no external power supply and take up no expansion slots.

Each device comes with an easy to use software package (PicoScope, PicoLog or both). C, Pascal, and Basic drivers are supplied for those who want to develop their own software, as is a manual giving full details of the hardware and software. All software supplied on 3.5" disk.

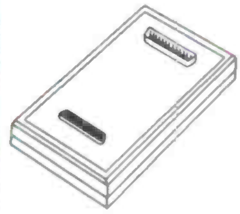
ADC-10



- Up to 24kHz sampling rate from a 386/33MHz machine
- 0-5V Input range
- BNC input connector allows use of standard scope probes
- 30V overload protection
- Parallel port connection
- Includes PicoScope software

Single Channel 8 bit ADC £49

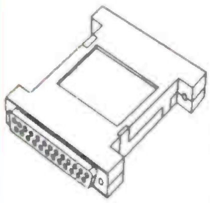
ADC-16



- Software selectable single ended or differential inputs
- Resolution programmable between 8 and 16 bits + sign
- ±2.5V input range
- 5V reference output
- Connects to serial port
- Includes PicoLog software

8 Channel 16 bit + sign ADC £99

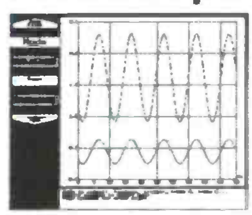
ADC-11



- 15K samples per second
- 0-2.5V Input range
- Digital output
- D25 input connector
- 30V overload protection
- Parallel port connection
- Includes both PicoScope and PicoLog software

11 Channel 10 bit ADC £75

PicoScope

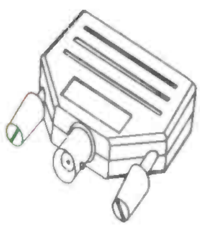


Scope, voltmeter, spectrum analyser

'Virtual instrument' software package for the ADC-10, ADC-11 and ADC-12.

Storage oscilloscope with trigger and timebase. Traces can be printed and saved. Multiple meters on screen. Real time spectrum analysis.

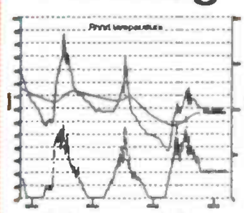
ADC-12



- Up to 18kHz sampling rate
- 0-5V Input range
- BNC input connector allows use of standard scope probes
- 30V overload protection
- Parallel port connection
- Includes both PicoScope and PicoLog software

Single Channel 12 bit ADC £85

PicoLog



Advanced data logging software

Collect samples from 1 per ms to one per day. Scale samples linearly, by equation or by table look-up. Graphical (against time or XY) and text reports can be displayed, printed or exported.

Picolog is also available for the ADC-10: call for details.

Typical application	ADC-10	ADC-11	ADC-12	ADC-16
Oscilloscope	●	●	●	
Voltmeter	●	●	●	●
Spectrum analyser	●	●	●	
Audio sampling	●		●	
Chart recorder emulation		●		●
Temperature measurement	●	●	●	●
Pressure measurement	●	●	●	●
Chromatography				●
Automotive monitoring		●		●
Medical research		●	●	●
Education	●	●	●	●

PICO BENEFITS

- 30 day no quibble money back policy
- Full 1 year guarantee
- 1 year's free software upgrades
- Free technical support
- Free user newsletter
- Same day dispatch

PICO TECHNOLOGY

VISA

Pico Technology Ltd. Broadway House, 149-151 St Neots Road, Hardwick, Cambridge. CB3 7QJ.

TEL: 0954-211716 FAX: 0954-211880

Phone or FAX for sales, ordering information, data sheets, technical support. All prices exclusive of VAT.